Incorporating Chinese Characters of Words for Lexical Sememe Prediction

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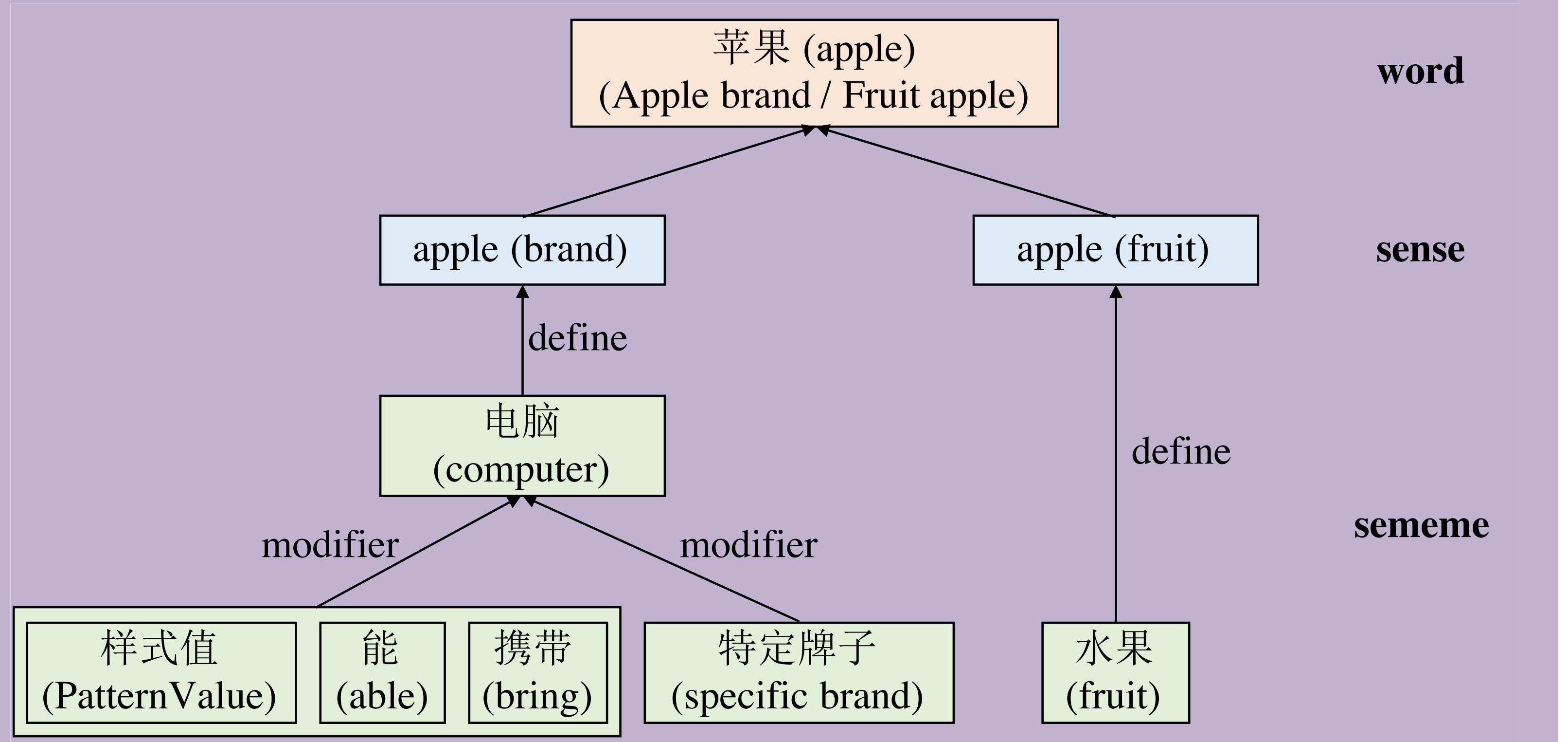
Backgrounds



- **Sememes**: minimum semantic units.
- The meanings of concepts can be composed by a finite number of sememes.
- Linguists build knowledge bases to annotate words with sememes manually.
- HowNet (Dong and Dong, 2006) is a classical widely-used sememe KB.
  - 100,000 common words in Chinese and English and 2,000 sememes.
  - Each word is represented as a tree-like sememe structure.

Sememe Prediction

SP with Word Embeddings (SPWE)

- Applies the ideas of collaborative filtering.
- Recommends the sememes of similar words.

