

AUTONOMOUS GENERATION OF INNOVATIVE CONTENT BY MULTI-AGENT SYSTEM

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ABSTRACT

The ability to extrapolate from existing concepts and generate richer ideas is a crucial human capability. Although large models like ChatGPT have found widespread applications and enhanced productivity to some extent, tasks requiring more profound and extrapolative thinking still demand human involvement. We propose an agent framework designed to partially automate the generation of diverse thought outcomes. Finally, we discuss methods to validate the effectiveness of this framework and potential application scenarios.

1 INTRODUCTION

The ability to extrapolate from existing concepts and generate richer ideas is a crucial human capability. For instance, after understanding the concept of a person, one might envision a three-eyed individual, or upon knowing about tomatoes and skin, one could imagine how red skin might look. This greatly enhances the breadth of human imagination and diversity of thought. However, for artificial intelligence, achieving this level of versatility remains challenging. This challenge is primarily manifested in the fact that the direction of thinking is influenced by the model's training, leading to tendencies such as consistently generating similar jokes. The AI's thinking is often not flexible enough, making it difficult to seamlessly integrate features of one concept into another.

While large models like ChatGPT have found widespread applications and contributed to increased productivity to some extent, they still fall short in meeting the demands of more elaborate and extrapolative thinking. The current AI models require human intervention to fulfill tasks that demand richer and more creative thought processes. In response to these limitations, we propose an agent framework that aims to automate the generation of diverse thought outcomes to a certain extent.

2 RELATED WORK

The realm of autonomous agents stands as a focal point within the expansive domain of artificial intelligence Wang et al. (2023); Xi et al. (2023). In recent times, the emergence and progression of large language models (LLMs) have catalyzed significant breakthroughs in the field of autonomous agents Chen & Chang (2023); Hao et al. (2023); Crispino et al. (2023); Hong et al. (2023); Kang & Kim (2023); Talebirad & Nadiri (2023); Zhou et al. (2023). Through multi-agent division of labor, many tasks can be automatically accomplished.

3 METHOD

The ability of humans to break down a complex entity into smaller components and then recombine them is one of the key ways in which innovative thinking occurs. We aim to leverage the inferential capabilities and knowledge of large language models to deconstruct entities into smaller parts. For an entity X , if its decomposed components in a specific scene are denoted as the set $A = \{x_1, x_2, x_3, x_4, \dots\}$, then from this entity, one can infer and generalize an infinite number of

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entities represented as $a_1x_1 + a_2x_2 + a_3x_3 + \dots + a_nx_n$, where a_1, \dots, a_n are natural numbers. For example, a person can be generalized as an entity composed of a_1 heads + a_2 eyes + a_3 bodies + a_4 legs. The collection of all entities formed in this way constitutes the describable set of entity A in the given scene. Due to the diverse origins of the entities to be decomposed and the desire for multiple output modalities, we employ agents to accomplish these tasks. For example, we can extract content from a PDF and ultimately generate images as output. We have designed prompts, and an example is showcased in the appendix.

