L-SHAPLEY AND C-SHAPLEY: EFFICIENT MODEL INTERPRETATION FOR STRUCTURED DATA

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ABSTRACT

Instancewise feature scoring is a method for model interpretation, which yields, for each test instance, a vector of importance scores associated with the feature vector. Methods based on the Shapley score have been proposed as a fair way of computing feature attributions of this kind, but incur an exponential complexity in the number of features for black-box models. This combinatorial explosion arises from the definition of the Shapley value and prevents these methods from being scalable to large data sets and complex models. We focus on settings in which the data have a graph structure, and the contribution of features to the target variable is well-approximated by a graph-structured factorization. In such settings, we develop two algorithms with linear complexity for instancewise feature importance scoring on black-box models. We establish the relationship of our methods to the Shapley value and a closely related concept known as the Myerson value from cooperative game theory. We demonstrate on both language and image data that our algorithms compare favorably with other methods for model interpretation.

1 INTRODUCTION

Although many black box machine learning models, such as random forests, deep neural networks, and kernel methods, can produce highly accurate prediction in many applications, such prediction often comes at the cost of interpretability. Ease of interpretation is a crucial criterion when these tools are applied in areas such as medicine, financial markets, and criminal justice; for more background, see the discussion paper by Lipton (2016) as well as references therein.

In this paper, we study instancewise feature importance scoring as a specific approach to the problem of interpreting the predictions of black-box models. Given a predictive model, such a method yields, for each instance to which the model is applied, a vector of importance scores associated with the underlying features. The instancewise property means that this vector, and hence the relative importance of each feature, is allowed to vary across instances. Thus, the importance scores can act as an explanation for the specific instance, indicating which features are the key for the model to make its prediction on that instance.

There is now a large body of research focused on the problem of scoring input features based on the prediction of a given instance (see, e.g., Shrikumar et al., 2017; Bach et al., 2015; Ribeiro et al., 2016; Lundberg & Lee, 2017; Štrumbelj & Kononenko, 2010; Baehrens et al., 2010; Datta et al., 2016; Sundararajan et al., 2017). Of most relevance to this paper is a line of recent work (Štrumbelj & Kononenko, 2010; Lundberg & Lee, 2017; Datta et al., 2016) that has developed methods for model interpretation based on Shapley value (Shapley, 1953) from cooperative game theory. The Shapley value was originally proposed as an axiomatic characterization of a fair distribution of a total surplus from all the players, and can be applied to predictive models, in which case each feature is modeled as a player in the underlying game. While the Shapley value approach is conceptually appealing, it is also computationally challenging: in general, each evaluation of a Shapley value requires an exponential number of model evaluations. Different approaches to circumventing this complexity barrier have been proposed, including those based on Monte Carlo approximation (Štrumbelj & Kononenko, 2010; Datta et al., 2016) and methods based on sampled least-squares with weights (Lundberg & Lee, 2017).

In this paper, we take a complementary point of view, arguing that the problem of explanation is best approached within a model-based paradigm. In this view, explanations are cast in terms of a model,

which may or may not be the same model as used to fit the data. Criteria such as Shapley value, which are intractable to compute when no assumptions are made, can be more effectively computed or approximated within the framework of a model. We focus specifically on settings in which a graph structure is appropriate for describing the relations between features in the data (e.g., chains for sequences and grids for images), and distant features according to the graph have weak interaction during the computation of Shapley values. We propose two methods for instancewise feature importance scoring in this framework, which we term *L-Shapley* and *C-Shapley*; here the abbreviations "L" and "C" refer to "local" and "connected," respectively. By exploiting the underlying graph structure, the number of model evaluations is reduced to linear—as opposed to exponential—in the number of features. We demonstrate the relationship of these measures with a constrained form of Shapley value, and we additionally relate C-Shapley with another solution concept from cooperative game theory, known as the Myerson value (Myerson, 1977). The Myerson value is commonly used in graph-restricted games, under a local additivity assumption of the model on disconnected subsets of features. Finally, we apply our feature scoring methods to several state-of-the-art models for both language and image data, and find that our scoring algorithms compare favorably to several existing sampling-based algorithms for instancewise feature importance scoring.

2 Background and preliminaries

We begin by introducing some background and notation for instancewise feature importance scoring and the Shapley value.

2.1 Importance of a feature subset

We are interested in studying models that are trained to perform prediction, taking as input a feature vector $x \in \mathcal{X} \subset \mathbb{R}^d$ and predicting a response or output variable $y \in \mathcal{Y}$. We assume access to the output of a model via a conditional distribution, denoted by $\mathbb{P}_m(\cdot|x)$, that provides the distribution of the response $Y \in \mathcal{Y}$ conditioned on a given vector $X = x$ of inputs. For any given subset $S \subset \{1, 2, \ldots, d\}$, we use $x_S = \{x_j, j \in S\}$ to denote the associated sub-vector of features, and we let $\mathbb{P}_m(Y \mid x_S)$ denote the induced conditional distribution when $\mathbb{P}_m$ is restricted to using only the sub-vector x_S. In the corner case in which $S = \emptyset$, we define $\mathbb{P}_m(Y \mid x_\emptyset) := \mathbb{P}_m(Y)$. In terms of this notation, for a given feature vector $x \in \mathcal{X}$, subset S and fitted model distribution $\mathbb{P}_m(Y \mid x)$, we introduce the *importance score*

$$v_x(S) := \mathbb{E}_m \left[-\log \frac{1}{\mathbb{P}_m(Y \mid x_S)} \;\middle|\; x \right],$$

where $\mathbb{E}_m[\cdot \mid x]$ denotes the expectation over $\mathbb{P}_m(\cdot \mid x)$. The importance score $v_x(S)$ has a coding-theoretic interpretation: it corresponds to the negative of the expected number of bits required to encode the output of the model based on the sub-vector x_S. It will be zero when the model makes a deterministic prediction based on x_S, and larger when the model returns a distribution closer to uniform over the output space.

There is also an information-theoretic interpretation to this definition of importance scores, as discussed in Chen et al. (2018). In particular, suppose that for a given integer $k < d$, there is a function $x \mapsto S^*(x)$ such that, for all almost all x, the k-sized subset $S^*(x)$ maximizes $v_x(S)$ over all subsets of size k; then we are guaranteed that the mutual information $I(X_{S^*(X)}, Y)$ between $X_{S^*(X)}$ and Y is maximized, over any conditional distribution that generates a subset of size k given X. The converse is also true.

In many cases, class-specific importance is favored, where one is interested in seeing how important a feature subset S is to the predicted class, instead of the prediction as a conditional distribution. In order to handle such cases, it is convenient to introduce the degenerate conditional distribution

$$\hat{\mathbb{P}}_m(y \mid x) := \begin{cases} 1 \text{ if } y \in \arg\max_{y'} \mathbb{P}_m(y' \mid x), \\ 0 \text{ otherwise.} \end{cases}$$

We can then define the importance of a subset S with respect to $\hat{\mathbb{P}}_m$ using the modified score

$$v_x(S) := \hat{\mathbb{E}}_m \left[-\log \frac{1}{\mathbb{P}_m(Y \mid x_S)} \;\middle|\; x \right],$$

which is the expected log probability of the predicted class given the features in S.

Estimating the conditional distribution: In practice, we need to estimate—for any given feature vector $\bar{x} \in \mathcal{X}$—the conditional probability functions $\mathbb{P}_m(y \mid \bar{x}_S)$ based on observed data. Past work has used one of two approaches: either estimation based on empirical averages (Štrumbelj & Kononenko, 2010), or plug-in estimation using a reference point (Datta et al., 2016; Lundberg & Lee, 2017).

Empirical average estimation: In this approach, we first draw a set of feature vector $\{x^j\}_{j=1}^M$ by sampling with replacement from the full data set. For each sample x^j, we define a new vector $\tilde{x}^j \in \mathbb{R}^d$ with components

$$(\tilde{x}_j)_i = \begin{cases} \bar{x}_i & \text{if } i \in S, \text{ and} \\ x_i^j & \text{otherwise.} \end{cases}$$

Taking the empirical mean of $\mathbb{P}_m(y \mid \tilde{x}^j)$ over $\{\tilde{x}^j\}$ then provides an estimate of $\mathbb{P}_m(y \mid \bar{x}_S)$.

Plug-in estimation: In this approach, the first step is to specify a reference vector $x^0 \in \mathbb{R}^d$ is specified. We then define the vector $\tilde{x} \in \mathbb{R}^d$ with components

$$(\tilde{x})_i = \begin{cases} \bar{x}_i & \text{if } i \in S, \text{ and} \\ x_i^0 & \text{otherwise.} \end{cases}$$

Finally, we use the conditional probability $\mathbb{P}_m(y \mid \tilde{x})$ as an approximation to $\mathbb{P}_m(y \mid \bar{x}_S)$. The plug-in estimate is more computationally efficient than the empirical average estimator, and works well when there exist appropriate choices of reference points. We use this method for our experiments, where we use the index of padding for language data, and the average pixel strength of an image for vision data.

2.2 Shapley value for measuring interaction between features

Consider the problem of quantifying the importance of a given feature index i for feature vector x. A naive way of doing so would be by computing the importance score $v_x(\{i\})$ of feature i on its own. However, doing so ignores interactions between features, which are likely to be very important in applications. As a simple example, suppose that we were interested in performing sentiment analysis on the following sentence:

It is not heartwarming or entertaining. It just sucks. ($\star$)

This sentence is contained in a movie review from the IMDB movie data set (Maas et al., 2011), and it is classified as negative sentiment by a machine learning model to be discussed in the sequel. Now suppose we wish to quantify the importance of feature "*not*" in prediction. The word "*not*" plays an important role in the overall sentence as being classified as negative, and thus should be attributed a significant weight. However, viewed in isolation, the word "*not*" has neither negative nor positive sentiment, so that one would expect that $v_x(\{\text{“}\textit{not}\text{”}\}) \approx 0$.

Thus, it is essential to consider the interaction of a given feature i with other features. For a given subset S containing i, a natural way in which to assess how i interacts with the other features in S is by computing the difference between the importance of all features in S, with and without i. This difference is called the *marginal contribution* of i to S, and given by

$$m_x(S, i) := v_x(S) - v_x(S \setminus \{i\}). \tag{1}$$

In order to obtain a simple scalar measure for feature i, we need to aggregate these marginal contributions over all subsets that contain i. The *Shapley value* (Shapley, 1953) is one principled way of doing so. For each integer $k = 1, \ldots, d$, we let $\mathcal{S}_k(i)$ denote the set of k-sized subsets that contain i. The Shapley value is obtained by averaging the marginal contributions, first over the set $\mathcal{S}_k(i)$ for a fixed k, and then over all possible choices of set size k:

$$\phi_x(\mathbb{P}_m, i) := \frac{1}{d} \sum_{k=1}^{d} \frac{1}{\binom{d-1}{k-1}} \sum_{S \in \mathcal{S}_k(i)} m_x(S, i). \tag{2}$$

Since the model $\mathbb{P}_m$ remains fixed throughout our analysis, we frequently omit the dependence of ϕ_x on $\mathbb{P}_m$, instead adopting the more compact notation $\phi_x(i)$.

The concept of Shapley value was first introduced in cooperative game theory (Shapley, 1953), and it has been used in a line of recent work on instancewise feature importance ranking (Štrumbelj & Kononenko, 2010; Datta et al., 2016; Lundberg & Lee, 2017). It can be justified on an axiomatic

basis (Shapley, 1953; Young, 1985) as being the unique function from a collection of 2^d numbers (one for each subset S) to a collection of d numbers (one for each feature i) with the following properties: (i) [Additivity] The sum of the Shapley values $\sum_{i=1}^{d} \phi_x(i)$ is equal to the difference $v_x(\{1,\ldots,d\}) - v_x(\emptyset)$. (ii) [Equal contributions] If $v_x(S \cup \{i\}) = v_x(S \cup \{j\})$ for all subsets S, then $\phi_x(i) = \phi_x(j)$. (iii) [Monotonicity] Given two models $\mathbb{P}_m$ and $\mathbb{P}_m$, let m_x and m'_x denote the associated marginal contribution functions, and let ϕ_x and ϕ'_x denote the associated Shapley values. If $m_x(S,i) \geq m'_x(S,i)$ for all subsets S, then we are guaranteed that $\phi_x(i) \geq \phi'_x(i)$. Note that all three of these axioms are reasonable in our feature selection context.

2.3 The challenge with computing Shapley values

The exact computation of the Shapley value $\phi_x(i)$ takes into account the interaction of feature i with all 2^{d-1} subsets that contain i, thereby leading to computational difficulties. Various approximation methods have been developed with the goal of reducing complexity. For example, Štrumbelj & Kononenko (2010) proposed to estimate the Shapley values via a Monte Carlo approximation built on an alternative permutation-based definition of the Shapley value. Lundberg & Lee (2017) proposed to evaluate the model over randomly sampled subsets and use a weighted linear regression to approximate the Shapley values based on the collected model evaluations.

In practice, such sampling-based approximations may suffer from high variance when the number of samples to be collected per instance is limited. For large-scale predictive models, the number of features is often relatively large, meaning that the number of samples required to obtain stable estimates can be prohibitively large. The main contribution of this paper is to address this challenge in a model-based paradigm, where the contribution of features to the response variable respects the structure of an underlying graph. In this setting, we propose efficient algorithms and provide bounds on the quality of the resulting approximation. As we discuss in more detail later, our approach should be viewed as complementary to sampling-based or regresssion-based approximations of the Shapley value. In particular, these methods can be combined with the approach of this paper so as to speed up the computation of the L-Shapley and C-Shapley values that we propose.

3 Methods

In many applications, the features can be associated with the nodes of a graph, and we can define distances between pairs of features based on the graph structure. Intuitively, features distant in the graph have weak interactions with each other, and hence excluding those features in the computation of Shapley value has little effect. For instance, each feature vector x in sequence data (such as language, music etc.), can be associated with a line graph, where positions too far apart in a sequence may not affect each other in Shapley value computation; similarly, each image data is naturally modeled with a grid graph, such that pixels that are far apart may have little effect on each other in the computation of Shapley value.

In this section, we propose modified forms of the Shapley values, referred to as L-Shapley and C-Shapley values, that can be computed more efficiently than the Shapley value by excluding those weak interactions in the structured data. We also show that under certain probabilistic assumptions on the marginal distribution over the features, these quantities yield good approximations to the original Shapley values.

More precisely, given feature vectors $x \in \mathbb{R}^d$, we let $G = (V, E)$ denote a connected graph with nodes V and edges $E \subset V \times V$, where each feature i is associated with a a node $i \in V$, and edges represent interactions between features. The graph induces a distance function on $V \times V$, given by

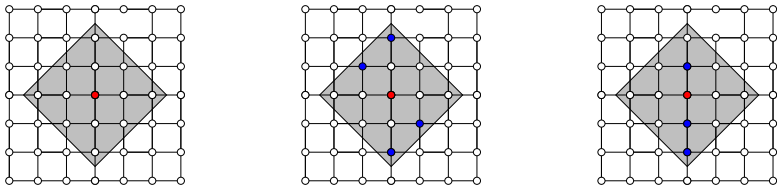
$$d_G(\ell, m) = \text{number of edges in shortest path joining } \ell \text{ to } m. \tag{3}$$

In the line graph, this graph distance corresponds to the number of edges in the unique path joining them, whereas it corresponds to the Manhattan distance in the grid graph. For a given node $i \in V$, its *k-neighborhood* is the set

$$\mathcal{N}_k(i) := \{j \in V \mid d_G(i,j) \leq k\} \tag{4}$$

of all nodes at graph distance at most k. See Figure 1 for an illustration for the 2D grid graph.

We propose two algorithms for approximating Shapley value in which features that are either far apart on the graph or features that are not directly connected have an accordingly weaker interaction.



(a) (b) (c)

Figure 1: In all cases, the red node denotes the target feature i. (a) Illustration of the $k = 2$ graph neighborhood $\mathcal{N}_2(i)$ on the grid graph. All nodes within the shaded gray triangle lie within the neighborhood $\mathcal{N}_2(i)$. (b) A disconnected subset of $\mathcal{N}_2(i)$ that is summed over in L-Shapley but not C-Shapley. (c) A connected subset of $\mathcal{N}_2(i)$ that is summed over in both L-Shapley and C-Shapley.

