

# Through The Eyes of A Poet: Classical Poetry Recommendation with Visual Input on Social Media

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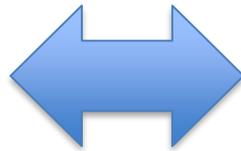
ASONAM 2019, Vancouver, Canada



# Motivation: Image Inspired Classical Poetry

We focus on bridging image with classical poetry

- Both images and poems can express emotions, themes, through symbolism and metaphors.
- Both images and poems describe real-world object in an artistic way.

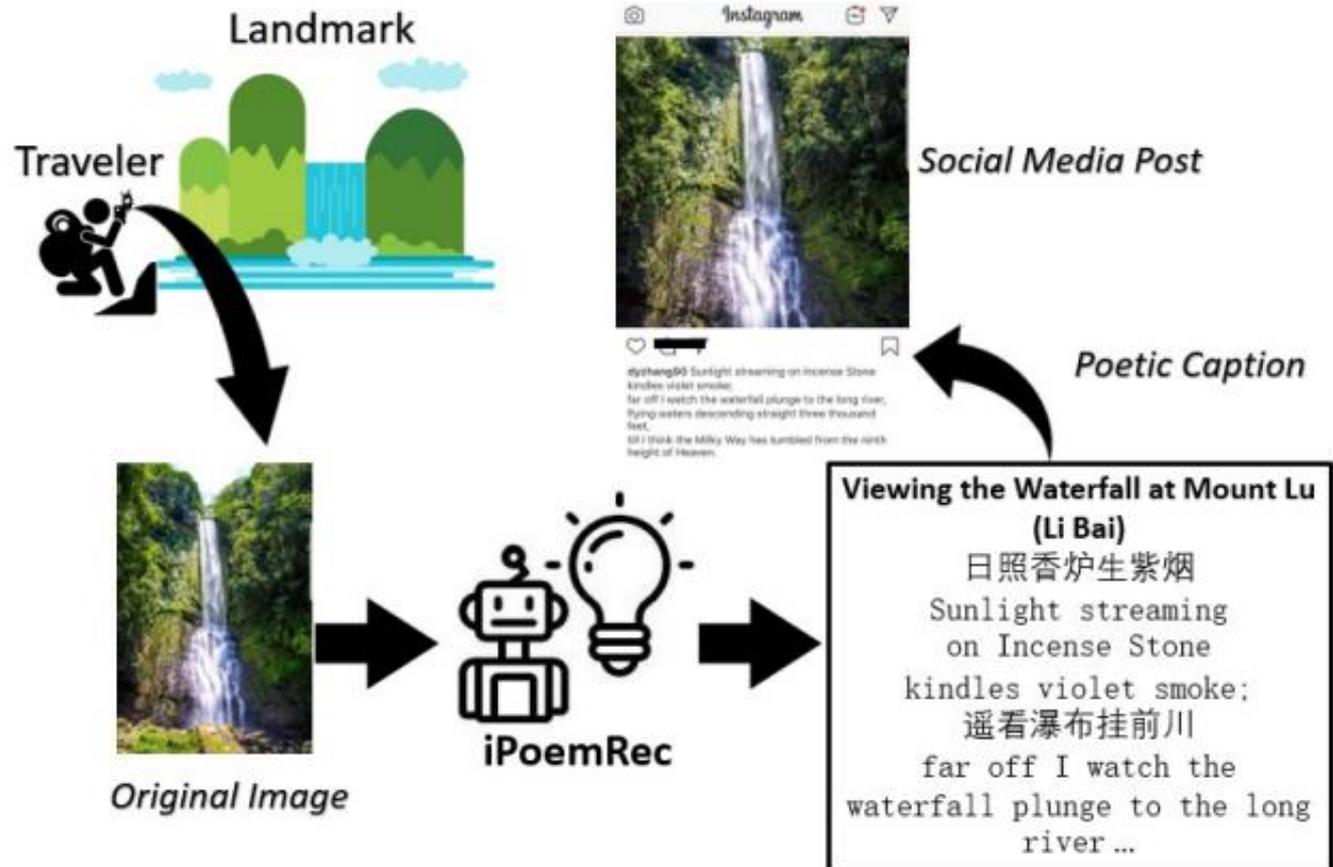


A lonely swan from the sea flies,  
To alight on puddles it does not deign.  
Nesting in the poplar of pearls  
It spies and questions green birds twain:  
"Don't you fear the threat of slings,  
Perched on top of branches so high?  
Nice clothes invite pointing fingers,  
High climbers god's good will defy.  
Bird-hunters will crave me in vain,  
For I roam the limitless sky."

# Motivation: Image Inspired Classical Poetry

## Application scenario – Image Caption

- Image sharing has been one of the popular activity on social media
- Poetry recommendation assigns artistic caption to the image.



# Motivation: Image Inspired Classical Poetry

## Application scenario – **Image/Literature Search**

- We can use poetry to search for matching images or use images to find matching classical poems

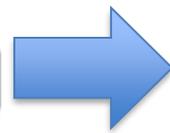
A. E. Housman

Loveliest of trees, the cherry now  
Is hung with bloom along the bough,  
And stands about the woodland ride  
Wearing white for Eastertide.

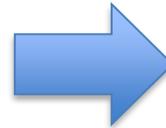


# Related Work: Poetry Recommendation

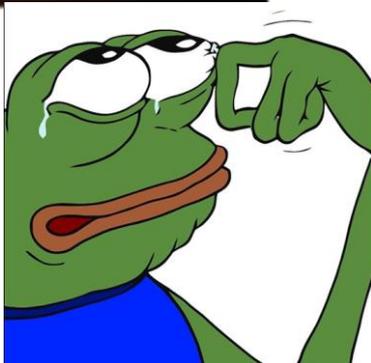
- Existing solutions focus on keyword matching
- Fail to capture the correct **artistic conception**:
  - E.g., **sentiments** and **themes** of the image
  - Or in general what people **feel** about the image



Bird  
Sunset  
Tree branch



With the green grass of spring  
coloring the steps,  
And birds chirping happily under  