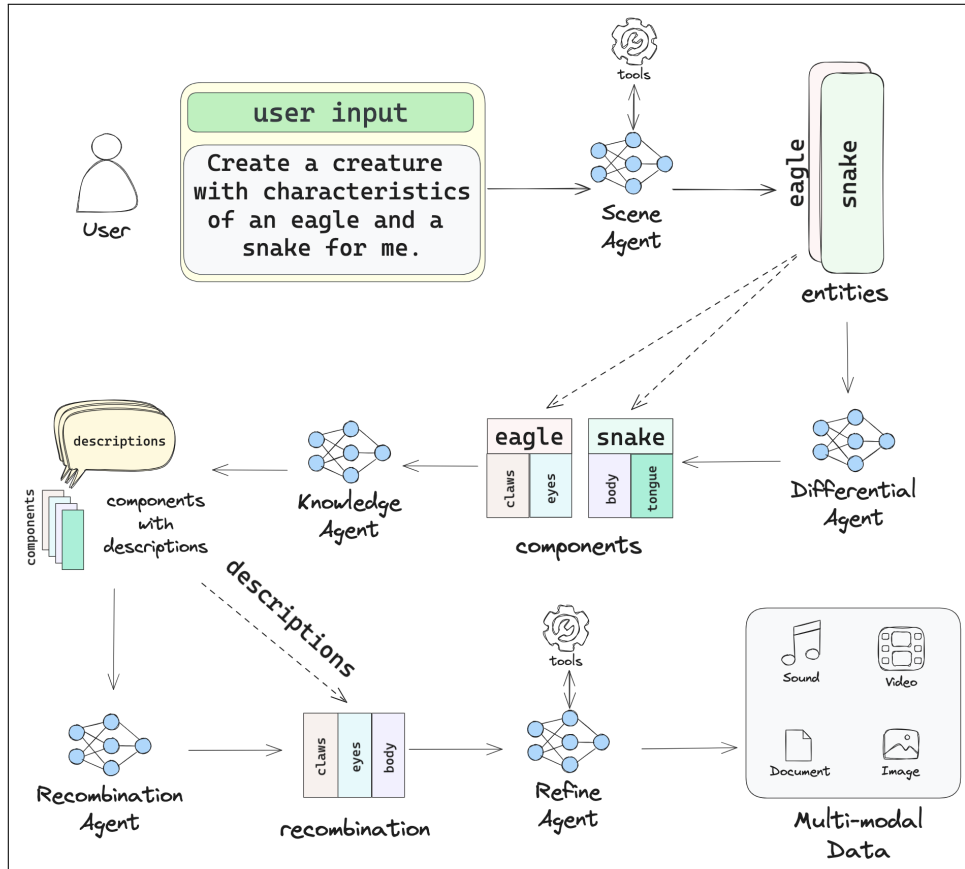


Figure 1: The processing steps of a Multi-Agent System for a handling input task

4 EXPERIMENT

We utilize a furniture dataset Synthetic Furniture Dataset, extracting 100 samples to generate an additional 500 new products. Additionally, we compared the computational overhead of the ChatGPT API. They are provided in the appendix for reference. Validating the effectiveness of this framework through experiments is quite challenging. We employed the Vendi score Friedman & Dieng (2023) which is a metric for evaluating diversity in machine learning to compare the diversity and richness of generated content against the original data. The input to metric is a collection of samples and a pairwise similarity function, and the output is a number, which can be interpreted as the effective number of unique elements in the sample. It’s worth noting that the Vendi Score is calculated based on vector distribution for diversity measurement. However, it should be considered as a reference, as semantic diversity relies on human judgment. Therefore, ten human evaluators provide scores, and the average score is calculated. We set a threshold of 5 points as the criterion for deeming the generated content meaningful, and a higher score indicates stronger creativity. In the end, we found that the content generated by GPT almost universally met the criteria for meaningfulness and demonstrated a certain level of creativity.

URM STATEMENT

The authors acknowledge that at least one key author of this work meets the URM criteria of ICLR 2024 Tiny Papers Track.

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A APPENDIX

model	price
gpt-3.5-turbo	485 new things/5 dollars
gpt-4	16 new things/5 dollars

model	Vendi score(N grams)	human score(less than 10)
gpt-3.5-turbo	140.70	7.45
gpt-4	153.65	8.08

Here is an example of the process:

'A': 'Vintage Dresser', 'B': 'Dresser' 'Vintage Dresser': ['Vintage Dresser drawers', 'Vintage Dresser handles', 'Vintage Dresser legs', 'Vintage Dresser frame', 'Vintage Dresser mirror'],