3.1 Local Shapley

In order to motivate our first graph-structured Shapley score, let us take a deeper look at Example ($\star$). In order to compute the importance score of "*not,*" the most important words to be included are "*heartwarming*" and "*entertaining.*" Intuitively, the words distant from them have a weaker influence on the importance of a given word in a document, and therefore have relatively less effect on the Shapley score. Accordingly, as one approximation, we propose the L-Shapley score, which only perturbs the neighboring features of a given feature when evaluating its importance:

Definition 1. *Given a model $\mathbb{P}_m$, a sample x and a feature i, the* L-Shapley estimate of order k *on a graph G is given by*

$$\hat{\phi}_x^k(i) := \frac{1}{|\mathcal{N}_k(i)|} \sum_{\substack{T \ni i \\ T \subseteq \mathcal{N}_k(i)}} \frac{1}{\binom{|\mathcal{N}_k(i)|-1}{|T|-1}} m_x(T, i). \tag{5}$$

The coefficients in front of the marginal contributions of feature i are chosen to match the coefficients in the definition of the Shapley value restricted to the neighborhood $\mathcal{N}_k(i)$. We show in Section 4 that this choice controls the error under certain probabilistic assumptions. In practice, the choice of the integer k is dictated by computational considerations. By the definition of k-neighborhoods, evaluating all d L-Shapley scores on a line graph requires $2^{2k}d$ model evaluations. (In particular, computing each feature takes 2^{2k+1} model evaluations, half of which overlap with those of its preceding feature.) A similar calculation shows that computing all d L-Shapley scores on a grid graph requires $2^{4k^2}d$ function evaluations.

3.2 Connected Shapley

We also propose a second algorithm, C-Shapley, that further reduces the complexity of approximating the Shapley value. Coming back to Example ($\star$) where we evaluate the importance of "*not,*" both the L-Shapley estimate of order larger than two and the exact Shapley value estimate would evaluate the model on the word subset "*It not heartwarming,*" which rarely appears in real data and may not make sense to a human or a model trained on real-world data. The marginal contribution of "*not*" relative to "*It not heartwarming*" may be well approximated by the marginal contribution of "not" to "*not heartwarming.*" This motivates us to proprose *C-Shapley*:

Definition 2. *Given a model $\mathbb{P}_m$, a sample x and a feature i, the* C-Shapley estimate of order k *on a graph G is given by*

$$\tilde{\phi}_x^k(i) := \sum_{U \in \mathcal{C}_k(i)} \frac{2}{(|U|+2)(|U|+1)|U|} m_x(U, i), \tag{6}$$

where $\mathcal{C}_k(i)$ denotes the set of all subsets of $\mathcal{N}_k(i)$ that contain node i, and are connected in G.

The coefficients in front of the marginal contributions are a result of using Myerson value to characterize a new coalitional game over the graph G, in which the influence of disconnected subsets of features are additive. The error between C-Shapley and the Shapley value can also be controlled under certain statistical assumptions. See Section 4 for details.

For text data, C-Shapley is equivalent to only evaluating n-grams in a neighborhood of the word to be explained. By the definition of k-neighborhoods, evaluating the C-Shapley scores for all d features takes $\mathcal{O}(k^2 d)$ model evaluations on a line graph, as each feature takes $\mathcal{O}(k^2)$ model evaluations.

4 PROPERTIES

In this section, we study some basic properties of the L-Shapley and C-Shapley values. In particular, under certain probabilistic assumptions on the features, we show that they provide good approximations to the original Shapley values. We also show their relationship to another concept from cooperative game theory, namely that of Myerson values, when the model satisfies certain local additivity assumptions.

4.1 APPROXIMATION OF SHAPLEY VALUE

In order to characterize the relationship between L-Shapley and the Shapley value in terms of some conditional independence assumption between features, we introduce *absolute mutual information* as a measure of dependence. Given two random variables X and Y, the absolute mutual information $I_a(X;Y)$ between X and Y is defined as

$$I_a(X;Y) = \mathbb{E}\left[\left|\log \frac{P(X,Y)}{P(X)P(Y)}\right|\right], \tag{7}$$

where the expectation is taken jointly over X, Y. Based on the definition of independence, we have $I_a(X;Y) = 0$ if and only if $X \perp\!\!\!\perp Y$. Recall the mutual information (Cover & Thomas, 2012) is defined as $I(X;Y) = \mathbb{E}[\log \frac{P(X,Y)}{P(X)P(Y)}]$. The new measure is more stringent than the mutual information in the sense that $I(X;Y) \leq I_a(X;Y)$. The absolute conditional mutual information can be defined in an analogous way. Given three random variables X, Y and Z, we define the absolute conditional mutual information to be $I_a(X;Y \mid Z) = \mathbb{E}[|\log \frac{P(X,Y|Z)}{P(X|Z)P(Y|Z)}|]$, where the expectation is taken jointly over X, Y, Z. Recall that $I_a(X;Y \mid Z)$ is zero if and only if $X \perp\!\!\!\perp Y|Z$.

Theorem 1 and Theorem 2 show that L-Shapley and C-Shapley values, respectively, are related to the Shapley value whenever the model obeys a Markovian structure that is encoded by the graph. We leave their proofs to Appendix B.

Theorem 1. *Suppose there exists a feature subset $S \subset \mathcal{N}_k(i)$ with $i \in S$, such that*

$$\sup_{U \subset S\setminus\{i\}, V \subset [d]\setminus S} I_a(X_i; X_V | X_U, Y) \leq \varepsilon; \quad \sup_{U \subset S\setminus\{i\}, V \subset [d]\setminus S} I_a(X_i; X_V | X_U) \leq \varepsilon, \tag{8}$$

where we identify $I_a(X_i; X_V|X_\emptyset)$ with $I_a(X_i; X_V)$ for notational convenience. Then the expected error between the L-Shapley estimate $\hat{\phi}_X^k(i)$ and the true Shapley-value-based importance score $\phi_i(\mathbb{P}_m, x)$ is bounded by 4ε:

$$\mathbb{E}_X|\hat{\phi}_X^k(i) - \phi_X(i)| \leq 4\varepsilon. \tag{9}$$

In particular, we have $\hat{\phi}_X^k(i) = \phi_X(i)$ almost surely if we have $X_i \perp\!\!\!\perp X_{[d]\setminus S}|X_T$ and $X_i \perp\!\!\!\perp X_{[d]\setminus S}|X_T, Y$ for any $T \subset S \setminus \{i\}$.

Theorem 2. *Suppose there exists a neighborhood $S \subset \mathcal{N}_k(i)$ of i, with $i \in S$, such that Condition 8 is satisfied. Moreover, for any connected subset $U \subset S$ with $i \in U$, we have*

$$\sup_{V \subset R(U)} I_a(X_i; X_V | X_{U\setminus\{i\}}, Y) \leq \varepsilon; \quad \sup_{V \subset R(U)} I_a(X_i; X_V | X_{U\setminus\{i\}}) \leq \varepsilon, \tag{10}$$

where $R(U) := \{i \in [d] - U : \text{ for any } j \in U, (i,j) \notin E\}$. Then the expected error between the C-Shapley estimate $\tilde{\phi}_X^k(i)$ and the true Shapley-value-based importance score $\phi_i(\mathbb{P}_m, x)$ is bounded by 6ε:

$$\mathbb{E}_X|\tilde{\phi}_X^k(i) - \phi_X(i)| \leq 6\varepsilon. \tag{11}$$

In particular, we have $\hat{\phi}_X^d(i) = \phi_X(i)$ almost surely if we have $X_i \perp\!\!\!\perp X_{R(U)}|X_{U\setminus\{i\}}$ and $X_i \perp\!\!\!\perp X_{R(U)}|X_{U\setminus\{i\}}, Y$ for any $U \subset [d]$.

4.2 RELATING THE C-SHAPLEY VALUE TO THE MYERSON VALUE

Let us now discuss how the C-Shapley value can be related to the Myerson value, which was introduced by Myerson (1977) as an approach for characterizing a coalitional game over a graph G.

Given a subset of nodes S in the graph G, let $\mathcal{C}_G(S)$ denote the set of connected components of S. Thus, if S is a connected subset of G, then $\mathcal{C}_G(S)$ consists only of S; otherwise, it contains a collection of subsets whose disjoint union is equal to S.

Consider a score function $T \mapsto v(T)$ that satisfies the following decomposability condition: for any subset of nodes S, the score $v(S)$ is equal to the sum of the scores over the connected components of S:

$$v(S) = \sum_{T \in \mathcal{C}_G(S)} v(T). \tag{12}$$

For any such score function, we can define the associated Shapley value, and it is known as the *Myerson value* on G with respect to v. Myerson (1977) showed that the Myerson value is the unique quantity that satisfies both the decomposability property, as well as the properties additivity, equal contributions and monotonicity given in Section 2.2.

In our setting, if we use a plug-in estimate for conditional probability, the decomposability condition (12) is equivalent to assuming that the influence of disconnected subsets of features are additive at sample x, and C-Shapley of order $k = d$ is exactly the Myerson value over G. In fact, if we partition each subset S into connected components, as in the definition of Myerson value, and sum up the coefficients (using Lemma 1 in Appendix B), then the Myerson value is equivalent to equation 6.

4.3 Connections with related work

Let us now discuss connections with related work in more depth, and in particular how methods useful for approximating the Shapley value can be used to speed up the evaluation of approximate L-Shapley and C-Shapley values.

Sampling-based methods There is an alternative definition of the Shapley value based on taking averages over permutations of the features. In particular, the contribution of a feature i corresponds to the average of the marginal contribution of i to its preceding features over the set of all permutations of d features. Based on this definition, Štrumbelj & Kononenko (2010) propose a Monte Carlo approximation, based on randomly sampling permutations.

While L-Shapley is deterministic in nature, it is possible to combine it with this and other sampling-based methods. For example, if one hopes to consider the interaction of features in a large neighborhood $\mathcal{N}_k(i)$ with a feature i, where exponential complexity in k becomes a barrier, sampling based on random permutation of local features may be used to alleviate the computational burden.

Regression-based methods Lundberg & Lee (2017) proposed to sample feature subsets based on a weighted kernel, and carry out a weighted linear regression to estimate the Shapley value. Suppose the model is evaluated on N feature subsets at x. In weighted least squares, each row of the data matrix $X \in \{0,1\}^{N \times d}$ is a d-dimensional vector, with the j^{th} entry being one if the feature j is selected, and zero otherwise. The response $F \in \mathbb{R}^N$ is the evaluation of the model over feature subsets. The weight matrix W is diagonal with $W_{ii} = (d-1)/(\binom{d}{n_i} n_i (d - n_i))$ with $n_i = \sum_{j=1}^{d} X_{ij}$.

Lundberg & Lee (2017) provide strong empirical results using this regression-based approximation, referred to as KernelSHAP; see, in particular, Section 5.1 and Figure 3 of their paper. We can combine such a regression-based approximation with our modified Shapley values to further reduce the evaluation complexity of the C-Shapley values. In particular, for a chain graph, we evaluate the score function over all connected subsequences of length $\leq k$; similarly, on a grid graph, we evaluate it over all connected squares of size $\leq k \times k$. Doing so yields a data matrix $X \in \{0,1\}^{kd \times d}$ and a response vector $F \in \mathbb{R}^{kd}$, where $X_{ij} = 1$ if the jth feature is included in the ith sample, and $F_i := v_x(S_i)$, the score function evaluated on the corresponding feature subset. We use the solution to this weighted least-squares problem as a regression-based estimate of C-Shapley—that is, $\tilde{\phi}_x^k \approx (X^T W X)^{-1} X^T F$.

5 Experiments

We evaluate the performance of L-Shapley and C-Shapley on real-world data sets involving text and image classification. We compare L-Shapley and C-Shapley with several competitive algorithms for instancewise feature importance scoring on black-box models, including the regression-based approximation known as KernelSHAP (Lundberg & Lee, 2017), SampleShapley (Štrumbelj & Kononenko, 2010), and the LIME method (Ribeiro et al., 2016). We emphasize that our focus

Data Set	Classes	Train Samples	Test Samples	Average #w	Model	Parameters	Accuracy
IMDB Review (Maas et al., 2011)	2	25,000	25,000	325.6	WordCNN	351,002	90.1%
AG's News (Zhang et al., 2015)	4	120,000	7,600	43.3	CharCNN	11,337,988	90.09%
Yahoo! Answers (Zhang et al., 2015)	10	1,400,000	60,000	108.4	LSTM	7,146,166	70.84%

Table 1: A summary of data sets and models in three experiments. "Average #w" is the average number of words per sentence. "Accuracy" is the model accuracy on test samples.

is model-agnostic interpretation, and we omit the comparison with interpretation methods requiring additional assumptions or specific to a certain class models, like Integrated Gradients (Sundararajan et al., 2017), DeepLIFT (Shrikumar et al., 2017), LRP (Bach et al., 2015) and LSTM-specific methods (Karpathy et al., 2015; Strobelt et al., 2018; Murdoch & Szlam, 2017).

As discussed previously, KernelSHAP forms a weighted regression-approximation of the Shapley values, whereas SampleShapley estimates Shapley value by random permutation of features. The LIME method uses a linear model to locally approximate the original model through weighted least squares. For all methods, the number of model evaluations is the same, and linear in the number of features. We also choose the objective to be the log probability of the predicted class, and use the plug-in estimate of conditional probability across all methods (see Section 2.1).

5.1 Text Classification

Text classification is a classical problem in natural language processing, in which text documents are assigned to predefined categories. We study the performance of L-Shapley and C-Shapley on three popular neural models for text classification: word-based CNNs (Kim, 2014), character-based CNNs (Zhang et al., 2015), and long-short term memory (LSTM) recurrent neural networks (Hochreiter & Schmidhuber, 1997), with the following three data sets on different scales. See Table 1 for a summary, and Appendix A for all of the details.

IMDB Review with Word-CNN: The Internet Movie Review Dataset (IMDB) is a dataset of movie reviews for sentiment classification (Maas et al., 2011), which contains $50,000$ binary labeled movie reviews, with a split of $25,000$ for training and $25,000$ for testing. A simple word-based CNN model composed of an embedding layer, a convolutional layer, a max-pooling layer, and a dense layer is used, achieving an accuracy of 90.1% on the test data set.

AG news with Char-CNN: The AG news corpus is composed of titles and descriptions of $196,000$ news articles from $2,000$ news sources (Zhang et al., 2015). It is segmented into four classes, each containing $30,000$ training samples and $1,900$ testing samples. Our character-based CNN has the same structure as that proposed in Zhang et al. (2015). The model achieves an accuracy of 90.09% on the test data set.

Yahoo! Answers with LSTM: The corpus of Yahoo! Answers Topic Classification Dataset is divided into ten categories, each class containing $140,000$ training samples and $5,000$ testing samples. Each input text includes the question title, content and best answer. We train a bidirectional LSTM which achieves an accuracy of 70.84% on the test data set, close to the state-of-the-art accuracy of 71.2% obtained by character-based CNNs (Zhang et al., 2015).

We choose zero paddings as the reference point for all methods, and make $4 \times d$ model evaluations, where d is the number of words for each input. Given the average length of each input (see Table 1), this choice controls the number of model evaluations under $1,000$, taking less than one second in TensorFlow on a Tesla K80 GPU for all the three models. For L-Shapley, we are able to consider the interaction of each word i with the two neighboring words in $\mathcal{N}_1(i)$ given the budget. For C-Shapley, the budget allows the regression-based version to evaluate all n-grams with $n \leq 4$.

The change in log-odds scores before and after masking the top features ranked by importance scores is used as a metric for evaluating performance, where masked words are replaced by zero paddings. This metric has been used in previous literature in model interpretation (Shrikumar et al., 2017; Lundberg & Lee, 2017). We study how the average log-odds score of the predicted class decreases as the percentage of masked features over the total number of features increases on $1,000$ samples from the test set. Results are plotted in Figure 2.

On IMDB with Word-CNN, the simplest model among the three, L-Shapley, achieves the best performance while LIME, KernelSHAP and C-Shapley achieve slightly worse performance. On AG's news with Char-CNN, L-Shapley and C-Shapley both outperform other algorithms. On Yahoo! Answers with LSTM, C-Shapley outperforms the rest of the algorithms by a large margin, followed by

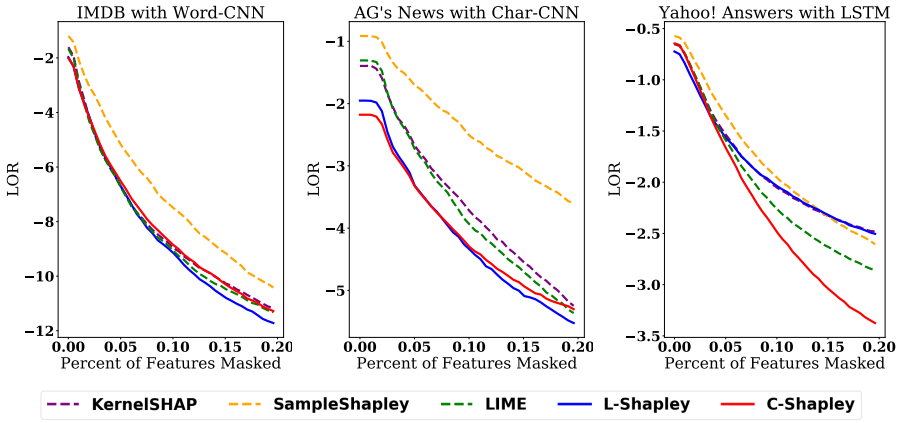


Figure 2: The above plots show the change in log odds ratio of the predicted class as a function of the percent of masked features, on the three text data sets. Lower log odds ratios are better.

