

# Semantic Codebook Learning for Dynamic Recommendation Models

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**Algorithm 1:** Semantic Codebook Learning for Dynamic Recommendation Models

**Module 1:**  $\triangleright$  *Item to Semantic*

**Target:** Item Sequence  $s_v \mapsto$  Semantic Sequence  $s_c$   
**Input:** Item Sequence  $s_v$   
**Output:** Semantic Sequence  $s_c$

**Module 2:**  $\triangleright$  *Semantic Parameter Generation*

**Target:** Semantic Sequence  $s_c \mapsto$  Semantic Parameter Generator  $\mathcal{M}_c$  and Semantic Encoder  $E_c$   
**Input:** Semantic Sequence  $s_c$   
**Output:** (Parameter  $\Theta_d$ ), Prediction  $\hat{y}$

**Module 3:**  $\triangleright$  *Semantic Metacode Learning*

**Target:** Item Sequence  $s_v$ , Semantic Sequence  $s_c \mapsto$  Item Parameter Generator  $\mathcal{M}_v$ , Item Encoder  $E_v$ , Semantic Parameter Generator  $\mathcal{M}_c$ , and Semantic Encoder  $E_c$   
**Input:** Item Sequence  $s_v$ , Semantic Sequence  $s_c$   
**Output:** (Parameter  $\Theta_d$ ), Prediction  $\hat{y}$

**Module 4:**  $\triangleright$  *Semantic Codebook Learning*

**Target:** Item Sequence  $s_v$ , Semantic Sequence  $s_c$ , Semantic Encoder  $E_c \mapsto$  Codebook  $D$   
**Input:** Item Sequence  $s_v$ , Semantic Sequence  $s_c$ , (Semantic Encoder  $E_c$ )  
**Output:** (Parameter  $\Theta_d$ ), Prediction  $\hat{y}$

**Overview:**  $\triangleright$  *Training Procedure*

**Input:** Item Sequence  $s_v$ , Semantic Sequence  $s_c$ .

**Output:** (Parameters  $\Theta_d$ ), Prediction  $\hat{y}$ .

**Initialization:** Randomly initialize the models  $\mathcal{M}$ ,  $\mathcal{M}_c$ ,  $\mathcal{M}_v$  with parameters  $\Theta_s$ ,  $\Theta_c$ ,  $\Theta_v$  respectively.

Item Sequence  $s_v \mapsto$  Semantic Sequence  $s_c$

**repeat**

**if** *Semantic Parameter Generator  $\mathcal{M}_c$  and Semantic Encoder  $E_c$  have not yet been well-trained* **then**  
        Train as follows (see Eq.12 for the details),  
         $\min_{\Theta_s, \Theta_c, \Theta_v} \mathcal{L} = \sum_{u, v, s_c, y \in \mathcal{D}} l_{CE}(y, \hat{y})$

**end**

**until** *Convergence*;

**Initialization:** Initialize the Codebook  $D$  via pretrained Semantic Encoder  $E_c$

**repeat**

**if** *Semantic Parameter Generator  $\mathcal{M}_c$  and Semantic Encoder  $E_c$  have not yet been well-trained* **then**  
        Train as follows (see Eq.13 for the details),  
         $\min_{\Theta_s, \Theta_c, \Theta_v} \mathcal{L} = \sum_{u, v, s_c, y \in \mathcal{D}} l_{CE}(y, \hat{y}) + \lambda l_{MSE}(\mathbf{E}_v, \mathbf{E}'_v)$

**end**

**until** *Convergence*;

**return**  $\mathcal{M}_c$ ,  $\mathcal{M}_v$ ,  $D$ .

**Table 1:** Statistics of Datasets.

Dataset	#User	#Item	#Interaction	Density
Arts	45,486	21,019	395,150	0.0004133
Office	87,436	25,986	684,837	0.0003014
Instruments	24,962	9,964	208,926	0.0008400
Scientific	8,442	4,385	59,427	0.0016053
CDs	1,578,597	486,360	3,749,004	0.0000049
Electronic	4,201,696	476,002	7,824,482	0.0000039
Book	46,549	212,996	1,861,533	0.0001878
Music	39,743	164,224	1,792,502	0.0002746

**Table 2:** Hyperparameters and training schedules of SOLID.

Dataset	Parameters	Setting
Arts Office Instruments Scientific CDs Electronic Book Music	GPU	Tesla A100
	Optimizer	Adam
	Learning Rate	0.001
	Batch Size	1024
	Sequence Length	10
	the Dimension of Embedding	1×32
	the Amount of MLP	2
	Hidden Dimension of Semantic Codebook	64
	z Dimension of Semantic Codebook	32

## A APPENDIX

This is the Appendix for “Semantic Codebook Learning for Dynamic Recommendation Models”.

### A.1 Supplementary Methodology

*A.1.1 Pseudo Code of SOLID.* Algorithm 1 shows the pseudo code of SOLID. ( $x$ ) represents that  $x$  is a intermediate variable.

### A.2 Supplementary Experiments

*A.2.1 Datasets.* The statistics of the datasets used in the experiments is shown in Table 1.

*A.2.2 Hyperparameters and Training Schedules.* We summarize the hyperparameters and training schedules of the datasets used in the experiments in Table 2.