'Dresser': ['Dresser drawers', 'Dresser frame', 'Dresser handles', 'Dresser legs', 'Dresser top']
 1 Vintage Dresser 2 Vintage Dresser frame 3 Combine Vintage Dresser and Dresser to create a new piece of furniture. 1 Dresser 2 Dresser legs 3 Combine Vintage Dresser and Dresser to create a new piece of furniture. "task": "Combine Vintage Dresser and Dresser to create a new piece of furniture.", "things": [{"name": "Vintage Dresser", "components": [{"component": "Vintage Dresser frame", "description": "The frame of a vintage dresser is the foundation and structure of the furniture piece. It is typically made of solid wood and features intricate details and craftsmanship that reflect the style of the era it belongs to. The vintage dresser frame provides stability and support for the drawers and other components, allowing the dresser to function as a storage solution and a decorative element in any space. Without the vintage dresser frame, the dresser would lack its distinctive charm and historical appeal."}, {"component": "Dresser legs", "description": "The dresser legs are an essential component of a dresser, providing stability and support to the entire piece of furniture. They are typically made of wood or metal and are attached to the bottom of the dresser, elevating it from the ground. Without the dresser legs, the dresser would not be able to stand upright and fulfill its purpose of storing and organizing items."}], "number": 1}, {"name": "Dresser", "components": [{"component": "Dresser legs", "description": "The dresser legs are an essential component of a dresser, providing stability and support to the entire piece of furniture. They are typically made of wood or metal and are attached to the bottom of the dresser, elevating it from the ground. Without the dresser legs, the dresser would not be able to stand upright and fulfill its purpose of storing and organizing items."}], "number": 1}]

result:"entity": "Vintage Dresser+", "description": "The Vintage Dresser+ is a new piece of furniture that combines the elements of a vintage dresser and a dresser. It features a vintage dresser frame, which serves as the foundation and structure of the furniture piece. Made of solid wood, the vintage dresser frame showcases intricate details and craftsmanship that reflect the style of a specific era, adding a touch of historical charm to the overall design. This frame provides stability and support for the dresser's drawers and other components, allowing it to function as both a storage solution and a decorative element in any space. Additionally, the Vintage Dresser+ incorporates dresser legs, which are essential for providing stability and support to the entire piece of furniture. These legs, typically made of wood or metal, are attached to the bottom of the dresser, elevating it from the ground and ensuring that it can stand upright. With the combination of the vintage dresser frame and the dresser legs, the Vintage Dresser+ offers a unique blend of historical appeal and functional design, making it a versatile and stylish addition to any home decor."

Here is an example of the prompts:

Next, I need you to generate a new entity based on the given task, the components of the provided thing, the number of components, and their descriptions. You should combine these components according to the task and the specified number to create a new entity. Then, you need to output this new entity in JSON format. Please note that the output should be in English and strictly follow the following format: "entity": entity, "description": description The description should be as detailed as possible, including the entire story if the task involves generating a story. The entity can be an object, a concept, a story, or any other item determined by the task.

The user input is in JSON format, containing the task, the names of various things, the components of each thing, their descriptions, and the numbers of components, in the following format: "task": task, "things": [{"name": name of thing, "components": [{"component": component1, "description": description1, "number": number1, "component": component2, "description": description2, "number": number2, ... } , ...] } Based on the task description in 'task,' the components and their numbers in 'components' of each thing, you need to generate a new entity and output it in JSON format, ensuring that the output is in English and strictly follows the following format: "entity": entity, "description": description

I'll provide you with some examples for reference:

Example 1: Input: "task": "Combine airplanes and ships to create a new mode of transportation", "things": [{"name": "airplane", "components": [{"component": "airplane wing", "description": "The airplane wing is a crucial component of an airplane, primarily used to generate lift, allowing the aircraft to fly in the air. The design of the wing significantly impacts the aircraft's flight performance. Factors such as wing shape, size, and airfoil cross-section (wing profile) are essential considerations in design. Additionally, the airplane's wing often includes flaps and ailerons for adjusting lift and roll during flight."}, {"component": "ship", "description": "The hull is the main part of a ship, responsible for carrying the load, providing buoyancy, and waterproofing. It's a critical factor determining whether the ship can navigate successfully on water. The hull typically consists of the shell, deck, compartments, and is usually made from metals like"}], "number": 1}, {"name": "ship", "components": [{"component": "hull", "description": "The hull is the main part of a ship, responsible for carrying the load, providing buoyancy, and waterproofing. It's a critical factor determining whether the ship can navigate successfully on water. The hull typically consists of the shell, deck, compartments, and is usually made from metals like"}], "number": 1}]