the leaves.



**Incorrect sentiment and theme!**

# Challenge 1 - Implicit Artistic Conception

## Takeaway Points

1. Pure object matching leads to wrong recommendation
2. A poem is matching even without mentioning the object in the image, as long as the artistic conception matches

Loneliness  
Ambition  
Peaceful  
Sad  
...



deign.

Poem B ✓ **Sadness**

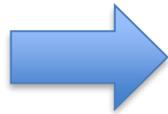
How much brighter the moonlight  
is at home!  
O my brothers, lost and scattered,  
What is life to me without you?

Poem C ✗ **Happiness**

With the green grass of spring  
coloring the steps,  
And birds chirping happily under  
the leaves.

# Challenge 1 - Implicit Artistic Conception

More examples of artistic conceptions



Love, romance

Many artistic conceptions are cultural specific

Love, romance



Lovesickness



Homesickness

Family love



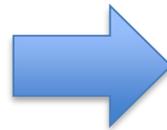
# Challenge 2 – Identify Poetic Objects

- Objects in the image have different poetic values
- Some objects are even distractive in finding matching poems



- 1 - Bird
- 2 - Sunset
- 3 - Tree branch

**How to find the “useful” objects in poetry recommendation?**



- 1 - Rose
- 2 - Other plants
- 3 - House

# Challenge 3 – Diversified User Perception

- Users of the poetry recommender system are subjective and may have diversified perceptions of the same image

**Peaceful**

**How to make the recommendation more diversified?**

**Lonely**



**Beautiful**



# Problem Formulation

## Objective Function

$$\arg \max_{RL} \sum_{\tilde{P} \in RL} (OC_{I, \tilde{P}} + TC_{I, \tilde{P}} + SC_{I, \tilde{P}})$$

**DEFINITION.** *Object Consistency:* the objects the image describes should match the objects in the recommended poems.

**DEFINITION.** *Theme Consistency:* the theme in an image should match the theme expressed by the recommended poem.

**DEFINITION.** *Sentiment Consistency:* the sentiment of the image should match the sentiment expressed by the recommended poem.