SP with Sememe Embeddings (SPSE)

- Maps sememe and word embeddings into the same low-dimensional space.
- Measures the distances between words and sememes as the scores to recommend.

Huiming's Homepage

Hao's Homepage

Our Code

Zhiyuan's Homepage

Ruobing's Homepage

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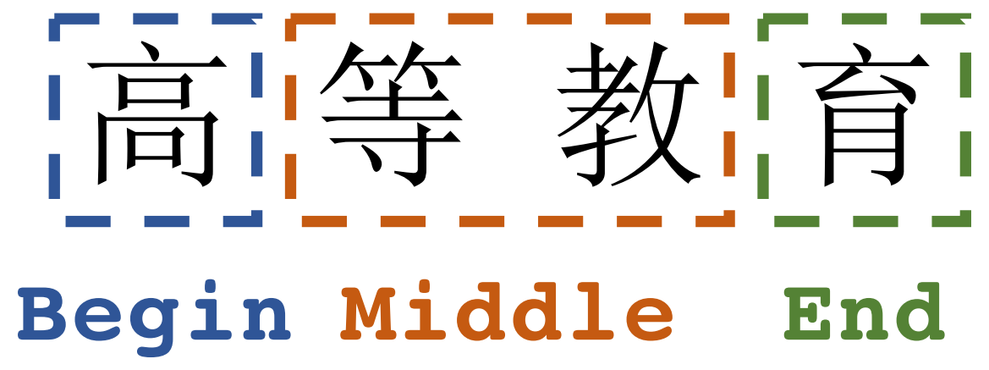
Methodology

- Character-enhanced Sememe Prediction (CSP).
- Ensemble of two parts:
  - Using internal information or character-level information (*internal* models) — SPWCF and SPCSE.
  - Using external information or corpora (*external* models) — the existing methods.

SP with Word-to-Character Filtering (SPWCF)



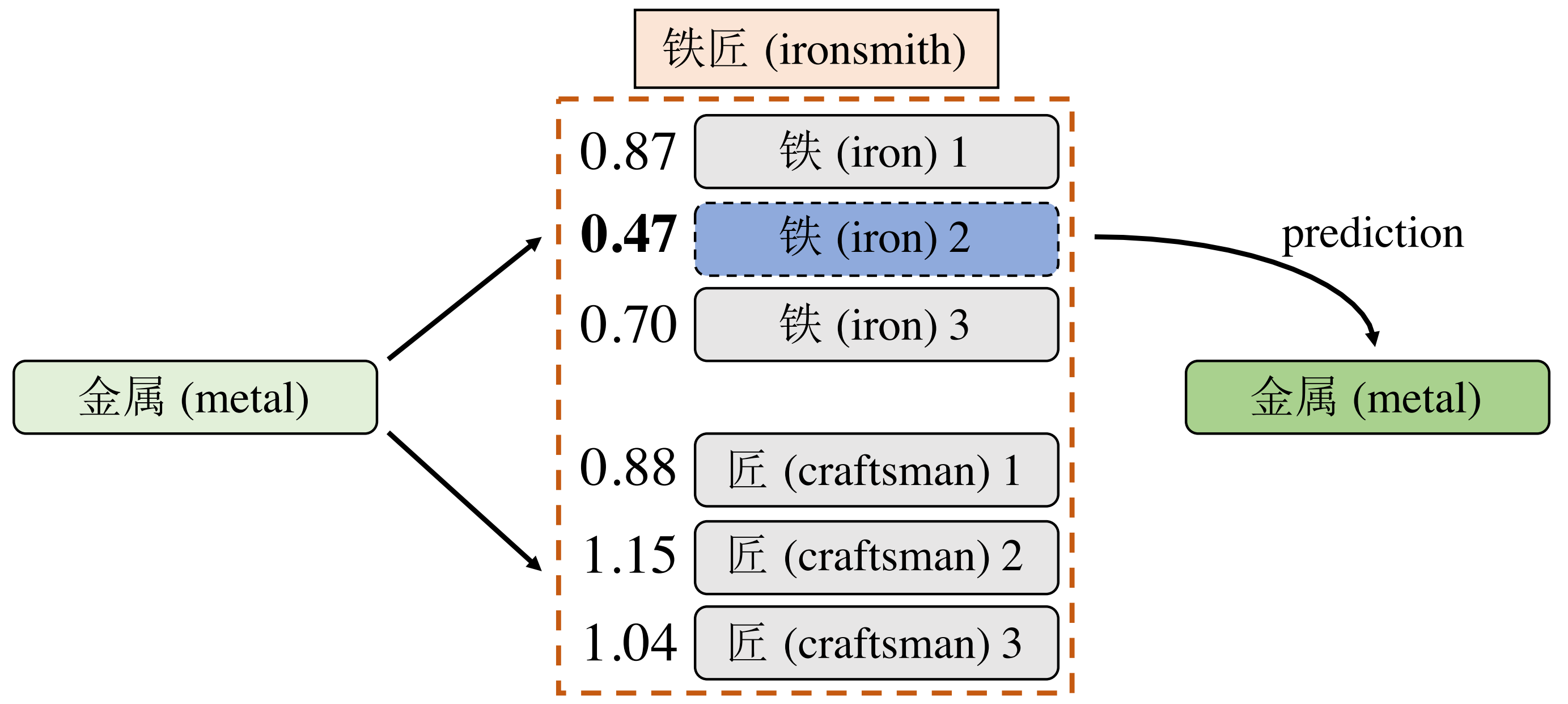
- The positional score function:

$$P_p(s_j|c) \sim \frac{\sum_{w_i \in W \wedge c \in \pi_p(w_i)} \mathbf{M}_{ij}}{\sum_{w_i \in W \wedge c \in \pi_p(w_i)} |S_{w_i}|}$$

- The final score function:

$$P(s_j|w) \sim \sum_{p \in \{B,M,E\}} \sum_{c \in \pi_p(w)} P_p(s_j|c)$$

SP with Character and Sememe Embeddings (SPCSE)



- Selects the most representative character embedding to represent a word:

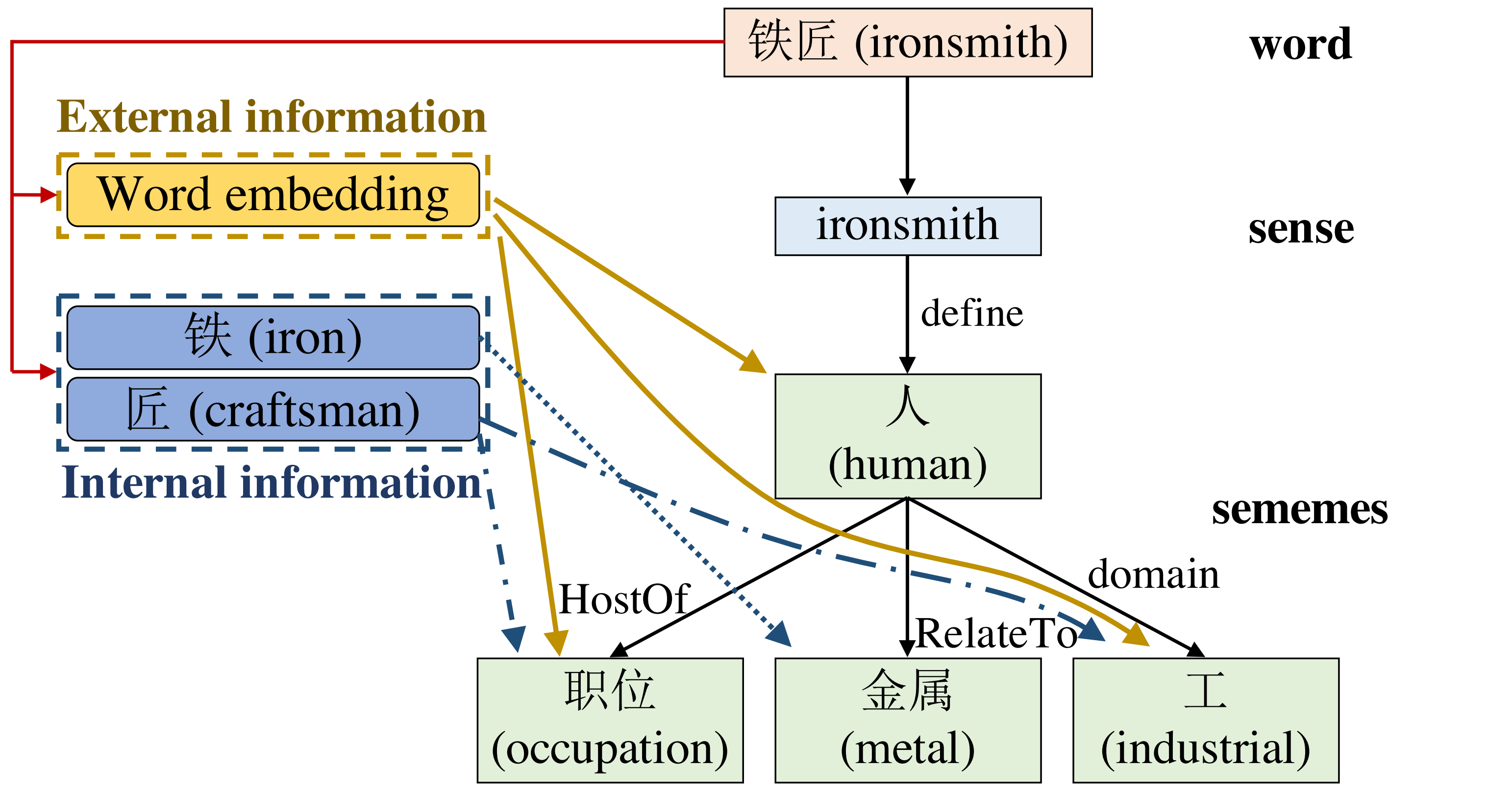
$$\hat{k}, \hat{r} = \arg\min_{k,r} \left[1 - \cos(\mathbf{c}_k^r, (\mathbf{s}'_j + \bar{\mathbf{s}}'_j))\right]$$