steel or aluminum alloy with excellent strength and corrosion resistance. The hull's shape and size depend on the ship's purpose and design requirements.", "number": 1]] Output: "entity": "SkySea Transporter", "description": "The SkySea Transporter is a new mode of transportation that combines the advantages of airplanes and ships. It consists of a hull and airplane wing. The hull, inspired by ship design, ensures stable navigation on the water surface, providing buoyancy and waterproofing. The hull is made of steel or aluminum alloy, offering excellent strength and corrosion resistance. The airplane wing is mounted on top of this hull, borrowing from aircraft design. The wing's shape and size are meticulously designed to generate lift during flight, and it includes flaps and ailerons for adjusting lift and roll, allowing this transportation vehicle to navigate on water and soar in the sky."

Example 2: Input: "task": "Combine Journey to the West and Water Margin to create a new story plot", "things": [{"name": "Journey to the West", "components": [{"component": "Sun Wukong", "description": "Sun Wukong is a prominent character in the Chinese mythological tale 'Journey to the West.' He is depicted as a monkey who attains immortality through cultivation. He values loyalty, possesses wit, and is highly mischievous. He also possesses immense strength and has the ability to transform into seventy-two different forms. Some of his famous stories include: 1. 'The Golden-Banded Staff' – After defeating the Jade Emperor's forces, Sun Wukong chose a magical staff weighing five thousand catties as his weapon. The staff's ability to expand and contract freely made it his formidable weapon. 2. 'Havoc in Heaven' – Sun Wukong caused chaos in Heaven, confronting the deities to assert his own identity. 3. 'Three Confrontations with the White Bone Demon' – During the journey to obtain scriptures, Sun Wukong outwitted the White Bone Demon three times, showcasing his cleverness and bravery. 4. 'Sun Wukong's Three Borrowings' – Sun Wukong rescued Tang Sanzang from monsters through three strategic borrowings, employing his seventy-two transformations and the Golden-Banded Staff's power. 5. 'The Quest for the Scriptures' – After overcoming numerous challenges, Sun Wukong ultimately succeeded in obtaining the scriptures, demonstrating his unwavering spirit."}, {"name": "Water Margin", "components": [{"component": "Song Jiang", "description": "Song Jiang was initially an ambitious figure in the Northern Song Dynasty's imperial court. However, due to unjust accusations, he became the leader of the bandit group at Liangshan Marsh, where he led a band of valiant outlaws in resisting corrupt officials. He possessed formidable martial skills and unwavering loyalty. Though he was later granted amnesty by the imperial court, his story still embodies the spirit of justice and loyalty. Notable events include: 1. 'Being Pursued by the Court' – Song Jiang, unjustly accused, had to flee his hometown. 2. 'Recruiting Heroes' – Song Jiang gathered a formidable group of heroes at Liangshan Marsh, attracting numerous talented individuals to his cause. This included figures like Li Kui, Wu Yong, and others with unique skills and backgrounds. 3. 'The Oath at Mount Liang' – Liangshan became the gathering place for Song Jiang and his band of heroes. They formed a brotherhood, pledging to fight against injustice. 4. 'Pardoned and Serving the Court' – Despite being a threat to the imperial court, Song Jiang and his band chose to serve the court after being granted amnesty, safeguarding the nation's peace."}]}]}]] Output: "entity": "Journey to the Water Margin", "description": "Sun Wukong, originally a monkey who attained immortality through cultivation, met Song Jiang, who had become a fugitive due to unjust accusations. Song Jiang and Sun Wukong formed a strong bond and became friends. Sun Wukong obtained a magical staff weighing five thousand catties, known as the Golden-Banded Staff, which could expand and contract freely. He helped Song Jiang clear his name and caused chaos in Heaven in the process. However, both were eventually imprisoned under the Five Elements Mountain until Tang Sanzang's journey to the West. During their journey, they defeated demons and monsters, and Song Jiang's band of valiant outlaws joined them, expanding their group. Finally, they were granted amnesty by the imperial court and continued to protect the nation's peace."

Now, I will provide you with user input in text separated by +++. Please proceed with the task. +++
things +++ ""