# Problem Formulation – Cont'd



Object: singing bird  
Sentiment: happy  
Theme: spring



Spring, the sweet spring, is the year's  
pleasant king,  
Then blooms each thing, then maids dance in  
a ring,

Why addition?

$$\arg \max_{RL} \sum_{\tilde{P} \in RL} (OC_{I, \tilde{P}} + TC_{I, \tilde{P}} + SC_{I, \tilde{P}})$$

Sometimes not all criteria can  
be satisfied (e.g., Poem B)

Poem A ✓

A lonely swan from the sea flies,  
To alight on puddles it does not  
deign.

Poem B ✓

How much brighter the moonlight  
is at home!  
O my brothers, lost and scattered,  
What is life to me without you?

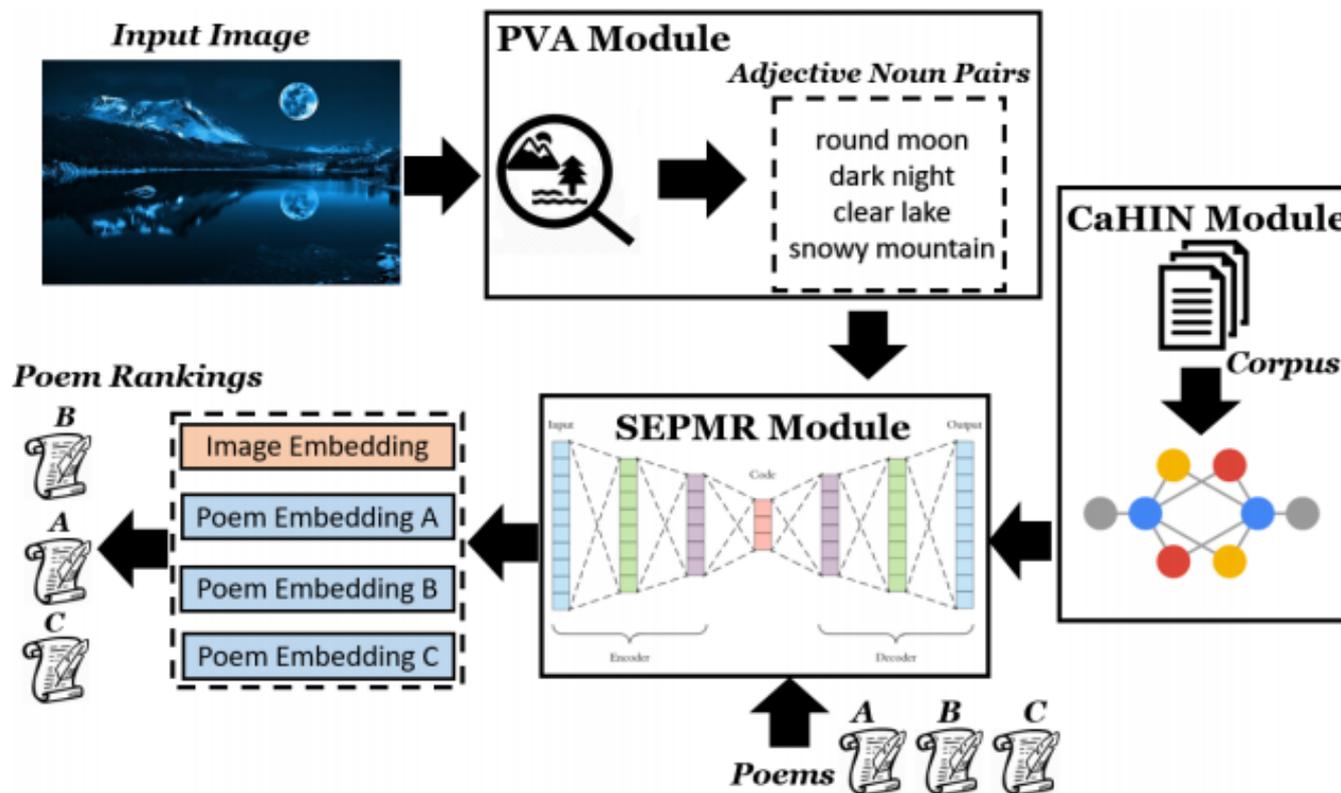
Poem C ✗

With the green grass of spring  
coloring the steps,  
And birds chirping happily under  
the leaves.



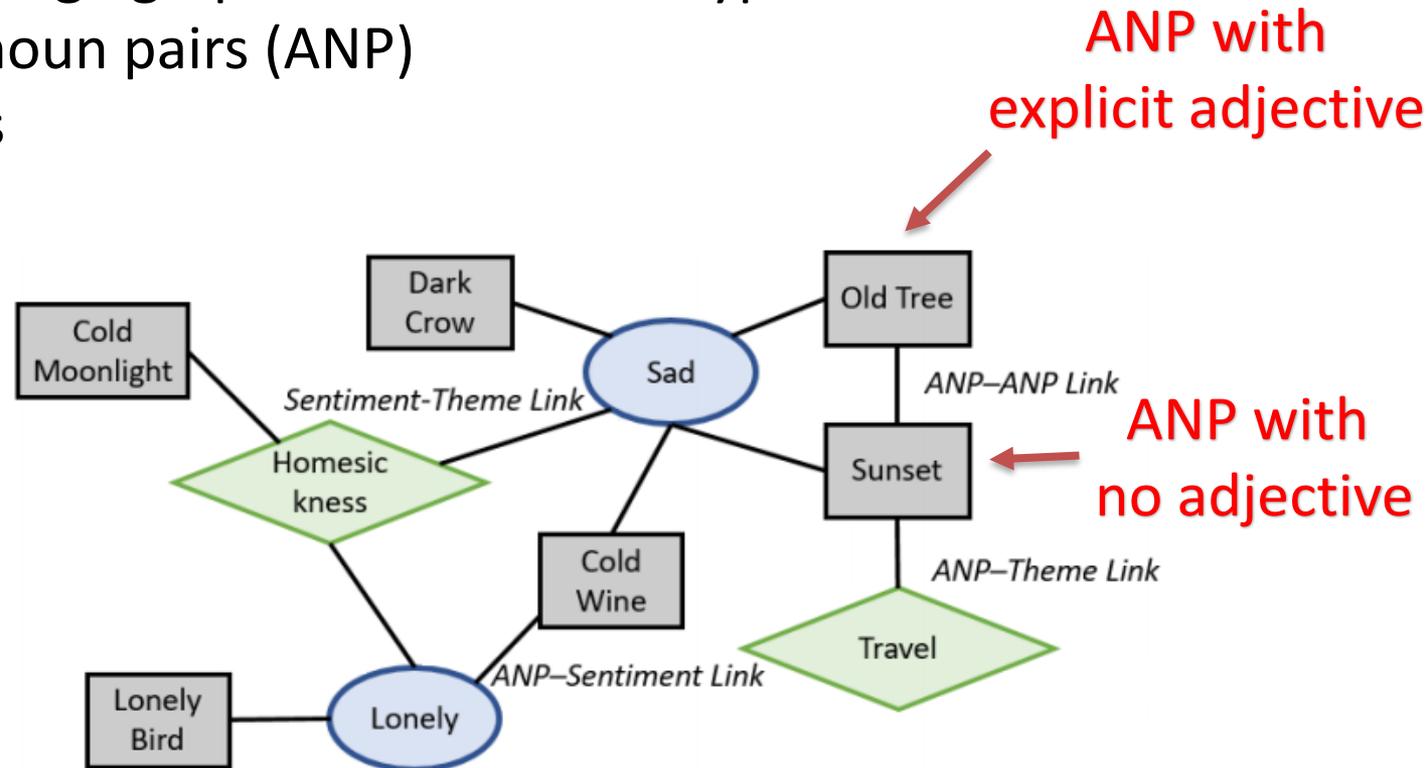
# Solution Overview

- **CaHIN**: build a knowledge graph that models the relationship among sentiments, themes, and terms.
- **PVA**: extracts poetic information from images.
- **SEPMR**: a network embedding scheme that maps poems and images into the same subspace.