Method	Explanation
Shapley	It is not heartwarming or entertaining . It just sucks .
C-Shapley	It is not heartwarming or entertaining . It just sucks .
L-Shapley	It is not heartwarming or entertaining . It just sucks .
KernelSHAP	It is not heartwarming or entertaining . It just sucks .
SampleShapley	It is not heartwarming or entertaining . It just sucks .

Table 2: Each word is highlighted with the RGB color as a linear function of its importance score. The background colors of words with positive and negative scores are linearly interpolated between blue and white, red and white respectively.

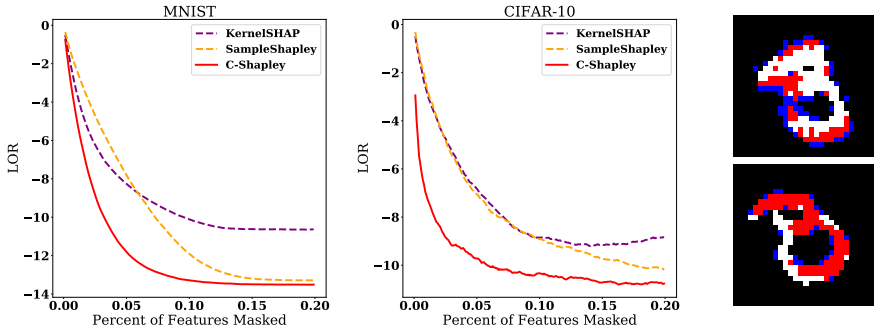


Figure 3: Left and Middle: change in log-odds ratio vs. the percent of pixels masked on MNIST and CIFAR10. Right: top pixels ranked by C-Shapley for a "3" and an "8" misclassified into "8" and "3" respectively. The masked pixels are colored with red if activated (white) and blue otherwise.

LIME. L-Shapley with order 1, SampleShapley, and KernelSHAP do not perform well for LSTM model, probably because some of the signals captured by LSTM are relatively long n-grams.

We also visualize the importance scores produced by different Shapley-based methods on Example ($\star$), which is part of a negative movie review taken from IMDB. The result is shown in Table 2. More visualizations by our methods can be found in Appendix D and Appendix E.

5.2 Image Classification

We carry out experiments in image classification on the MNIST and CIFAR10 data sets:

MNIST: The MNIST data set contains 28×28 images of handwritten digits with ten categories $0 - 9$ (LeCun et al., 1998). A subset of MNIST data set composed of digits 3 and 8 is used for better visualization, with $12,000$ images for training and $1,000$ images for testing. A simple CNN model achieves 99.7% accuracy on the test data set.

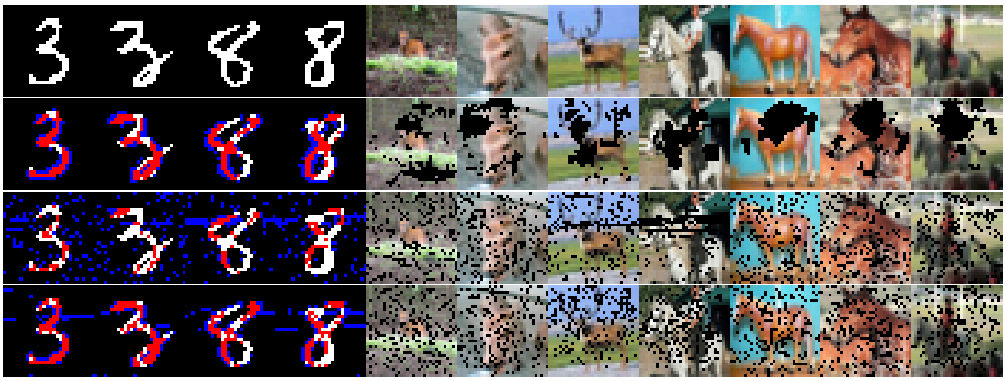


Figure 4: Some examples of explanations obtained for the MNIST and CIFAR10 data sets. The first row corresponds to the original images, with the rows below showing images masked based on scores produced by C-Shapley, KernelSHAP and SampleShapley respectively. For best visualization results, 15% and 20% pixels are masked for MNIST and CIFAR10 respectively. For MNIST, the masked pixels are colored with red if activated (white) and blue otherwise. For SampleShapley and KernelSHAP, unactivated pixels in MNIST are attributed nonzero scores when evaluated jointly with activated pixels (before any ad hoc post-processing).

CIFAR10: The CIFAR10 data set (Krizhevsky, 2009) contains 32×32 images in ten classes. A subset of CIFAR10 data set composed of deers and horses is used for better visualization, with $10,000$ images for training and $2,000$ images for testing. A convolutional neural network modified from AlexNet (Krizhevsky et al., 2012) achieves 96.1% accuracy on the test data set.

We take each pixel as a single feature for both MNIST and CIFAR10. We choose the average pixel strength and the black pixel strength respectively as the reference point for all methods, and make $4 \times d$ model evaluations, where d is the number of pixels for each input image, which keeps the number of model evaluations under $4,000$.

LIME and L-Shapley are not used for comparison because LIME takes "superpixels" instead of raw pixels segmented by segmentation algorithms as single features, and L-Shapley requires nearly sixteen thousand model evaluations when applied to raw pixels.[1] For C-Shapley, the budget allows the regression-based version to evaluate all $n \times n$ image patches with $n \leq 4$.

Figure 3 shows the decrease in log-odds scores before and after masking the top pixels ranked by importance scores as the percentage of masked pixels over the total number of pixels increases on $1,000$ test samples on MNIST and CIFAR10 data sets. C-Shapley consistently outperforms other methods on both data sets.

Figure 4 provides additional visualization of the results. By masking the top pixels ranked by various methods, we find that the pixels picked by C-Shapley concentrate around and inside the digits in MNIST. For SampleShapley and KernelSHAP, unactivated pixels in MNIST are attributed nonzero scores when evaluated jointly with activated pixels. While one could use post-processing by not choosing unactivated pixels, we choose to visualize the original outputs from all algorithms for fairness of comparison. More visualization results are available in Appendix C.

The C-Shapley yields the most interpretable results in CIFAR10. In particular, C-Shapley tends to mask the parts of head and body that distinguish deers and horses, and the human riding the horse. Figure 3 shows two misclassified digits by the CNN model. Interestingly, the top pixels chosen by C-Shapley visualize the "reasoning" of the model: more specifically, the important pixels to the model are exactly those which could form a digit from the opposite class.

6 Discussion

We have proposed two new algorithms—L-Shapley and C-Shapley—for instancewise feature importance scoring, making use of a graphical representation of the data. We have demonstrated the superior performance of these algorithms compared to other methods on black-box models for instancewise feature importance scoring in both text and image classification.

[1] L-Shapley becomes practical if we take small patches of images instead of pixels as single features.

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A MODEL STRUCTURE

IMDB Review with Word-CNN The word-based CNN model is composed of a 50-dimensional word embedding, a 1-D convolutional layer of 250 filters and kernel size three, a max-pooling and a 250-dimensional dense layer as hidden layers. Both the convolutional and the dense layers are followed by ReLU as nonlinearity, and Dropout Srivastava et al. (2014) as regularization. The model is trained with rmsprop Hinton et al.. The model achieves an accuracy of 90.1% on the test data set.

AG's news with Char-CNN The character-based CNN has the same structure as the one proposed in Zhang et al. (2015), composed of six convolutional layers, three max-pooling layers, and two dense layers. The model is trained with SGD with momentum 0.9 and decreasing step size initialized at 0.01. (Details can be found in Zhang et al. (2015).) The model reaches accuracy of 90.09% on the test data set.

Yahoo! Answers with LSTM The network consists of a 300-dimensional randomly-initialized word embedding, a bidirectional LSTM, each LSTM unit of dimension 256, and a dropout layer as hidden layers. The model is trained with rmsprop Hinton et al.. The model reaches accuracy of 70.84% on the test data set, close to the state-of-the-art accuracy of 71.2% obtained by character-based CNN Zhang et al. (2015).

MNIST A simple CNN model is trained on the data set, which achieves 99.7% accuracy on the test data set. It is composed of two convolutional layers of kernel size 5×5 and a dense linear layer at last. The two convolutional layers contain 8 and 16 filters respectively, and both are followed by a max-pooling layer of pool size two.

CIFAR10 A convolutional neural network modified from AlexNet Krizhevsky et al. (2012) is trained on the subset. It is composed of six convolutional layers of kernel size 3×3 and two dense linear layers of dimension 512 and 256 at last. The six convolutional layers contain 48,48,96,96,192,192 filters respectively, and every two convolutional layers are followed by a max-pooling layer of pool size two and a dropout layer. The CNN model is trained with the Adam optimizer Kingma & Ba (2015) and achieves 96.1% accuracy on the test data set.

B PROOF OF THEOREMS

In this appendix, we collect the proofs of Theorems 1 and 2.

B.1 PROOF OF THEOREM 1

We state an elementary combinatorial equality required for the proof of the main theorem:

Lemma 1 (A combinatorial equality)**.** *For any positive integer n, and any pair of non-negative integers with $s \geq t$, we have*

$$\sum_{j=0}^{n} \frac{1}{\binom{n+s}{j+t}} \binom{n}{j} = \frac{s+1+n}{(s+1)\binom{s}{t}} \tag{13}$$

Proof. By the binomial theorem for negative integer exponents, we have

$$\frac{1}{(1-x)^{t+1}} = \sum_{j=0}^{\infty} \binom{j+t}{j} x^j.$$

The identity can be found by examination of the coefficient of x^n in the expansion of

$$\frac{1}{(1-x)^{t+1}} \cdot \frac{1}{(1-x)^{s-t+1}} = \frac{1}{(1-x)^{s+1+1}}. \tag{14}$$

In fact, equating the coefficients of x^n in the left and the right hand sides, we get

$$\sum_{j=0}^{n} \binom{j+t}{j}\binom{(n-j)+(s-t)}{n-j} = \binom{n+s+1}{n} = \frac{n+s+1}{s+1}\binom{n+s}{n}. \tag{15}$$

Moving $\binom{n+s}{n}$ to the right hand side and expanding the binomial coefficients, we have

$$\sum_{j=0}^{n} \frac{(j+t)!}{j!t!} \cdot \frac{(n-j+s-t)!}{(n-j)!(s-t)!} \cdot \frac{n!s!}{(n+s)!} = \frac{n+s+1}{s+1}, \tag{16}$$

which implies

$$\begin{aligned}\sum_{j=0}^{n} \binom{n}{j}\binom{s}{t}\Big/\binom{n+s}{j+t} &= \sum_{j=0}^{n} \frac{n!}{(n-j)!j!} \cdot \frac{s!}{t!(s-t)!} \cdot \frac{((n+s)-(j+t))!(j+t)!}{(n+s)!} \\ &= \sum_{j=0}^{n} \frac{(j+t)!}{j!t!} \cdot \frac{(n-j+s-t)!}{(n-j)!(s-t)!} \cdot \frac{n!s!}{(n+s)!} = \frac{n+s+1}{s+1}.\end{aligned}$$

□

Taking this lemma, we now prove the theorem. We split our analysis into two cases, namely $S = \mathcal{N}_k(i)$ versus $S \subset \mathcal{N}_k(i)$. For notational convenience, we extend the definition of L-Shapley estimate for feature i to an arbitrary feature subset S containing i. In particular, we define

$$\hat{\phi}_x^S(i) := \frac{1}{|S|} \sum_{\substack{T \ni i \\ T \subseteq S}} \frac{1}{\binom{|S|-1}{|T|-1}} m_x(T, i). \tag{17}$$

Case 1: First, suppose that $S = \mathcal{N}_k(i)$. For any subset $A \subset [d]$, we introduce the shorthand notation $U_S(A) := A \cap S$ and $V_S(A) := A \cap S^c$, and note that $A = U_S(A) \cup V_S(A)$. Recalling the definition of the Shapley value, let us partition all the subsets A based on $U_S(A)$, in particular writing

$$\phi_X(i) = \frac{1}{d} \sum_{\substack{A \subseteq [d] \\ A \ni i}} \frac{1}{\binom{d-1}{|A|-1}} m_X(A, i) \;=\; \frac{1}{d} \sum_{\substack{U \subseteq S \\ U \ni i}} \sum_{\substack{A \subseteq [d] \\ U_S(A) = U}} \frac{1}{\binom{d-1}{|A|-1}} m_X(A, i).$$

Based on this partitioning, the expected error between $\hat{\phi}_X^S(i)$ and $\phi_X(i)$ can be written as

$$\mathbb{E}\left|\hat{\phi}_X^S(i) - \phi_X(i)\right| = \mathbb{E}\left|\frac{1}{|S|} \sum_{\substack{U \subseteq S \\ U \ni i}} \frac{1}{\binom{|S|-1}{|U|-1}} m_X(U, i) - \frac{1}{d} \sum_{\substack{U \subseteq S \\ U \ni i}} \sum_{\substack{A \subseteq [d] \\ U_S(A) = U}} \frac{1}{\binom{d-1}{|A|-1}} m_X(A, i)\right|. \tag{18}$$

Partitioning the set $\{A : U_S(A) = U\}$ by the size of $V_S(A) = A \cap S^c$, we observe that

$$\begin{aligned}\sum_{\substack{A \subseteq [d] \\ U_S(A) = U}} \frac{1}{\binom{d-1}{|A|-1}} &= \sum_{i=0}^{d-|S|} \frac{1}{\binom{d-1}{i+|U|-1}} \binom{d-|S|}{i} \\ &= \frac{(|S|-1)+1+(d-|S|)}{((|S|-1)+1)\binom{|S|-1}{|U|-1}} \\ &= \frac{d}{|S|} \frac{1}{\binom{|S|-1}{|U|-1}},\end{aligned}$$

where we have applied Lemma 1 with $n = d - |S|$, $s = |S| - 1$, and $t = |U| - 1$. Substituting this equivalence into equation equation 18, we find that the expected error can be upper bounded by

$$\mathbb{E}|\hat{\phi}_X^S(i) - \phi_X(i)| \leq \frac{1}{d} \sum_{\substack{U \subseteq S \\ U \ni i}} \sum_{\substack{A \subseteq [d] \\ U_S(A) = U}} \frac{1}{\binom{d-1}{|A|-1}} \mathbb{E}\left|m_X(U, i) - m_X(A, i)\right|, \tag{19}$$

where we recall that $A = U_S(A) \cup V_S(A)$.

Now omitting the dependence of $U_S(A), V_S(A)$ on A for notational simplicity, we now write the difference as

$$\begin{aligned} m_X(A,i) - m_X(U,i) &= \mathbb{E}_m\left[\log\frac{\mathbb{P}_m(Y|X_{U\cup V})}{\mathbb{P}_m(Y|X_{U\cup V\setminus\{i\}})} - \log\frac{\mathbb{P}_m(Y|X_U)}{\mathbb{P}_m(Y|X_{U\setminus\{i\}})} \mid X\right] \\ &= \mathbb{E}_m\left[\log\frac{\mathbb{P}(Y,X_{U\setminus\{i\}})\mathbb{P}(X_U)P(X_{U\cup V\setminus\{i\}})P(X_{U\cup V},Y)}{\mathbb{P}(Y,X_U)\mathbb{P}(X_{U\setminus\{i\}})P(X_{U\cup V})P(X_{U\cup V\setminus\{i\}},Y)} \mid X\right] \\ &= \mathbb{E}_m\Bigg[\log\frac{\mathbb{P}(X_i,X_V \mid X_{U\setminus\{i\}},Y)}{\mathbb{P}(X_i \mid X_{U\setminus\{i\}},Y)\mathbb{P}(X_V \mid X_{U\setminus\{i\}},Y)} \\ &\qquad - \log\frac{\mathbb{P}(X_i,X_V|X_{U\setminus\{i\}})}{\mathbb{P}(X_i|X_{U\setminus\{i\}})\mathbb{P}(X_V \mid X_{U\setminus\{i\}})} \mid X\Bigg]. \end{aligned}$$

Substituting this equivalence into our earlier bound equation 19 and taking an expectation over X on both sides, we find that the expected error is upper bounded as

$$\begin{aligned} \mathbb{E}|\hat{\phi}_X^S(i) - \phi_X(i)| \leq \frac{1}{d}\sum_{\substack{U\subseteq S\\ U\ni i}}\sum_{\substack{A\subseteq[d]\\ U_S(A)=U}}\frac{1}{\binom{d-1}{|A|-1}}\Bigg\{&\mathbb{E}\left|\log\frac{\mathbb{P}(X_i,X_{V_S(A)}|X_{U\setminus\{i\}},Y)}{\mathbb{P}(X_i|X_{U\setminus\{i\}},Y)\mathbb{P}(X_{V_S(A)}|X_{U\setminus\{i\}},Y)}\right| \\ &+\mathbb{E}\left|\log\frac{\mathbb{P}(X_i,X_{V_S(A)}|X_{U\setminus\{i\}})}{\mathbb{P}(X_i \mid X_{U\setminus\{i\}})\mathbb{P}(X_{V_S(A)}|X_{U\setminus\{i\}})}\right|\Bigg\}. \end{aligned}$$

Recalling the definition of the absolute mutual information, we see that

$$\begin{aligned} \mathbb{E}|\hat{\phi}_X^S(i) - \phi_X(i)| &\leq \frac{1}{d}\sum_{\substack{U\subseteq S\\ U\ni i}}\sum_{\substack{A\subseteq[d]\\ U_S(A)=U}}\frac{1}{\binom{d-1}{|A|-1}}\Big\{I_a(X_i;X_{V_S(A)} \mid X_{U\setminus\{i\}},Y) \\ &\qquad + I_a(X_i;X_{V_S(A)} \mid X_{U\setminus\{i\}})\Big\} \\ &\leq 2\varepsilon, \end{aligned}$$

which completes the proof of the claimed bound.