- Learns the sememe embeddings with the loss function:

$$\mathcal{L} = \sum_{w_i \in W, s_j \in S} \left(\mathbf{c}_{\hat{k}}^{\hat{r}} \cdot (\mathbf{s}'_j + \bar{\mathbf{s}}'_j) + \mathbf{b}_{\hat{k}}^c + \mathbf{b}''_j - \mathbf{M}_{ij}\right)^2 + \lambda' \sum_{s_j, s_q \in S} \left(\mathbf{s}'_j \cdot \bar{\mathbf{s}}'_q - \mathbf{C}_{jq}\right)^2$$

- The score function of a word $w = c_1 ... c_{|w|}$:

$$P(s_j|w) \sim \mathbf{c}_{\hat{k}}^{\hat{r}} \cdot (\mathbf{s}'_j + \bar{\mathbf{s}}'_j)$$



Experiments

- Sememe selection: 1,400.
- Corpus for embeddings: Sogou-T.
- Word embeddings: GloVe.
- Character embeddings: Cluster-based Character Embeddings (Chen et al., 2015).

Method	MAP
SPSE	0.411
SPWE	0.565
SPWE+SPSE	0.577
SPWCF	0.467
SPCSE	0.331
SPWCF + SPCSE	**0.483**
SPWE + fastText	0.531
CSP	**0.654**

word frequency occurrences	⩽ 50 8537	51– 100 4868	101 – 1,000 3236	1,001 – 5,000 2036	5,001 – 10,000 663	10,001 – 30,000 753	>30,000 686
SPWE	0.312	0.437	0.481	0.558	0.549	0.556	0.509
SPSE	0.187	0.273	0.339	0.409	0.407	0.424	0.386
SPWE + SPSE	0.284	0.414	0.478	0.556	0.548	0.554	0.511
SPWCF	0.456	0.414	0.400	0.443	0.462	0.463	0.479
SPCSE	0.309	0.291	0.286	0.312	0.339	0.353	0.342
SPWCF + SPCSE	0.467	0.437	0.418	0.456	0.477	0.477	0.494
SPWE + fastText	0.495	0.472	0.462	0.520	0.508	0.499	0.490
CSP	**0.527**	**0.555**	**0.555**	**0.626**	**0.632**	**0.641**	**0.624**

words	models	Top 5 sememes
钟表匠 (clockmaker)	internal	人**(human)**, 职位**(occupation)**, 部件(part), 时间**(time)**, 告诉**(tell)**
	external	人**(human)**, 专(ProperName), 地方(place), 欧洲(Europe), 政(politics)
	ensemble	人**(human)**, 职位**(occupation)**, 告诉**(tell)**, 时间**(time)**, 用具**(tool)**
奥斯卡 (Oscar)	internal	专**(ProperName)**, 地方(place), 市(city), 人(human), 国都(capital)
	external	奖励**(reward)**, 艺**(entertainment)**, 专**(ProperName)**, 用具(tool), 事情**(fact)**
	ensemble	专**(ProperName)**, 奖励**(reward)**, 艺**(entertainment)**, 著名(famous), 地方(place)

Take-home Message

- Models using only internal information could make good predictions.
- Integrating with methods incorporating character information could improve prediction performance and especially frequency robustness.
- Our CSP framework achieves the state of the art on sememe prediction.