# Conception-aware Heterogeneous Information Network (CaHIN) Module

- Builds a knowledge graph that lists three types of entities
  - Adjective-noun pairs (ANP)
  - Sentiments
  - Themes

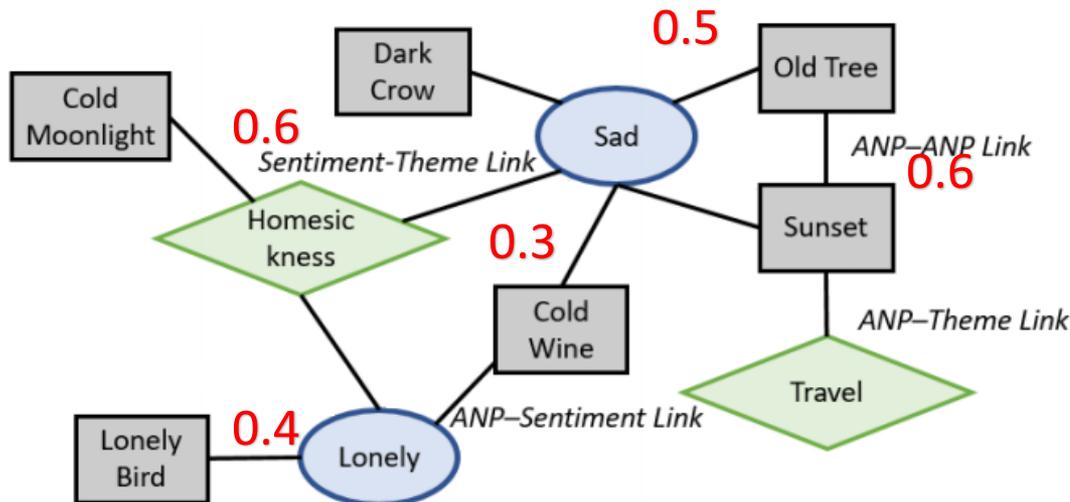


The rectangular blocks are ANP entities; the diamond blocks are theme entities; and the oval blocks are sentiment entities.

Figure: CaHIN Example

# Conception-aware Heterogeneous Information Network (CaHIN) Module (Cont'd)

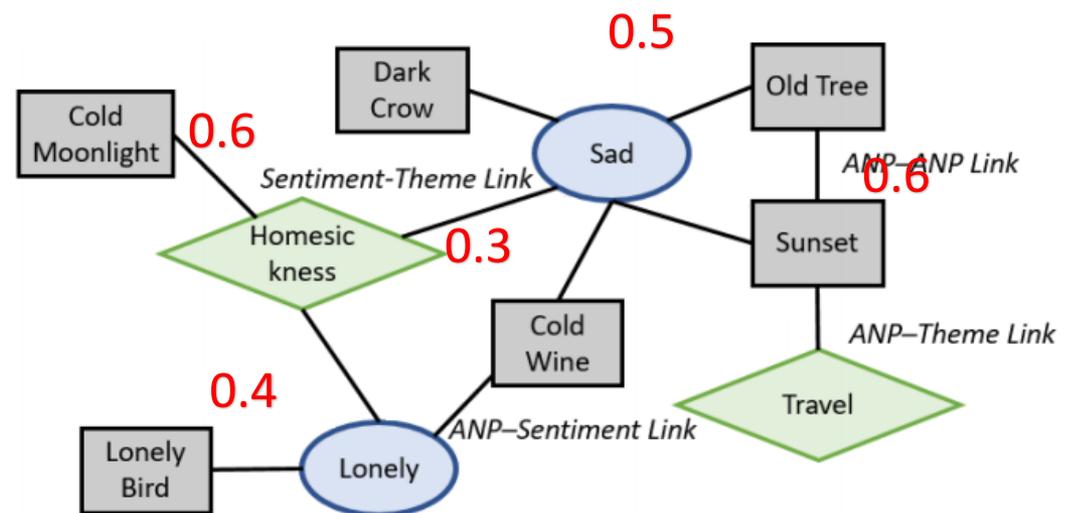
- Then we derive links between these entities
  - 5 types of links
  - Each link assigned a weight
  - Links with small weights are discarded (e.g.,  $<0.1$ )
- **ANP-ANP link (AA):** a link representing the similarity between two ANPs.
- **ANP-Sentiment link (AS):** a link representing the relevance between an ANP and a sentiment entity.
- **ANP-Theme link (AT):** a link representing the relevance between an ANP and a theme entity.
- **Theme-Theme link (TT):** a link representing the similarity between two theme entities.
- **Sentiment-Theme link (ST):** a link representing the relevance between a sentiment entity and a theme entity.