Finally, in the special case that $X_i \perp\!\!\!\perp X_{[d]\setminus S}|X_T$ and $X_i \perp\!\!\!\perp X_{[d]\setminus S}|X_T, Y$ for any $T \subset S$, then this inequality holds with $\varepsilon = 0$, which implies $\mathbb{E}|\hat{\phi}_X^S(i) - \phi_X(i)| = 0$. Therefore, we have $\hat{\phi}_X^S(i) = \phi_X(i)$ almost surely, as claimed.

Case 2: We now consider the general case in which $S \subset \mathcal{N}_k(i)$. Using the previous arguments, we can show

$$\mathbb{E}|\hat{\phi}_X^S(i) - \phi_X^k(i)| \leq 2\varepsilon, \quad \text{and} \quad \mathbb{E}|\hat{\phi}_X^S(i) - \phi_X(i)| \leq 2\varepsilon.$$

Appylying the triangle inequality yields $\mathbb{E}|\hat{\phi}_X^k(i) - \phi_X(i)| \leq 4\varepsilon$, which establishes the claim.

B.2 Proof of Theorem 2

As in the previous proof, we divide our analysis into two cases.

Case 1: First, suppose that $S = \mathcal{N}_k(i) = [d]$. For any subset $A \subset S$ with $i \in A$, we can partition A into two components $U_S(A)$ and $V_S(A)$, such that $i \in U_S(A)$ and $U_S(A)$ is a connected subsequence. $V_S(A)$ is disconnected from $U_S(A)$. We also define

$$\mathcal{C} = \{U \mid i \in U, U \subset [d], U \text{ is a connected subsequence.}\} \tag{20}$$

We partition all the subsets $A \subset S$ based on $U_S(A)$ in the definition of the Shapley value:

$$\begin{aligned} \phi_X(i) &= \frac{1}{d}\sum_{\substack{A\subseteq S\\ A\ni i}}\frac{1}{\binom{d-1}{|A|-1}}m_X(A,i) \\ &= \frac{1}{d}\sum_{U\in\mathcal{C}}\sum_{A:U_S(A)=U}\frac{1}{\binom{d-1}{|A|-1}}m_X(A,i). \end{aligned}$$

The expected error between $\tilde{\phi}_X^{[d]}(i)$ and $\phi_X(i)$ is

$$\mathbb{E}|\tilde{\phi}_X^{[d]}(i) - \phi_X(i)| = \mathbb{E}\left|\frac{1}{d}\sum_{U\in\mathcal{C}}\frac{2d}{(|U|+2)(|U|+1)|U|}m_X(U,i) - \frac{1}{d}\sum_{U\in\mathcal{C}}\sum_{A:U_S(A)=U}\frac{1}{\binom{d-1}{|A|-1}}m_X(A,i)\right|. \tag{21}$$

Partitioning $\{A : U_S(A) = U\}$ by the size of $V_S(A)$, we observe that

$$\begin{aligned}\sum_{A:U_S(A)=U}\frac{1}{\binom{d-1}{|A|-1}} &= \sum_{i=0}^{d-|U|-2}\frac{1}{\binom{d-1}{i+|U|-1}}\binom{d-|U|-2}{i} \\ &= \frac{(|U|+1)+1+(d-|U|-2)}{((|U|+1)+1)\binom{|U|+1}{|U|-1}} \\ &= \frac{2d}{(|U|+2)(|U|+1)|U|},\end{aligned}$$

where we apply Lemma 1 with $n = d-|U|-2$, $s = |U|+1$ and $t = |U|-1$. From equation equation 21, the expected error can be upper bounded by

$$\mathbb{E}\left|\tilde{\phi}_X^{[d]}(i) - \phi_X(i)\right| \le \frac{1}{d}\sum_{U\in\mathcal{C}}\sum_{A:U_S(A)=U}\frac{1}{\binom{d-1}{|A|-1}}\mathbb{E}\left|m_X(U,i) - m_X(A,i)\right|,$$

where $A = U_S(A)\cup V_S(A)$. We omit the dependence of $U_S(A)$ and $V_S(A)$ on the pair (A,S) for notational simplicity, and observe that the difference between $m_x(A,i)$ and $m_x(U,i)$ is

$$\begin{aligned}m_X(A,i) - m_X(U,i) &= \mathbb{E}_m\left[\log\frac{\mathbb{P}_m(Y|X_{U\cup V})}{\mathbb{P}_m(Y|X_{U\cup V\setminus\{i\}})} - \log\frac{\mathbb{P}_m(Y|X_U)}{\mathbb{P}_m(Y|X_{U\setminus\{i\}})} \mid X\right] \\ &= \mathbb{E}_m\left[\log\frac{\mathbb{P}(Y,X_{U\setminus\{i\}})\mathbb{P}(X_U)P(X_{U\cup V\setminus\{i\}})P(X_{U\cup V},Y)}{\mathbb{P}(Y,X_U)\mathbb{P}(X_{U\setminus\{i\}})P(X_{U\cup V})P(X_{U\cup V\setminus\{i\}},Y)} \mid X\right] \\ &= \mathbb{E}_m\Bigg[\log\frac{\mathbb{P}(X_i,X_V|X_{U\setminus\{i\}},Y)}{\mathbb{P}(X_i|X_{U\setminus\{i\}},Y)\mathbb{P}(X_V|X_{U\setminus\{i\}},Y)} \\ &\qquad - \log\frac{\mathbb{P}(X_i,X_V|X_{U\setminus\{i\}})}{\mathbb{P}(X_i|X_{U\setminus\{i\}})\mathbb{P}(X_V|X_{U\setminus\{i\}})} \mid X\Bigg].\end{aligned}$$

Taking an expectation over X at both sides, we can upper bound the expected error by

$$\begin{aligned}\mathbb{E}|\tilde{\phi}_X^{[d]}(i) - \phi_X(i)| &\le \frac{1}{d}\sum_{U\in\mathcal{C}}\sum_{A:U_S(A)=U}\frac{1}{\binom{d-1}{|A|-1}}\Bigg(\mathbb{E}\left|\log\frac{\mathbb{P}(X_i,X_{V_S(A)}|X_{U\setminus\{i\}},Y)}{\mathbb{P}(X_i|X_{U\setminus\{i\}},Y)\mathbb{P}(X_{V_S(A)}|X_{U\setminus\{i\}},Y)}\right| \\ &\qquad + \mathbb{E}\left|\log\frac{\mathbb{P}(X_i,X_{V_S(A)}|X_{U\setminus\{i\}})}{\mathbb{P}(X_i|X_{U\setminus\{i\}})\mathbb{P}(X_{V_S(A)}|X_{U\setminus\{i\}})}\right|\Bigg) \\ &= \frac{1}{d}\sum_{U\in\mathcal{C}}\sum_{A:U_S(A)=U}\frac{1}{\binom{d-1}{|A|-1}}(I_a(X_i;X_{V_S(A)}|X_{U\setminus\{i\}},Y) + I_a(X_i;X_{V_S(A)}|X_{U\setminus\{i\}})) \\ &\le 2\varepsilon.\end{aligned}$$

Let $R(U) := [d] - U \cup \{\max(u-1,1), \min(u+l+1,d)\}$. If we have $X_i \perp\!\!\!\perp X_{R(U)}|X_{U\setminus\{i\}}$ and $X_i \perp\!\!\!\perp X_{R(U)}|X_{U\setminus\{i\}}, Y$ for any $U \subset [d]$, then $\varepsilon = 0$, which implies $\mathbb{E}|\tilde{\phi}_X^{[d]}(i) - \phi_X(i)| = 0$. Therefore, we have $\tilde{\phi}_X^{[d]}(i) = \phi_X(i)$ almost surely.

Case 2: We now turn to the general case $S \subset \mathcal{N}_k(i) \subset [d]$. Similar as above, we can show

$$\mathbb{E}|\tilde{\phi}_X^k(i) - \hat{\phi}_X^k(i)| \le 2\varepsilon.$$

Based on Theorem 1, we have

$$\mathbb{E}|\hat{\phi}_X^k(i) - \phi_X(i)| \le 4\varepsilon.$$

Applying the triangle yields $\mathbb{E}|\tilde{\phi}_X^k(i) - \phi_X(i)| \le 6\varepsilon$, which establishes the claim.

C VISUALIZATION OF MNIST AND CIFAR10

C.1 MNIST

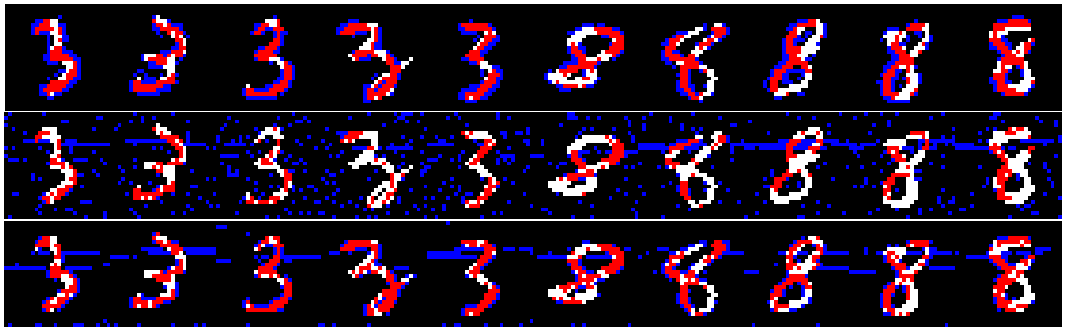

Figure 5: The above figure shows explanation results on ten randomly selected figures of 3 and 8. We mask 118 pixels out of 784 pixels for each image, where the masked pixels are colored with red if activated (white) and blue otherwise. The masking scores are produced by ConnectedShapley, KernelSHAP and SampleShapley for each row respectively.

C.2 CIFAR10

Figure 6: The above figure shows explanation results on ten randomly selected figures of horses and deers. We mask 205 top pixels chosen by each method out of 1,024 pixels for each image. The first row shows the original images. The rest of the rows show images masked based on scores produced by ConnectedShapley, KernelSHAP and SampleShapley respectively.

D VISUALIZATION ON IMDB WITH WORD-CNN

Only the ten words with the largest scores and the ten words with the smallest scores are colorized. The words with largest scores with respect to the predicted class are highlighted with red. The ten words with smallest scores with respect to the predicted class are highlighted with blue. (In other words, red words tend to contain positive attitude for a positive prediction, but negative attitude for a negative prediction.) The corresponding RGB entries are linearly interpolated based on importance scores. The lighter a color is, the less information with respect to the prediction the corresponding word is.

Table 3: Visualization on IMDB with Word-CNN

Class	Perturbed
positive	This was the second Cinemascope spectacle that Fox produced after the Robe . Notice how some of the Roman sets are redressed to pass for Egyptian sets . The film is produced with all first class elements , beautiful photography , stirring soundtrack (Alfred Newman and Bernard Herrmann _ see if you can tell which composer scored specific scenes). However , the principal acting is a bit weak . Edmund Purdom seems to have a limited range of emotions and is uninteresting to watch . The best performances come from Peter Ustinov as the one _ eyed slave and Polish actress Bella Darvi as the Babylonian temptress Nefer . I find this movie in general to be strong on plot which is rare for these large spectacles produced at the time . All in all , the film does an interesting and entertaining job of social commentary on what Egyptian society might have looked like .
negative	I saw this movie only because Sophie Marceau . However , her acting abilities its no enough to salve this movie . Almost all cast dont play their character well , exception for Sophie and Frederic . The plot could give a rise a better movie if the right pieces was in the right places . I saw several good french movies but this one i dont like .
negative	If it wasnt for the performances of Barry Diamond and Art Evans as the clueless stoners , I would have no reason to recommend this to anyone . The plot centers around a 10 year high school reunion , which takes place in a supposed abandon high school (looks more like a prop from a 1950s low budget horror flick), and the deranged student the class pulled a very traumatizing prank on . This student desires to kill off the entire class for revenge . John Hughes falls in love with his characters too much , as only one student is killed as well as the lunch lady (Goonies Anne Ramsey). Were led to believe that the horny coupled gets killed , but never see a blasted thing ! This is a horrible movie that continued National Lampoons downward spiral throughout the 80s and 90s .

negative	I have read each and every one of Baroness Orczys Scarlet Pimpernel books . Counting this one , I have seen 3 pimpernel movies . The one with Jane Seymour and Anthony Andrews i preferred greatly to this . It goes out of its way for violence and action , occasionally completely violating the spirit of the book . I dont expect movies to stick directly to plots , i gave up being that idealistic long ago , but if an excellent movie of a book has already been made , dont remake it with a tv movie that includes excellent actors and nice costumes , but a barely decent script . Sticking with the 80s version .... Rahne
negative	I viewed this movie in DVD format . My copy may have been affected but I was disappointed with the lack of menu screen for the DVD . I will say that my initial reason for viewing this movie was Claire Forlani . While fun to watch , I feel she didnt live up to my expectations that I have so far found from her other films . I actually was equally pleased to see Arkin turn in a humorous performance . The other two actors I wasnt very familiar with so I cant compare their performance , however they were fairly enjoyable also . The acting is the only endearing quality of this movie in my opinion . The story line , while some could say slightly compelling , lacked direction . I feel that the main problem stems from the script and not the direction of this film . If you enjoy any of these actors to a fair extent then I recommend this film , but otherwise leave it alone .
positive	This is a wonderful look , you should pardon the pun , at 22 women talking about breasts __ theirs , their mothers , other womens , and how they affect so many aspects of their lives . Young girls , old women , and everyone in between (with all shapes , sizes , configurations , etc) talk about developing , reacting , celebrating , hiding , enhancing , or reducing their breasts . Its charming , delightful , sad , funny , and everything in between . Intercut with documentary footage and clips from those famous old young womens films that the girls got taken to the cafeteria to see , the interviews are a fascinating window for men who love women & their breasts into what the other half has to say when they dont know youre listening .
positive	This movie doesnt have any pretense at being great art , which is good . But it is a well written script with well developed characters and solid acting . I think if I wrote it I could do without the drama surrounding the wife , but it wasnt distracting enough to detract from the main story concerning Minnie Drivers character . I think that all too often Hollywood abandons an attempt at real quality writing to try and inject more visual drama when , with an adult themed movie such as this , the emotional type of drama is all thats really needed _ and probably more believable too . Overall , its a very well done offering and well worth seeing .

negative	Fairly appalling enterprise suggests Welsh to be an infantile artist , helplessly drawn to the violent milieu he knows best , but unable to resist vacuous elaborations rooted in banal fantasy . The first story is a ham _ fisted , meaningless trudge with a B _ movie sci _ fi premise . The second achieves some poignancy , but only via the outrage _ inducing surplus of humiliation visited on its central character . The third and most risible seems to aspire to being a dislocated sequel to Childs Play . The direction is consistently clueless _ all whirling sound and fury , a slave to the extreme unpleasantness of the environment ; suffocating in an ill _ chosen music score and in indifferently flashy acting . This is sheer stupidity masquerading as a guerilla sensibility _ as arbitrary and hollow as the abstract images that link the three sections .
positive	This movie embodies the soul of modern elite foodculture , even though the movie is 17 years old . The standing principle in the movie is : Food is more than just nourishing matter . It is also a powerful symbol and a medium for culture itself . The main characters literally get drunk on the finest wine and food , become inspired by idealistic thoughts and culture , as they let go of their puritanism and passion _ denying table manners . Karen Blixens shortstory makes use of the difference between North Europe and South Europe , to point out their inherently different approaches to food . As the strict and and rather dull scandinavians get infused with Eros from south , the party gets going . So what are you waiting for ? Go watch it ..... again !
positive	This is just as good as the original 101 if not better . Of course , Cruella steals the show with her outrageous behaviour and outfits , and the movie was probably made because the public wanted to see more of Cruella . We see a lot more of her this time round . I also like Ioan Gruffudd as Kevin , the rather bumbling male lead . To use Paris as the climax of the movie was a clever idea . The movie is well worth watching whatever your age , provided you like animals .
negative	I vowed a long time ago to NEVER , EVER watch a movie that has ANYONE who EVER was a regular cast member of Saturday Night Live . I didnt rent Corky Romano but I was forced by my unfailing good manners to watch it for half an hour . Then my good manners failed . Stupid , not funny . Tedious , not hilarious . Bad , not good . That in a nutshell is all I can say for this video .
positive	this took me back to my childhood in the 1950 s so corny but just fab no one ever could play FLASH GORDON like LARRY BUSTER CRABBE , just great . i have two more series to view flash gordons trip to mars and flash gordon conquers the universe cannot wait

positive	I loved this movie and i never knew it was this old it came out the day n year i was born in and now i am 19 now i still love this movie especially the songs like My Mother and Boys and Girls of Rock N Roll and i remember as a kid i believe i was 5 n my sister was 6 and my cousin (boy) was 6 as well we used to pretend to be the characters in the movie i was Eloner and Janette and my sister was Britany and my cousin was Alvin Simon and Theodore those were good times and i miss it and having this movie reminds me of the good times since my cousin is old for this stuff and so am i and my sis we are not going to forget about the chipmunk and the chipmunk movie i still even remember the songs and the words off by heart even though i havent seen this movie for 12 years but now starting to love it again ALVIN AND THE CHIPMUNKS AND CHIPETTES < 3 < 3 < 3 < 3
positive	Magnificent and unforgettable , stunningly atmospheric , and brilliantly acted by all . I really cannot understand what sort of people are panning this masterpiece and giving the preponderance of votes as 8 (and nine ones !) This , along with Grapes of Wrath , is John Fords greatest movie . I would say that Long Voyage Home is next in line , though quite a way back . Rating : 10 . It deserves a 12 .
negative	I agree with most of the Columbo fans that this movie was an unnecessary change of format . Columbo is a unique cop with unorthodox police methods . This movie looks like a remake of any other ordinary detective dramas from the past . And that is the disturbing point , because Columbo is no ordinary detective . There are two parts in this film that left me intriguing . First , I cant figure out the title of this movie . It is misleading . Maybe a better title wouldve been The Vanishing Bride or something similar . Second , Columbo hides a piece of evidence without offering the reason (to the viewers at least) why he does it . I dont feel betrayed , just disappointed . Im glad Peter Falk went back to the usual Columbo .
positive	The Battleship Potemkin is now the oldest film Ive seen and it is also the first silent film Ive seen . I heard a lot of good things about this movie so I got the tape out at home and I watched it . When it ended I just thought that this was a classic masterpiece . The story is based on the real _ life Russian Battleship Potemkin . You wouldnt think it but some of it was sad and disgusting . Sad being that the mother dies and the pram rolls down the stairway and disgusting being they have to eat rotten meat with maggots in it . Today it is still considered to be one of the best silent and Russian films ever made . I think that everyone should see it (if they can find it .) You will be presently surprised at how good it is . Its a must see classic . 5 / 5 .

positive	Mani sir as usual brings out another amazing story with Kannathil Muthamittal . Such an amazing relationship between parents and child is brought out in a beautiful fashion . Mani Sir as usual without much special effects and not much outdoor shoots .(In fact this was the only movie where he went outside India ever .. that too just to sri lanka). Manis class is written all over the movie ... and to add to it ARRs music .. which is just amazing ... Vellai Pookal is one of my most fav songs ever ... Maddy , who is what he is in the film industry has impressed a lot too . Starting from alaipayuthey , to kannathil to ayutha ezuthu to guru .. Mani ratnam has showed to the world what a versatile actor Maddy is . Simran has been really good too . She has showed that she can act too in non _ glamorous and character roles . In all an amazing movie . Sad that the tamil public could not appreciate this gr8 movie and it bombed at the box _ office ....
negative	It is way beyond me how this script was ever sold much less produced and distributed . The dialogue was so bad it was sickening . The train and helicopter scenes appeared to have been done on flash cards by high school students . Lou Diamond Phillips must have hidden under his seat when this ___ this movie ? was shown at a private screening afterwhich he most likely left by the back door . The only emotion it aroused in me was pity for the cast , they had to bite the bullet to get through this one . I couldnt stand to watch all of it , it was so predictable that it was funny . Who knows maybe it will be picked up by one of the networks as a situation comedy .
positive	Going into seeing this movie I was a bit skeptical because fantasy movies are not always my cup of tea . Especially a romantic fantasy . Little did I know that I was in for a ride through cinematic magic . Everything in the movie from plot to dialogue to effects was very near perfection . Claire Danes shines like the star she is in this movie . From beginning to end you fall more and more in love with this character . Michelle Pfeiffer is menacing as an evil witch bent on capturing the star for eternal youth and beauty . Robert De Niro is a lovable character who gives the audience the greatest bit of comic relief as the movie is gaining momentum towards the climax . Overall this was a movie that surprised and delighted me as a movie fan . If you are looking for a fun and enjoyable movie that will be fun for the kids and adults alike , Stardust is the way to go .

positive	Goodbye , Mr . Chips is a superbly written and photographed musical version of the classic 1939 film . Aside from Peter OTooles wonderfully controlled , understated performance as the pedantic schoolmaster who finds love and is changed by it , the film contains hundreds of stunning visuals , from Grecian ruins to London side streets to an extended countryside montage . The music and lyrics by Leslie Bricusse have been criticized as being dull or not _ up _ to par for film musicals , but they are used to enhance the story rather than tell it . Many songs are used to underscore montages or scenes ; the few that dont are relegated to show biz numbers . In this manner , the songs do not intrude upon this delicate story but heighten what the characters are thinking or feeling . Where Did My Childhood Go ?, Walk Through the World With Me , and You and I are especially effective . An absorbing , brilliantly acted , directed and written film .
negative	The plot of Edison was decent , but one actor in particular ruined the entire film . Justin Timberlake ruined the film with every line he uttered during the movie . He is by far one of the worst actors I have ever seen , and should face the same fate as the entire F . R . A . T . squad . Whether it was an emotional scene , an action scene , or even a silent scene , Justin Timberlake managed to ruin it . Do not waste your time watching this film . Dont even bother downloading it , midget porn would be a much better choice . And Justin , if youre reading this , stick to music . Even though youre no good at that , youve done a wonderful job tricking people into thinking you can actually sing .
negative	The scariest thing about this horror movie is that the end alludes to a sequel . The Cave is really a disappointing action movie . A team of cave and undersea researchers go to Romania (one of these inexpensive places to make a movie , for now at least) and following a destroyed church enter in a cave that proves to be a realm of underground monsters . Or are they daemons ? The movie never decides if it wants to be action , science fiction , or horror , it is a mix of all without salt or fun , and acted in a wooden manner . The best thing about the movie is the cinematography , but even the dark landscape of the cave becomes soon boring , because the film lacks pace and the characters are simply not interesting . Waste of time .

negative	I purchased this movie at a car boot sale , so I was not expecting it to be a horror movie on the same level as A Nightmare on Elm Street (1984) or The Hills Have Eyes (1977) but I thought that it would still be fairly enjoyable to watch . However , it proved to be not at all enjoyable , but instead the acting and the general movie was mock _ able , such as the ways the the unsees killer murders his victims and how all of the people killed just happen to be young blonde women . It was a stereotypical horror film . I say this because of the following reasons : 1) Three blonde women in danger , the majority get killed . 2) One survives by crawling around in the dark while being chased by the killer . 3) Surprise surprise , help arrives in the form of a shotgun ! By using three simple points , I have saved you two odd hours by summarising this poor excuse of a horror movie , so you are now lucky enough to not have to watch it .
negative	Kind of drawn in by the erotic scenes , only to realize this was one of the most amateurish and unbelievable bits of film Ive ever seen . Sort of like a high school film project . What was Rosanna Arquette thinking ?? And what was with all those stock characters in that bizarre supposed Midwest town ? Pretty hard to get involved with this one . No lessons to be learned from it , no brilliant insights , just stilted and quite ridiculous (but lots of skin , if that intrigues you) videotaped nonsense .... What was with the bisexual relationship , out of nowhere , after all the heterosexual encounters . And what was with that absurd dance , with everybody playing their stereotyped roles ? Give this one a pass , its like a million other miles of bad , wasted film , money that could have been spent on starving children or Aids in Africa .....
negative	Yes , In 35 years of film going I have finally viewed the stinker that surpasses all other ghastly movies I have seen . Beating Good Will Hunting Baise Moi and Flirt for sheer awfulness . This is pretentious blige of the first order ... not even entertaining pretentious bilge . The effects are cheap , and worse _ pointless . The script seems to have been written by a first year film student who doesnt get out much but wants to appear full of portent ! The acting is simply undescribably bad _ Tilda Swinton caps a career filled with vacuous woodeness with a performance which veers neurotically between comotose and laughable intensity . Apparently , some fool out there has allowed the director of this film to make another one ... be warned

positive	I find it sad that just because Edward Norton did not want to be in the film or have anything to do with it , people automatically think the movie sucks without even watching it or giving it a chance . I really hope Norton did not do this . He is a fine actor and all but he scared people away from a decent movie . I found it entertaining . It wasnt mind blowing or anything with crazy special effects , but it was not a bad . It was fun to watch . But yea , definitely not a bad / horrible movie . 7 / 10
positive	Beautifully done . A lot of angst . Friendship may not endure all , but in the end its all that matters , or so a group of friends learn . I have watched it over and over again . The music is also amazing . When Kei loses the one friend he has he gives up until he meets Sho , an orphan boy who is not repelled by his true nature . In the lawless streets of Mallepa they struggle for their own place among a melting pot of Asian races , and learn that sometimes being on top can cost you more than you are ever ready to pay . A surprise ending that grips as much as the whole movie does . I couldnt get enough of it . Gackt and Hyde do a wonderful job of acting , proving they are more than pretty boys who sing .
positive	What I Like About You is definitely a show that I couldnt wait to see each day . Amanda Bynes is such an excellent actress and I grew up watching her show : The Amanda Show . Shes a very funny person and seems to be down to earth . Holly is such a like _ able person and has an out _ there personality . I enjoyed how she always seemed to turn things around and upside down , so she messed herself up at times . But thats what made the show so great . I especially loved the show when the character Vince came along . Nick Zano is very HOT and funny , as well as Gary , Wesley Jonathan . The whole cast was great , each character had their own personality and charm . Jennie Garth , Allison Munn , and Leslie Grossman were all very interesting . I especially loved Lauren ; shes the best ! She helped make the show extra funny and you never know what shes gonna do or say next ! Overall the show is really nice but the reason I didnt give it a 10 was because theres no more new episodes and because the episodes couldve been longer and more deep .
positive	Ive watched the first 17 episodes and this series is simply amazing ! I havent been this interested in an anime series since Neon Genesis Evangelion . This series is actually based off an h _ game , which Im not sure if its been done before or not , I havent played the game , but from what Ive heard it follows it very well . I give this series a 10 / 10 . It has a great story , interesting characters , and some of the best animation Ive seen . It also has some great Japanese music in it too ! If you havent seen this series yet , check it out . You can find subbed episodes on some anime websites out there , its straight out of Japan .

positive	Jane Porters former love interest Harry Holt (Neil Hamilton) and his friend Martin (Paul Cavanagh) come to Tarzans hidden away jungle escarpment searching for the ivory gold mine that is the Elephants Graveyard first seen in TARZAN , THE APE MAN ... only we soon discover both men have hidden intentions ... namely Jane . Will Tarzan stand for that ? Not likely (in fact Tarzan wont even stand for any disturbance done to the Elephants Graveyard) and knowing this Martin attempts to take Tarzan out of the picture only he later finds himself in a world of trouble later he and his party (including Jane who leaves with them after she believes Tarzan is dead) is captured by a native tribe intent on feeding them to the lions .. will Tarzan be will and able enough to get to them in time ? This film is adventure filled with loads of scenes involving Tarzan and other facing down wild animals and a climax that grips the viewers interest and doesnt let up . The cruelty displayed towards animals and the portrayal of native people may disturb some today but all should remember this is basically fantasy adventure entertainment and shouldnt be taken so seriously .
negative	Based on a Ray Bradbury story ; a professional photographer (Brian Kerwin) returns to his modest home near a tiny desert town , where most of the citizens wishes he stayed away . A lonely boy (Jonathan Carrasco) latches onto him for the attention ; and the two witness the landing of an alien craft in the rocky region of the desert . The aliens turn themselves into the images of townspeople . Kerwin must convince evacuation of the town and falls in love with the young boys mother (Elizabeth Pena). Acting is pretty shallow ; the story line is no worse than some others ; this movie leaves you feeling that you got shorted on a decent ending . Supporting cast includes : Howard Morris , Dean Norris and Mickey Jones .
negative	very badly made film , the action / violence scenes are ridiculous . 1 point for the presence of Burton and Mastroianni + 1 point for the real tragic event of the massacre of the innocent italians : 2 / 10 .
negative	For a film made in Senegal , based , I guess loosely on Carmen , the book , by Prosper Merimee , this film doesnt achieve a mere resemblance of the story that has been made famous as an opera and as other films . Ms . Gai as the Karmen of the title is very good to look at . Her fiery dancing smolders the screen , as is the case with her torrid love scene at the beginning of the film . This is a Karmen that aims to please to all genders , but a real Carmen , she is not ! We would like to see Ms . Gai in other films in which her talent is better used than here .

negative	I dont think this can legally qualify as film . The plot was so flimsy , the dialogue so shallow , and the lines so terrible that I couldnt believe that someone actually wrote the lines down , said , Holy sh t ! This is a masterpiece and then actually pitched it to a producer . I , for one , am still dumbfounded and will forever remember this film as the mark of the degeneracy of intelligence in America __ that , and Crossroads , of course .
negative	Generally I dont like films directed by Sydney Pollack (The Firm being somewhat of an exception) and Ive never been a Robert Redford fan either . Still , I thought Three Days of the Condor must be good because of the number of praising comments it has received . Although the widescreen cinematography is quite pleasing for the eye and Max von Sydow does a nice job as the sinister professional killer , I found the whole affair tremendously disappointing . The film undeniably radiates paranoid atmosphere , but everything is ruined by the muddled plot which doesnt seem to make any sense . The film also contains one of the most unsatisfying endings I have ever seen which really leaves the viewer hanging in the air . And what can one say about that absurd romance between Redford and Dunaway ? Id much rather watch any of Hitchcocks films five times in succession than to sit through this piece of waste once more .
negative	J Carol Nash and Ralph Morgan star in a movie about a mad scientist in love with a pianists daughter . When his advances are spurned he injects the father with a disfiguring disease so that she will be forced to come to him to get a cure . God this is awful . Its dull and boring and youll nod off before the pianist gets uglified , I was on the verge . Yea it picks up once things are set in motion but this is one of those old movies better remembered then seen again . If you must see it come in late4 out of 10
positive	GEORGE LOPEZ , in my opinion , is an absolute ABC classic ! I havent seen every episode , but I still enjoy it . There are many episodes that I enjoyed . One of them was where Amy (Sandra Bullock) walked into a moving piece of machinery . If you want to know why , youll have to have seen it for yourself . Before I wrap this up , Id like to say that everyone always gave a good performance , the production design was spectacular , the costumes were well _ designed , and the writing was always very strong . In conclusion , even though new episodes can currently be seen , I strongly recommend you catch it just in case it goes off the air for good .

positive	Here is a movie of adventure , determination , heroism , & bravery . Plus , its set back in the late 1800s which makes it even more interesting . Its a wonderful , adventurous storyline , and Alyssa Milano is wonderful at playing the wholesome , confident , no _ nonsense Fizzy ... a great role _ model . This is one of my favorite movies . It is a movie to be watched again and again and will inspire you and enrich your life without a doubt . Not only is the storyline excellent , but the movie also has fabulous scenery and music and is wonderfully directed . This movie is as good as gold !
positive	This is a gorgeous movie visually . The images of the Mexican desert , the old mansion , the characters in their picturesque costumes ... all amount to a real work of art . The story seems a bit loose , but thats because its not meant to be realistic . It is taken from a book called One Hundred Years of Solitude , and it is supposed to be an evocation of the isolated , otherworldly atmosphere of Latin America so far from God , and so close to the United States . The tremendous debt that Erendira owes to her grandmother is symbolic of Latin Americas international debt burden , although there many layers of meaning . If you can appreciate a slow _ moving , richly _ textured movie , this one is for you .
negative	Having broken into a secret database file for matching DNA serums , federal agent Frank Poo (Andy Garcia) discovers the only person who can save his sons life is a psychopath , played by Michael Keaton . However , when a serum transfer at the local hospital goes terribly wrong , a certain Mr . Poo has to do everything in his power to ensure the madman stays alive in order to make the inevitable transfer possible . By the way , his name isnt really Poo , I just feel like calling it him . Despite the original concept at hand , this is an implausible and turgidly unexciting action thriller . Ive never been a big fan of Andy Garcia , and granted his charecter here isnt that attachable , this movie winds up all the worse . The action sequences are handled pretty disappointingly , and the ending sucks pretty bad . Having done a great villain in Pacific Heights , Keatons psychopathic bad guy here is a let down , providing a madman too funny and charismatic to be deplored . Brian Cox is also wasted as Garcias firm and frank superior .
positive	I loved this . It starts out as a fairly normal , slightly ponderous French art movie and then all of a sudden , halfway through its turned on its head . This part is brilliant as you realise you have been watching 2 plots not one . Sadly , the ending doesnt make much sense , which is a great shame . Oh yes , and its brilliantly filmed .

negative	The game of hockey I play and watch has something called speed which the actual hockey scenes in this limp movie never even come close to capturing . Add to that a storyline that is clich , predictable and stupider than stupid with some of the lamest 80s music numbing your senses in every scene and you have Youngblood . Oh , Keanu as a French Canadian , yeah , whatever . Gimme Dunlop , Braden and the Hansons anytime ... ONE out of TEN .
negative	Poor action films are the graveyards for aging martial art stars . In such films they struggle to maintain that dangerous demeanor that made their early work successful , but they all end in failure . Seagal is too old for this type of role but he wont let go ... no matter how silly he looks . Some hope his current work will somehow bring back the magic , but there is no magic left . The late 80s and early 90s belonged to Steven Seagal and his work made me a fan . I could see him fit nicely in a slot on The Sopranos where his overweight body , jowly features and sullen attitude could have found a home . I wonder what the return is on his run of direct to video films ?! Since he produces them Im assuming the $$$ is more than satisfactory . If this is the deal we will be subjected to poorly done Seagal action films well into his late 60s and 70s .....
positive	Bend it like Beckham is packed with intriguing scenes yet has an overall predictable stroy line . It is about a girl called Jess who is trying to achieve her life long dream to become a famous soccer player and finally gets the chance when offered a position on a local team . there are so many boundaries and limits that she faces which hold her back yet she is still determined and strives . i would recommend it for anyone who likes a nice light movie and wants to get inspired by what people can achieve . The song choices are really good , hush my child , just move on up ... to your destination and you make boundaries and complications . Anyway hope that was at help to your needs in a review . Bend it like Beckham great flick
negative	This crock of doodoo won a award ? They must have been desperate for giving out an award for something . This movie reeks of teeny bopper stuff and it made me sick . Thankfully I watched it alongside MST3Ks Mike and the bots so it made it bearable . Horrid acting , unsettling mother / daughter moment , silly premise , if you want a bad movie here it is . Be warned though watch it with Mike and the bots or you will suffer . 1 out of 10 . I still cant believe it won an award , and the director is defending this movie !

positive	What a gem of a movie , so good that they made a sequel . The film starts off really good with a nasty monster who eats a few people and a party where the 2 main characters first set eyes on each other . Bendan Hughes plays the eccentric Vlad , a bit of an inkling there to who this character is , who has moved into town and uses the services of a particular real estate agent to find him a house . Hell , weve all seen vampire movies , we know the format . The movie is watchable , but the actors performances are very wooden and they seem as they dont want to be in this film , but may be thats just all part of the decadent ambiance . Didnt like the ending , but there is a sequel , must track it down . When I watched the film I thought Brendan Hughes didnt really fit the part . Later on , I couldnt stop thinking about him , he sort of exudes an eerie sensuality , so maybe he was right for the part . BRENDAN HUGHES Last seen in Hitler _ the rise of evil as Lt . Guffman . Where is he now ?
negative	I had never heard of this one before it turned up on Cable TV . Its very typical of late 50s sci _ fi : sober , depressing and not a little paranoid ! Despite the equally typical inclusion of a romantic couple , the film is pretty much put across in a documentary style _ which is perhaps a cheap way of leaving a lot of the exposition to narration and an excuse to insert as much stock footage as is humanly possibly for what is unmistakably an extremely low _ budget venture ! While not uninteresting in itself (the _ apocalypse _ via _ renegade _ missile angle later utilized , with far greater aplomb , for both DR . STRANGELOVE [1964] and FAIL _ SAFE [1964]) and mercifully short , the films single _ minded approach to its subject matter results in a good deal of unintentional laughter _ particularly in the scenes involving an imminent childbirth and a gang of clueless juvenile delinquents !
positive	There have been several films about Zorro , some even made in Europe , e . g . Alain Delon . This role has also been played by outstanding actors , such as Tyrone Power and Anthony Hopkins , but to me the best of all times has always been Reed Hadley . This serial gives you the opportunity to see an interesting western , where you will only discover the real villain , Don del Oro , at its end . The serial also has good performance of various actors of movies B like Ed Cobb , ex _ Tarzan Jim Pierce , C . Montague Shaw , eternal villains like John Merton and Charles King , and a very good performance of Hadley as Zorro . He was quick , smart , used well his whip and sword , and his voice was the best for any Zorro .

positive	Two years after Airplane ! took off , Jim Abrahams , Jerry and David Zucker cast one of its stars _ Leslie Nielsen _ in this hilarious television series , a glorious take _ off of old U . S . detective shows such as Dragnet . Nielsen played Frank Drebin , Americas answer to Inspector Clouseau . It had the same style of humour as Airplane !; clever visual gags in the background , unnoticed absurdities , and recurring characters such as Johnny the shoe _ shine boy who seems to know everything about everything . Guest _ stars (including William Shatner !) were killed off in the opening credits . Police Squad was the first U . S . sitcom since Batman to lack a laugh track . Many have lamented the fact that only six episodes were made , but I think it was about right . The concept could never have sustained a full 24 _ episode run . Five years later , Police Squad made a successful transfer to the big screen , when the first of the Naked Gun trilogy was released . Jim , Jerry , David , and Leslie had the last laugh .
positive	this movie was one of the best disney movies ive ever seen . great for the entire family to watch . the ideas may be a little far _ fetched , but its a feel _ good comedy and the acting is great . love the little boy , j . p . and academy award winner adrien brodys part may have been very short , but very memorable . highly recommended .
negative	The Bone Snatcher is about a group miners who go on a search for a missing crew of miners in the Namib Desert . When the find them , they are nothing more than bones stripped clean and they could not have been dead for more than six hours . The story keeps you interested as to what exactly caused this . The characters are well enough , and the acting is pretty good . About an hour and ten minutes in when you find out what is causing the bones to be stripped clean , you sigh oh , that is really stupid . The movie is ruined by bad writing and a non _ exciting ending . Up until that point , the movie was pretty good , and it is a shame that it took such a bad turn . So I cannot recommend this movie . I gave it a 4 / 10 .
positive	A delightful piece of cinema storytelling in a simple but effective way . Cinema after all is a visual media and Igor used its full potential . A young restless man boards a train with no destination in mind . In one of the compartments he meets with a girl . Words are not exchanged but their laundry washing are and from there we are taken on a ride with other peculiar characters and situations . The two leads are perfectly cast as their unique features tell you a story that needs no words .

positive	The story and music (George Gershwin !) are wonderful , as are Levant , Guetary , Foch , and , of course , Kelly . One things missing , and that thing is a good leading lady . Im sorry , Leslie Caron bothers me . Anyway , despite her , the plot moves along nicely with the famous (and deservedly so) Ballet . Oh the colours , the dazzling reds , blues , greens , and yellows . Musnt forget the beiges as well . ;) I just adore the contrast between the Beaux Arts Ball (completely black and white costumes) and the ever _ so _ brilliant Ballet . So I suppose what Im trying to say is this : Please , by all means see it , and enjoy it , because though it isnt the best , it is MARVELOUS . But be sure not to forget that other Gene Kelly musical with the 20 year old girl that was catapulted to stardom just afterward .
negative	Well it certainly stunned me _ I can not believe that someone made another Australian film thats even more boring than Somersault . The story is implausible , the characters , with the exception of Friels and Mailmans characters , are unlikeable and wooden , Tom Long possesses a VAST array of facial expressions : happy and not happy , and the sex scenes , which could have been very confronting and disturbingly erotic , would have been at home in a low _ budget porno flick . This is the first movie I have seen in 30 years of cinema _ going that has had me on the edge of my seat .... ready to get up and leave . The best thing about this movie is the promotional poster .
positive	The main reason I loved this movie is because IMx (formerly Immature) were in it . They were in House Party 3 when they were 11 , but they are all grown up now ! I was a little shocked at some of the things they were doing in the movie (almost ready to tear my hair out), but I had to realize that they were not my little boys anymore . I think Chris Stokes did a pretty good job , considering that is was his first movie .

positive	The majesty of Ramin Bahranis second feature is that , like the work of a poet , he portrays the very soul of humanity and lets it flourish on the screen . Beyond the scope of most other indie films out there , CHOP SHOP is wise , exuding the very best of the great cinema of the ages ; we can look back at the works of Bresson and Pasolini and compare Bahranis work to theirs , and yet CHOP SHOP is fresh and urgent to modern society . We can see the workings of a master here a certain sense of beauty , style , and content all merge together in a film that reminds us what it means to be alive . Instead of focusing on the side of NYC we so often see , we live and breathe with our young hero , Alejandro , in the destitute Willits Point a fascinating quasi _ sub _ world of our culture and yet its a very , very real place . Trying to stay afloat , Alejandro has to support himself and his older sister . Watch this film and feel the sense of raw spiritual understanding that Bahrani leads us toward all with profound and concise realism .
negative	I truly hate and despise this film and the filmmakers behind it . Sure , Im all for making a hard hitting and honest film about youth and youth culture . 1987s Rivers Edge is an excellent example of a well _ made teen drama . However , what I take exception to is the infantile , grubby and sensationalist approach that the makers of 2 : 37 took . A prime example is how it raises so many issues and yet fails in any significant way to comment or reach a resolution on even one of them . My other major problem with this film , apart from its complete plagiarism of Gus Van Sants Elephant (surprised Van Sant didnt sue) is its bull loose in a china shop attitude to quite delicate issues such as incest and particularly suicide . In short , avoid this film like the plague and anything that this filmmaker ever is involved with subsequently . Ive heard that his motivation for making 2 : 37 may or may not be based on lies . Having seen the substandard result , this doesnt surprise me in the slightest . This is a glorified student film exercise that has no place whatsoever being in a cinema or on DVD . Pure and simple .
negative	When I first started watching this movie I was looking for some kind of subtle metaphors but it soon dawned on me that this movie was indeed about people on a train . The interactions between people are like those you can see any day on the street and when in occasion there is a slightly more interesting situation the dialogue becomes stilted and boring . Its not that I dont get how this film is trying to portray the way people interact , its just that in this film they are very boring . If you want to see and analyse these kinds of relationships youd be best to actually go out and buy a train ticket and look at the people on the train with you . It is realistic but you wouldnt go to a movie to watch a film about you sitting there watching the movie .

positive	An excellent depiction of one of the more unwholesome aspects of that era . I loved the visuals __ very fitting for a story connected to a graphic novel . I thought Tom Hanks was really great in this , he came across very well as someone who has been hardened by his work (which he didnt fully choose for himself) but still wants to have a normal life for his family . He does the best he can to see that happen . DOnt want to spoil the plot __ but YOU HAVE TO SEE this movie if you are a person who wants more from a movie than the usual shoot em up action / gangster format . (It is violent though .)
positive	One Dark Night is a staple in the 1980s low budget horror genre . Filled with retro puns , clothing and scenery , ODN transports the viewer to a simpler time , when horror films were just that ... Horror ! Nothing so intense that you cant understand whats going on , the film tells a dark fable of what happens when you mess with the dead . Well acted by its stable of scream _ queens , and a fine directorial job by Tom McLoughlin , whom revels in the time and makes you believe what hes presenting . There is no Who done it ? and certainly no big twist at the end . It is straight _ forward and in your face horror from beginning to end , with a lot of 80s humor thrown in for added spice . I give it 8 simply because some of the special effects fall short towards the end of the film , but at least there is no CGI ... Perfect film for new fans to the 1980s horror genre , or anyone looking to re _ live a fun night of classic horror bliss .
positive	This movie will go down down in history as one of the greats , right along side of Citizen Kane , Casablanca , and On The Waterfront . Someone please convince Leno to do a sequel ! Leno and Morita are a comedy duo , the likes of which havent been seen since Abbot and Costello . The evil that emanates from Chris Sarandon , Tom Noonan , and Randall Tex Cobb will give you the chills . Dingmans character as the buffoonish oaf hearkens back to the days of Shakespeares comedies . And the climax . My goodness , the climax . I wont ruin it for you , but it makes the explosion of the Death Star pale in comparison . If you can track down this hard _ to _ find gem , do yourself and your family a favor and buy it immediately . Im still holding out hope for a special edition DVD one of these days .

positive	Making this short and to the point . This movie was great ! I loved it ! I actually picked this up at a Hollywood Video for 3 bucks on VHS and watched it about 5 times in the last couple weeks . Im a big Bogart fan and I just latched onto this movie . I thought the song was funny and now have it as a ring tone on my phone . Robert Sacchi is great and pulls off a good Bogart . His nose is a little big , his voice is a Bogart _ Columbo mix , and he does a few things that are awkward but otherwise , he was fantastic and this film was wonderful . No one can be a perfect Bogart but he was great . Remember , Sam Marlow is a fan of Bogart and isnt going to do everything he did . He mentions a lot of other movies and does some things that were never part of the real Bogarts characters . But , its so funny and hilarious and has a great cast , including some beautiful women . Watch it and have fun !
positive	Otto Premingers Dana Andrews cycle of films noirs are among the (largely) unsung jewels of the genre . Because they lack paranoia , misogyny or hysteria , they may have seemed out of place at the time , but the clear _ eyed imagery , the complex play with identity , masculinity and representation , the subversion of traditional psychological tenets , the austere , geometrical style all seem startlingly modern today , and very similar to Melville . The lucid ironies of this film are so loaded , brutal and ironic that the happy ending is one of the cruellest in Hollywood history . Brilliant on the level of entertaining thriller as well , tense , and packed with double _ edged dialogue .
negative	I have always admired Susan Sarandon for her integrity and honesty in her private life as well as her talents as an actor . I therefor found it strange that she would appear in a film that so distorted that facts . Her characters rescue from the South Pole was done by a Canadian charter company from Edmonton , Alberta flying a Canadian designed and built Twin Otter aircraft . The trip had been turned down by the US Airforce , Navy and Coast Guard as beyond their capabilities . The same company staged a similar rescue a few years later to bring out a man from the South Pole base . I feel that the film fairly represented a very gripping subject and documented a very courageous woman facing a frightening task . I fail to see why the producers would find it necessary ignore the bravery of the rescue pilots and show the rescue plane as a USAF Hercules .

positive	I always enjoy watching this cartoon , with Sylvester trying to catch Tweety on a train , rather than at Grandmas house . Its actually a standard fare , but entertaining , especially when Tweety pulls the emergency stop cord . One of my complaints about this is how sloppy the animators were with the train . When you watch this over and over , like my little boy did (who loves trains , which is why he liked it so much), you begin to notice some things . Throughout this short , the position of the baggage car changes on the train , either 3rd , 4th or 5th , and in long shots not at all . The engine has either the number 651 or 814 , or none at all . The coal tender has either the number 99 , or the letters S . P . & Q . R . on it , or no number or letters at all . The coaches carry the S . P . Q . R . without the & in long shots , and then in closeups it has the words SouthEast and Western . All of this doesnt interfere with the story , but the production details were obviously not looked into very carefully . Still this cartoon is among my favorites with Sylvester and Tweety .
positive	I became a fan of the TV series ‘ Homicide : Life on the Street late in the shows run , but became a fan very quickly . It was a cop show unlike any other : visually different in its use of hand _ held cameras , taking the viewer everywhere , with its multiethnic and mutiracial cast and their varying and fascinating personalities , and that it covered all of the good and bad of a police department , including the corruption and personality clashes that bubble up to the surface . Homicide : The Movie , the reunion follow _ up to the series , is as good as a made _ for _ television film can be . After Lt . Giardello (Yaphet Kotto), now a candidate for mayor of Baltimore , is shot , the series cast members are back to help find the killer . In addition , the cast members who left the force and those who died , also manage to have their place in the film . The intensity and fire that marked the series return , and the script bristles with the same fire that marked the series . All in all , a terrific TV movie . Vote : 9

negative	Stumbled over this film on Amazon . com . Had never heard of its release but the three reviews gave it five stars and rave reviews so being a lover of German movies I bought a copy ... Have to say that I was not impressed . The production values are cheap , the story is derivative , the characters are less than engaging and for a comedy it is surprisingly short on laughs . I wanted to like this but I just found it lackluster and dull . Or maybe I expected more of independent German cinema than a gay spin on The Full Monty and a cast of stereotypes . There are bits in the film that make no sense at all , like one of the Leather Bears trying to get Ecki in a sling __ like hed even look at him twice ? Or the vengeful ex _ wife turning up at the match but ending up cheering for her estranged gay husband ? Bunkum is not the word ! Well , at least it explains the movies UK title , I suppose ...
positive	Joan Cusack steals the show ! The premise is good , the plot line interesting and the screenplay was OK . A tad too simplistic in that a coming _ out story of a gay man was so positive when it is usually not quite _ so _ positive . Then again , it IS fiction . :) All in all an entertaining romp . One thing I noticed was the inside _ joke aspect . Since the target _ audience probably was straight , they may not get the gay stuff in context with the story . Kevin Kline showed a facet of his acting prowess that screenwriters sometimes dont take in consideration when suggesting Kline for a part . This one hit the mark .
negative	Someone told me that this was one of the best adult movies to date . I have since discredited everything told to me by this individual after seeing this movie . Its just terrible . Without going into lengthy descriptions of the various scenes , take my word for it , the sex scenes are uninteresting at best . Jenna in normal street clothes in the beginning was the highlight of the film (she does look good) but its all downhill from there .
positive	Inherited this from my xs DVD collection when he left with my best friend (enough said), watched it one night when there was nothing on the telly (nothing new there then) and got a very pleasant surprise . Very British (you no hardly any budget , no faces you know or have even seen before), the accents were a bit thick for my liking , but after a worrying start (a bit too close to home in my case) it began to grow on me . Apart from the some unnecessary jokey cutting that really didnt add anything , I found the film throughly uplifting , very real , natural performances throughout left me wanting more from an ending that came suddenly too soon . Highly recommended !

positive	Sure it may not be a classic but its one full of classic lines . One of the few movies my friends and I quote from all the time and this is fifteen years later (Maybe it was on Cinemax one too many times !) Michael Keaton is actually the worst actor in this movie __ he cant seem to figure out how to play it __ but hes surrounded by a fantastic cast who know exactly how to play this spoof . Looking for a movie to cheer you up ? This is it but rent it with friends __ itll make it even better .
positive	Hey what do you expect form a very low budget movie !?!? Although I havent seen Dahmer (2002) I can say that following what the media put out about Jeff this is a pretty accurate depiction . I have studied the Jeffrey Dahmer case and learned all I can about this man . This is a low budget movie but it shows the mentality of a serial killer . If you can get past gore and see what the underlying story of a sick mind . I loved this movie ! Just brace yourself for low budget and no blood . Its a story as seen through the eyes of a killer and his actions and thoughts from childhood up through his arrest . My favorite line is : If they had bothered to look in the back seat it might have saved a lot of lives Enjoy !
negative	like im sure other people have said this guy isnt a very worthwhile subject . sure , our society has a morbid fascination with death , and its funny hearing him talk about how much he smokes and how much coffee he drinks , but hes into giving himself an unworthy mystique . anyway , the bottom line is that hes a moron racist using feeble methods to try to disprove the mountain of evidence of the holocaust , and as such he should be forgotten by time . but Morris is in love with any kind of curiosities , which normally i wouldnt fault him for .
negative	Historically awful . Scarcely an accurate moment in 4 hours of ridiculosity . One cannot keep track of the inconsistencies while watching . As with all track and filed movies , nobody bothers to ask for any track consultants . Events and techniques that werent even created until the next century are shown . From the shots of runners jogging in a 400 meters to the highly overweight actor portraying the high jump and long jump winner , one would have to know absolutely nothing about track to even be mildly entertained . Likely thrown together in 1984 as a tribute to the games just prior to the LA Olympics .

Table 3: Visualization on IMDB with Word-CNN.

E VISUALIZATION ON YAHOO! ANSWERS WITH LSTM

Only the ten words with the largest scores and the ten words with the smallest scores are colorized. The words with largest scores with respect to the predicted class are highlighted with red. The ten words with smallest scores with respect to the predicted class are highlighted with blue. The

corresponding RGB entries are linearly interpolated based on importance scores. The lighter a color is, the less information with respect to the prediction the corresponding word is.

Table 4: Visualization on Yahoo! Answers with LSTM

Class	Perturbed
Society, Culture	eve was the mother of cain and abel did she have any daughters yes read genesis 5
Family, Relationships	good guys why is it that women leave me because they say i am to nice please tell me they want some one who is disrespectful and who will use them there dad was probably like that so that is what they are use to its normal to them
Science, Mathematics	what effect may global warming have on britain it might rain less longer summers not so bloody freezing in winter oh and the small matter of maybe wales flooding n n n nso this global warming is a bad thing yeah
Politics, Government	so if our borders need fixing and let's agree that they do how do we pay for it the united states congress seems to come up with all kinds of money for a lot of silly things here are some examples n 75 000 for seafood waste research n 500 000 for the arctic winter games n 300 000 for sunset and beaches in california n 350 000 for the chicago program for the design installation and maintenance of over 950 hanging baskets n 600 000 for the abraham lincoln commission n 100 000 for the police department has a population of 400 people n 2 500 000 for the space flight center for process dry cleaning capability n 500 000 for construction of the museum nand the list goes on and on n i think we could find a few places to make cuts to pay for securing our borders
Society, Culture	why do filipinos are using language yet there is no such a language some of them are forced to resort back to filipino language when they don't have the necessary command of further english to complete their sentence similar to should you personally go to a foreign country you'll likely have studied up on the language but no doubt you'll get into a situation where you start a sentence in the foreign language but don't have the knowledge to complete it with to english

Computers, Internet	can anyone tell me how to link graphics in a c and java program i want to insert graphics in a c program how can it be done please give the coding or the link where i could find the info thanks it depends which compiler u r using if u r using c c compiler then just include graphics h file in ur code and start using its functions but these graphics are simple and limited in what we want to do instead u can search on the web for comprehensive libraries there r so many libs available on web w o any cost i mean free
Education, Reference	i need more time management skills can anyone help i'm a high school student who is also doing another course but i can't find enough time to get everthing done i'm a week or two behind already please help you can try managing your time by by importance and or deadline you can start attending to requirements that are due at an earlier date it also helps if you regularly study as compared to studying or for a test the night before because you are always prepared it will also be a good idea to start right away when projects are given as also not to you'll feel less stressed n nthere is no best time management for everyone each one has his own time management technique so try and find your own style that works best for you n ni hope this helps good luck
Sports	do the yellow cards in the world cup carry through to the second round they carry on to the next game if the next game is the next round then the yellow card is going to be there which causes the player to sit out
Sports	are wwe wrestlers are really getting hurts while fighting yes totally

Society, Culture	if psychics know it all why arent they rich from winning the lottery all the time or have no problems in their life cause they know whats going to you've asked a brilliant question indeed if psychics know all why aren't they able to control their own lives avoid accidents get rich on stocks or the lottery n nthe answer is clearly they don't know all in fact they don't know anything except how to money out of gullible people commercial psychics use tricks of observation to out tells like in poker about someone and make general statements that could apply to anyone similar to the poor client using their powers of observation and about people they tell the client amazingly accurate things that they figured out no spirit doing the sorry n n here's a prediction despite being psychics will continue to have customers because as said a sucker is born every minute
Health	can drink water help me lose some of the bulge around my waist i was wondering if it will help me lose some weight around the middle it most certainly can i drank nearly a 2 liter bottle of water a day and lost about 30 lbs in 2 months of course it helps to diet and exercise but water nearly does the trick but careful it will also flush your system and increase your appetite
Politics, Government	how can a person from another country come here at the age of 65 and collect social security and not pay in no not a dime in this country i was under the impression that you must put in in order to receive this is why we are having problems with social security now i know when i turn 65 i want all of my money and interest and i don't care what they call it i have heard that too and that is crap i think you should have to pay to get it and be a citizen of the us to reap our benefits i don't know who's bright idea that was but i'm sure as soon as they let us know he will not be a very popular man
Politics, Government	whats a good way to raise money to get someone out of jail i need to get 1500 to get them out no i would assume you mean to make bail not pay for an escape but also remember if they make bail in most places they can not use a pubic defender since making bail shows they have or had the money to hire thier own attorney n nwork second job sell your computer tv

Business, Finance	take charge or sit back i seem to be in a power struggle at work i am only 5 months into my job and i came to this one with a lot of experience i want to do a good job but the politics are such that my supervisor oh don't concern yourself with that i am of a that i kind of need or want to be in control not the bosses but acknowledged for what i know plz help me know what is best if you sit back like a good little girl and don't make any waves that is what you are going to be know for a good little girl that doesn't make waves nit sounds to me that your supervisor is a little nervous about her position she is going to retard the growth and progress of anyone she feels knows more than she nyou might start off by making documented suggestions document them so she can't claim they are her ideas then take it from there ni would rather hire someone who is going to help my company then one who sits on their thumbs
Education, Reference	what is number in the 50 states and what is the ranking size in place 5 residents at the last census 20th in a list of population by state n17 43 people per km ranked out of 50 na total area of 113 sq mi ranked 6th out of 50 a state on february 14 1912 state out of 50
Health	lenses would you go for the hard or soft lenses does it also affect your vision if it's hard or soft go for soft contacts and the disposable kinds i knew a friend who had the hard contacts and apparently she said they were uncomfortable i've also heard that if you eyesight is really bad they use the hard contacts but if you have the choice soft

Family, Relationships	am i the maid of honor or not my best friend is getting married while talking about weddings one day before she got engaged she said that when she get married i would be her maid of honor she's now planning her wedding and we talk about it at work all the time my problem lies here when over at a friend's house i heard her sister say that she was walking down the isle with ryan which is the best man my friend hasn't said that i wasn't going to be her maid of honor i don't know if her sister is just assuming she's the maid of honor or if my friend really asked her i don't know how to bring it up any suggestions it's a sensitive subject but i say ask being maid of honor isn't some achievement of a lifetime but it is important there are things that the maid of honor normally helps take care of bridal shower parties random errands etc you don't want her thinking you are her maid of honor but you're not planning certain things because you're not sure and just say that i need to know so i can get started if not that's ok but i want to be clear i know i had a similar problem when my husband proposed one of my friends thought she was going to be and when i didn't say that she asked me i answered crisis and she still danced at my wedding
Health	q about is the pain all over your body or can it be just in the lower or upper please let me know the pain from can be anywhere and everywhere each person is different
Computers, Internet	i only got 12 free space i need get some stuff off so i can have more space so i can defrag can someone help go to n nhttp www ccleaner com
Education, Reference	is it no one or noone or are both correct no one is correct
Business, Finance	i need help starting an ebay business where do i start start at ebay they have all the info you need

Family, Relationships	what would you guys do if a girl know for few months now you guys have fun together and seems like your made for each other she makes out with you you guys take each other's clothes off and when your away from doing it she tell you she dont want to get that far she dont believe in sex before marriage she have done this to you for about 3 times now and your still sticking around is it mean you really want to get in her pants or you really want to be with her wow well if he is that nice n good looking that he can have any girl he want to but even then he is being you that just tell the answer that he really like you and wants to be with you because if he was just for sex i am sure he would have gotten it from else where i would have to say wait around and really dont give anything up you have start taking steps to a long term strong relationship i am sure he respect you alot for this nbye
Family, Relationships	how do i get get my boyfriend of 3 yrs to get up for work on time he always gets up 5 min before he needs to go to work we leave at 6 i get up at um let him worry about it what are you his mom
Health	if a man has been in a facility for over a week does that mean they have a serious illness being in their for so long i have been in hospitals before for longer than 2 weeks a lot of it depends on how the person is doing they start them on meds and if they are o k they may come home in a few days if they have reactions to it and have to start them on another they may be there longer it also has to do with how well they participate in their treatment if they don't go to groups talk etc then the staff may think they are not healthy enough to go back out into the world just because he's been there over a week doesn't mean he's seriously ill people are admitted for different reasons depression etc it may just be that they don't think he has progressed enough to go home they may still be watching him on his meds
Education, Reference	do you have to register your homeschool in chicago illinois see org it will give you info on your state
Sports	do u think that usa is going to the finals thanks for the 2 points

Politics, Government	what does the aclu think it is doing other than being a i mean honestly free speech is important but people also have to have decency they are helping to strip the nation of our the values and that make us americans they are ensuring that no one is judged based on their actions that anything and everything goes n nthey used to protect americans right to free speech but now they are so far left they make the 9th circus court of appeals appear right wing
Politics, Government	what is a a is the holder of various important jobs including n n formerly the head priest in an when it had responsibilities n n the chief academic officer at various universities in north america n n an officer of local government including the scottish equivalent of a mayor the lord is the scottish equivalent of lord mayor in edinburgh glasgow and n n the officer in charge of military police n n sergeant a sergeant in charge of police in the british and commonwealth armies n n the administrator of a prison n n
Entertainment, Music	if your husband had cheap on his breath and wanted to take you in bed would you like it you mean like the mother on that movie carrie huh n nand i liked it i liked it n n
Entertainment, Music	how does a band register to play the 2006 sorry to tell you this but the deadline for a band to register for a at this year's festival has long passed but registration for 2007 will be available in august
Education, Reference	know any ways to keep a mind challenged i graduated with my degree last spring and i've realized i kinda miss being in school not the stress over deadlines or the few terribly boring classes mind you i miss the discussion about new ideas wrapping my head around a complex concept or being pushed to form my own opinions about these ideas and concepts i read a lot but i want other ways to keep my mind i'm also looking to start using my affinity for writing but i don't know where to begin read everything that you can get your hands on fiction non fiction books journals newspapers magazines don't just read the stuff so much of life comes from less than stellar sources so embrace it n nas for writing the best thing to do if you want to write and don't know what to do or how to begin is start writing a journal or even better a notebook and fill it with ordinary events larger events interesting words other people's conversations and even things you read in magazines or on the back of a shampoo bottle everyday life can provide tremendous material for writing

Health	aloe vera how do you rate it oh joy bliss instant soothing totally cleared the eczema on my hand i haven't had an attack there since i started using it 8 years ago and it smells nice
Sports	what is what is in the nfl are you referring to a comment made about is basically doing what you want not in your gap or zone and going for the ball
Politics, Government	does president bush have a clue as to what is going on in iraq yes he and i wish he would take more vacations like reagan and the rest did you don't want him to make mistakes but you want him to work non stop some people are nuts not wanting to stand behind their president he's in for 3 more years why do you want him to fail that hurts us more yes thanks to our beloved troops and to the iranian guy we love iranians just not your leader he's scary
Sports	england currently out of form is it the players or the coach who is to be blamed english football team is now in a depression i am hardly remembering a satisfactory win for england with its new coach steve i am in a doubt whether england could atleast get a position in is it fault or the players not all the days are the days of spring every team has to suffer from a lean period which is inevitable blaming the team or the coach is not right but we should encourage the team

Society, Culture	if languages evolved how come there are no half languages also what use is half a language n nany would have been useless there are many forms of are found in the and louisiana all evolved from french into something more or less distinct while similar enough to french that a french speaker could usually understand the of what is being said in and that a speaker could make himself better understood with effort it's separate enough that someone actually has to study the other to speak it fluently louisiana takes this evolution from french further and some expressions from english n n nanother half languages you might be interested in is which evolved from a dutch dialect with influences from french something possibly on the way to becoming a half language is the difference between french which is similar to medieval french and the more modern french spoken in france and the found in western africa another possibility is the differences between the various of the us alone can a understand the heavy of a or new not easily if at all and i'm not even mentioning all the dialects of the british n nwhenever you see languages in the same family they came from half languages and sometimes still are effectively half languages latin evolved separately in france spain italy and romania though for a short enough time each was still only a regional dialect or half language and could be understood by each other especially if they made the effort to clearly we can see the slow shifting of german as it went from the west to east through europe eventually becoming english a german can sometimes understand the of dutch even today with a lot of work and vice versa

Health	my mom is old got fracture what to do now my mom fell down on her back i took her to e r x ray showed a fracture in tail bone about 5 mm nthey do not recommend surgery just pain killer said she might have to take pain medicine always n ni want to know does this kind of fracture heal without surgery n nshe is very brave and is still walking nit is not hair line it is seperated the bone will heal on its own those are probably one of the few displaced fractures that doesn't require surgery i don't know how old your mom is but those in and 70's tend to heal a little slower women also have the unfortunate condition called osteoporosis when they get older which will also slow down the healing time n nlike i mentioned not all fractures or breaks require surgical repair fractures collar bone will be left in their broken position and sent home to follow up with an doctor i would recommend an ortho follow up just to make sure she is healing properly and no neurological deficits occur
Entertainment, Music	what is this movie i saw this movie about 8 years ago and i can't remember the name of it i think the plot was something along the lines of a group of terrorists taking over a building and there is a girl who saves everybody the one line i remember in the movie is when the computer nerd says she's like bruce lee with boobs 'no with shannon mrs gene simmons
Politics, Government	so dems what now with iraq what will you do now that you have the probably both houses of congress please no answers like well whatever it is it'll be better than republicans i'm serious i would really like to know oh by the way cutting and running will terrorist organizations to think that america is weak and increase the chance that we get hit here also that will pretty much hand over a whole country for terrorists to take over fortunately most of the dems elected to congress understand that too ok so now what any real answers it would be foolish to just leave but we have to get the mechanisms in place so iraq can for themselves and perhaps get the world community to help

Politics, Government	abu al zarqawi was a young boy living in his native land he was thirsty for knowledge and learning there were few books in the desert and those that were available were written in english a language the could not comprehend he slowly learned to read and speak english mostly self taught one day as legend would have it he discovered a box of books that were and torn all with wonderful animation and written by the same author he read the books carefully and at first glance did not appreciate the dry wit after learning more of the of the english language he began to find the books mildly amusing then later hilarious the books were all written by an american named charles abu al zarqawi found the most interesting character to be pig pen he could identify with the constant dust around the young lad and felt a to him he started to write long flowing letters to charles all of them with the same theme he wanted to know about the pig pen character he also requested that charles change the name of pig pen to pig pen but none of his letters were ever answered later to his horror he found out that pig pen was based on a real human being rory emerald he discovered this one day while reading the new he was most outraged when he found out that rory emerald had violated charles pet animals and even had relations with a disgusting swine n nit appears that abu al zarqawi was not obsessed with destroying america or americans his obsession was more in the destruction of rory emerald the noted celebrity who has in both new york city and los angeles when he learned of mr bedding down with swine it so abu al zarqawi that his vision became blurred his mantra became the must die as a known terrorist abu al zarqawi had many weapons at his disposal fortunately his timely death ended the threat to rory life at abu al funeral rory emerald was quoted as saying it is a sad day in mankind when we cheer and applaud the death of another human being while tears slowly down his cheeks n npersonally i am glad he is dead but in keeping spirit with rory sage words i will not applaud too loudly his words brought tears to my eyes
Sports	what happened to the rock in wwe rock has been taken off the roster on wwe as he is concentrating on being an action movie star and he is doing a great job i miss the rock he was such an entertaining wrestler if ya what the rock is n ni loved the peoples yeah bring back the rock i say also cheers

Politics, Government	why did they do an autopsy on after he died from two 500 pound bombs war against terrorist because some liberal news said it looked like he d been beaten up by our guys
Sports	what is royal engineer the royal engineers afc is a football team founded in under the leadership of major of the corps of royal engineers the they enjoyed a great deal of success in the winning the fa cup in n nthe cup winning side were n w lt g h sim lieutenant g c lt r m lt p g von lt c k wood lt h e lt r h stafford lt h w lt a mein and lt c n nthe team drew 1 1 against old f c with a goal from and went on to win the replay 2 0 with a goal each from and stafford n nthey have maintained their character as an amateur team as was the tradition early on in football history and have not played in top competition since the
Entertainment, Music	why does walmart have two versions of the same commercial the one where the lady says she went for eye drops and came back with something eye opening why is there a black and white version i dont really think its all that all type of people shop at walmart no matter what race or color what is up with that the walmart marketing team probably feel that either version will make more of an impact in different markets it is the version with the black woman plays in so called black markets the version with the white woman probably plays in all markets whether it is considered white asian latino etc n nbut fear not it's only television television is not real
Health	i think i might have a uti could someone help me out here please i have had a urinary tract infection 2 or 3 times before mind you i'm almost 15 but i've never known it before i went to the doctor for something else and i had to do a urine sample so that's why i'm not sure if i have one now or not anyway for the past 2 or 3 days i have pain when i urinate but the pain is awful immediately after the pain is near my lower pelvis and i mean the pain is bad where i have to just stand still and walk carefully because it hurts so bad does this just happen sometimes could it be because i should be starting my period soon or should i go to a doctor thank you so much for your help go to a doctor

Entertainment, Music	why is fresh air bad for you cause every time i am in a club i can drink as much as i want and still walk about but as soon as i go outside and the fresh air hits me thats me down on my a se sometimes unconscious why is that lmao that's what i'll blame it on i went into fresh air
Family, Relationships	help me with my car and commitment my husband said he'd fix our only car no later then today well he's gone to the auto store 2 times today and now he says he doesn't want to go a third time today i however need it in the early morning what can i do 2 get him to finish what he started and keep his commitment help me uh i guess find a solution on yahoo answers
Science, Mathematics	what are some really good sites on the elements elements as in silicon carbon etc com any element and get everything from molar mass to melting point and electron configuration ect ect
Family, Relationships	we're both married dating but no sex involve coz we're both scared lately he asked for it but am confused should i give my self we're both in an unhappy marriage we enjoy each other's company i've never felt this kind of love for a long time it feels strong he said he feels but finds it hard to leave his wife but he calls me everyday when we dont see each other does he really love me should i stop seeing him i know its wrong but he's given my self confidence back coz my husband always lets me down he is very what should i do nyour advice will be very much appreciated i'm really confused coz we have a son plus his wife is a friend of mine so is my husband they know each other his wife always tell me they're always fighting that's before we started dating until now don't have sex with him and stop this involvement with him before it goes any further if you are unhappy in your marriage you should seek a divorce your reputation is intact right now so keep it that way if you commit with this man or another then your name could be dragged through the mud and your kids will be affected n nonce you have that divorce then you can see any available man that you desire just as long as he is not married n ngod bless you and good luck

Health	hello i have asthma i am 40 years old my works but it wont help cold air in house induced asthma what can i do i was on it made me sick in my throat and esophagus cold air does make asthma worse outside breath through a scarf and i have asthma and certain medicine would make me dizzy just your and he will give you a different med
Entertainment, Music	what is the song gear of war commercial mad world by gary jules
Entertainment, Music	does anyone like tech he is coming around here next saturday and i cant wait yes i like him
Politics, Government	i need information about the to joining a swat team in texas you have to be an experienced law enforcement officer preferably with some combat experience as well for most departments to even get in as a street cop you need a bachelors degree ideally in criminal justice
Science, Mathematics	the derivative of sq rt x 1 sq rt x 1 can you please show the entire process sq rt x x 1 2 1 sq rt x x 1 2 so your expression is x 1 2 x 1 2 1 the first derivative of the sum of the three parts is the sum of the first derivatives of each part d x 1 2 dx 1 2 x 1 2 d x 1 2 dx 1 2 x 3 2 d 1 dx 0 add the parts and you get 1 2 x 1 2 1 2 x 3 2 0 if you want to collect terms you can factor out 1 2 x 1 2 and then you would have 1 2 x 1 2 1 1 x there are many ways to factor the derived expression and all would be correct if you stay within the rules of mathematics as my ancient professor would say it's all obvious isn't it
Politics, Government	is g bush an idiot it seems he picks stupid people to work for him and he offers no for any thing picks stupid people to work for him would you like to add more info to this what people are you talking about this would make it alot for us to talk about if we are all on the same page
Business, Finance	what is the worst thing you have done to a customer it doesn't matter if you work in a restaurant a store a gas station an amusement park or if you used to work somewhere like that when a customer was treating you like crap what did you do to get revenge and what was the person doing to you why do you think a lot of people treat customer service workers so badly had sex with them and then cheated
Society, Culture	who is daughter she was a beautiful and tall as a goddess she is she was the one who found odysseus when he was ship her father was king of the in she later married son

Health	my back hurts whats wrong with me i lifted 800 lbs this morning was that wrong yea don't do that
Society, Culture	how can a certain day of the week matter if the modern day calender has nothing to do with the bible calender if our modern day calender was sorted out in the than how can any one say that sunday or saturday is the sabbath thank you nbut try to get some fundamentalist to understand that a day is a day if you really believe in keeping one of them holy whatever that even means what does it matter if it's tuesday or friday or what nif i was a goddess i would want my people to think of me with love a little bit of time every day not take a vacation day out of life every week to worship only me
Education, Reference	why of syphilis is different during its various stages i know that syphilis is only during the first 2 during the first four yrs of does any one have a clue about the reason this isn't a special education question
Family, Relationships	what questions should i ask my mate before getting married let's see are you willing to spend the rest of your life with me what is your view on divorce have you ever been convicted of a felony do you have twins in the family does anyone in your family have any major health problems how do feel about children how would you raise a child are you happy with your career my list can go on sit down with your mate and talk about your ideas and concerns before you get married it's a great way to see his her point of view best of luck
Politics, Government	do you agree w the aclu and there opinion with the seperation of church and state they say that according to the that they are suppose to be seperate however if you go back in history clearly the founding fathers promoted thomas jefferson himself the one who wrote the seperation of church state made it to promote to the indians one year later and use bibles as national school books why do you think the aclu is trying to change the meaning of our constitution and do you think people even do research to understand what jefferson meant before holding an opinion they are just a bunch of lawyers who enjoy screwing with the law just because they can if they dedicated their time to criminals it would be a better world to live in

Business, Finance	my college age daughter and i want to move to we need to find housing and jobs any suggestions my daughter has done alittle modeling i am an industrial engineer and would love to get back into the apparel industry my daughter would like to transfer to nyu as a film major it is really really expensive a one 2 bedroom apartment if you can find one will cost you at least 3 000
Health	is there such a thing as a surgical operation which will prevent a man to have an erection why do you want to prevent this
Sports	why do most people who play professional sports have tight clothes i think it's pretty gay unless there is a good reason for it because it is so much easier to play sports wearing loose clothes
Business, Finance	can a annuity be rolled over to an ira cd account at a bank without paying income tax it depends on the status of the tax annuity if the is an ira b 401 k or some sort of account that you took a tax deduction on your tax return the year s you made contributions then you can roll it to an ira cd at the bank look carefully at your statement from the and see if it says ira or 401 k or b or qualified account close to where your name or account number is located if you added money to this account thru a payroll deduction plan it probably is an account that can be rolled to the ira cd na can also be what is called a non qualified account meaning that you put after tax dollars into the account these accounts cannot be rolled over to a cd nit is often times hard to get the company or their representative to help you with you questions about moving money out of their company however the bank where you want to move the money to should have a representative that is more than willing to help you figure out how to move money to their bank take your statement to the bank and ask for their help i disagree with the previous answer about getting help from the company

Health	help please getting in shape i'm almost 14 and i have a really hard time myself to get off the couch and work out or go run or something r there ne fun ways to work out that i will look forward to doing i'm not fat but i'm getting there cus i dance about once a week like dance class and sometimes i play soccer but i dunno wat i should do to get my muscles toned and get in shape wat do u recomend for motivation think about what could be you are young now and you don't want to get fat keep that as a to be thin you don't want to end up huge n ndo get toned and in shape keep it simple sit ups push ups and running around your neighborhood
Health	can endometriosis be detected by a pap smear i have alot of the symtoms of endometriosis two weeks ago i had a pap smear and the test results came back today which said your recent pap report requires more attention please phone our office and speak to a nurse i'm just not sure if this can be something as serious as cancer or just endometriosis no your doctor your symptoms discusses your medical history and performs a pelvic exam to check for cysts unusual tenderness or a of the pelvic area they may also perform an ultrasound to check for cysts in your ovaries endometriosis is detected by a a thin microscope is inserted in a incision in the abdomen to view internal organs n for treating endometriosis depend on the severity of your symptoms the location and size of your and your plans your age is also a factor since your symptoms may as you grow older n ni had to take shots for 6 months the drug was expensive insurance paid for it but it helped to relieve the symptoms you can't do anything to prevent or cure endometriosis n nhope this helps good luck and god bless

Health	has anyone here had an back operation called its a operation involving some rods being put into the back to keep thier spine straight there is not a operation called that it's just called back surgery but someone can get scoliosis i had a 49 degree curve in my back and i got surgery which consisted of two 11 inch rods and 16 2 inch screws now my curve is down to 11 degrees and i no longer lean to my left i had my surgery done 5 years ago if you met today you would never guess that i had scoliosis unless i told you but there are few restrictions like someone was saying i am unable to go on roller or anything similar that would put alot of force upon my back
Sports	whos gonna win the golf hope it aint woods i don't pay one lick of attention to golf but thanks for your answers love them
Society, Culture	why is jesus mother called the virgin mary when she had kids after jesus so she is not a virgin anymore mr mister had it almost right n nhe said n no she is not a virgin anymore n n she was single and gave birth to jesus after the birth her and joseph got married and had kids n n jesus does have 1 2 brothers 1 2 sisters as we know them thats right n nactually joseph did marry mary and they went to pay taxes in another town called bethlehem that is where jesus was born after jesus was born the bible clearly tells us that mary had other children people do not realize it is there because it is not a religious point that ministers preach on and most people do not read their own bibles however it stated that she had other children n nshe was not a virgin after jesus but she was a virgin when jesus was born however to give her that title is not really wrong but an and declaration of her being a virgin at the time of jesus birth
Entertainment, Music	what are some really good dave matthews band songs ants marching n marching though would probably be my favorite or the first one i would recommend
Entertainment, Music	which type of film is preferred by more horror or funny ones funny they make people happy
Sports	how many ncaa titles has nc state won 2 in 1974 and 1983

Sports	the richest in the world and their ranking power rank name pay rank web rank press rank tv rank n2 tiger woods 4 12 2 11 n5 o'neal 26 26 5 12 n15 lance armstrong 41 39 9 8 n16 michael jordan 27 34 16 25 n17 michael schumacher 8 37 29 81 n19 kobe bryant 39 47 4 2 n26 david beckham 28 53 3 64 n33 michael vick 19 87 35 67 derek jeter 50 38 11 52 jeff gordon 53 56 13 45 phil 48 75 6 30 alex rodriguez 45 82 7 48 oscar de la hoya 18 91 65 82 lebron james 56 60 21 35 maria 62 52 14 44 andre 49 76 23 57 n60 manny ramirez 52 84 15 62 williams 73 44 12 27 rossi 41 30 76 99 ronaldo 55 54 59 92 venus williams 87 64 31 54 matt 57 97 68 95 walter jones 54 100 89 99 lindsay 89 88 20 70 86 81 32 82
Computers, Internet	im no getting any sound from the computer to the speakers anybody knows why let's start with the basics the solution is based on a windows xp operating system n n1 check to see that the speakers are plugged into the computer correctly make sure they are connected to the proper output n n2 check to see if there is power to the speakers if your speakers have no power there's your problem n n3 open your control panel go to sounds and audio devices make sure the sounds are not if the mute button is checked uncheck it n n4 also while in sounds and audio devices open the audio tab check to see if there is a default device make sure it is the correct one by changing it and testing your system n n5 if that doesn't work go to the hardware tab also in sounds and audio and try the button n n6 make sure your audio driver is and up to date nif this doesn't help please edit the question with more such as if the problem exists when you run certain programs what operating system you have what computer you have make and model and anything info you can provide n nhope this helps

Health	i have been prescribed should i take it my doctor has prescribed me to help with anxiety i have read on the net about the possible side affects and withdrawal symptom and find them very off putting i was not offered any counseling only the drugs i have not started to take the drugs is it normal practice to be prescribed drugs before counseling i myself take it is i have the dosage or lowered according to my mental state you can not think about if you should or shouldn't take an anti depressants your g ps advice and thoughts of you were that in there consideration you needed medication maybe go back and say you will take the tablets but you also want counselling good luck xx
Health	i want to be down to a size zero is this a good diet and workout 200 cals a day 1 and a half miles hour and a half of aerobics 200 calories a day are you me you wont survive and what the hell is a size zero
Entertainment, Music	should be in with the ones no similar questions found this is fun no n but my dad should i've never seem him without a beard
Health	i need help with my work which is on care am doing as well so wats is on abt i mean the question mite be able to help
Health	any other test can do without to check bladder function such as well there is the ever popular cat scan for mass detection and the common there a couple of blood tests that are combined with a liver function panel too but as far as specifics i'm not too sure
Education, Reference	how long does it take to get your ged hi guys im high school and want to go and get my ged i dropped out of high school as soon as i joined big mistake so i need like 22 or 24 credits if i went to adult ed or some program like that how long do you think it would take thank you i am thinking 1 year if you work really hard but otherwise on average 2 years because usually one basic course is 7 credits i beleive n n may i suggest these schools n nhttp www com school htm n nhttp com promo home htm n nhttp www com forms online html virtual virtual standard

Politics, Government	president bush said some people have too much freedom is it possible to have to much freedom he was referring to people on the internet with sites like bush sucks and bush bites but is an honored and right no matter how much it might offend the intended targets thomas jefferson made a famous statement to this effect it is late at night and i can't recall it so i won't try it has always seemed strange to me that someone who said he is trying to advance the cause of freedom around the globe is reluctant to do so when it means it is freedom to him his people have also thrown and arrested folks who have come to his everyone invited with t shirts critical of him means i may not like what you say but i will defend your right to say it i could go on for hours about this one but my short answer will be no as long as you do not hurt others defining hurt is even more of a task if you ask me
Computers, Internet	firefox ghost or something a while back i saw a program that was based on firefox but invisible and until you put your mouse on it or something anyone know what i'm talkin about you mean http www com n n is a browser that so completely into most typical windows office related programs that a casual would not even recognize it as a browser the most obvious use for this is to browse the web while at work when you ought to be doing something else but as they on the site this is not a good idea you can get fired the network administrator sees everything you do or end up wasting lots of time in fact the makers of dont actually intend for people to use it they consider it more of a form of computer art whatever it is im sure youll agree that its still pretty cool com
Sports	are you looking for a good website to play pool on check this out i got tired of yahoo pool and was looking for a better place to play thats when i came upon com this site is much better than yahoo pool in my opinion the graphics are much better more realistic and you can play 8 ball 9 ball or snooker all 4 free or you can pay to play in big money tournaments check it out and tell me what you think i think that is just trying to be helpful in light of the abundance of yahoo pool questions that have been on this page as of late personally i don't care to play pool based computer games but that's just me m d instructor referee

Table 4: Visualization on Yahoo! Answers with LSTM.