# Conception-aware Heterogeneous Information Network (CaHIN) Module (Cont'd)

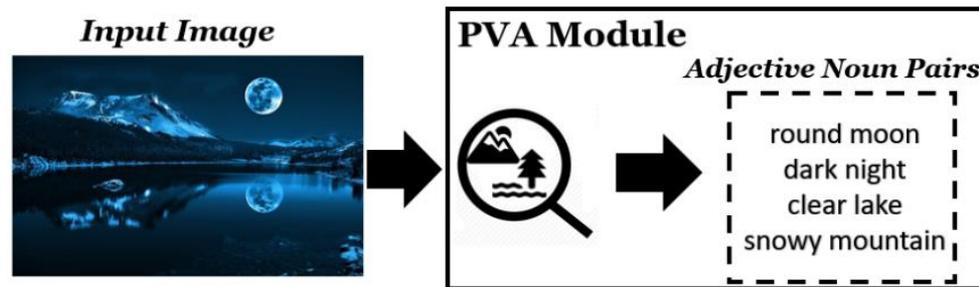
- **ANP-ANP Link:** word similarity (Word2Vec)
- **ANP-Sentiment Link:** co-occurrence of the ANP and the sentiment
- **ANP-Theme Link:** co-occurrence of the ANP and the theme
- **Sentiment-Theme Link:** co-occurrence of the sentiment and the theme
- **Theme-Theme Link:** co-occurrence of the themes

The themes and sentiment of each poem are manually labeled (due to small corpus of the poems).



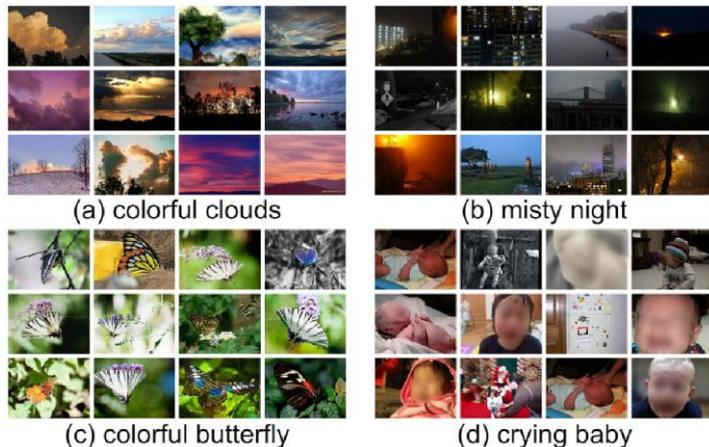
# Poetic Visual Analyzer (PVA) Module

- Extract “visual adjective-noun pairs (ANP)” from images
- Use SentiBank dataset to acquire a training set of ANPs for images
- Train a deep CNN classifier (pretrained using ImageNet) to classify input images

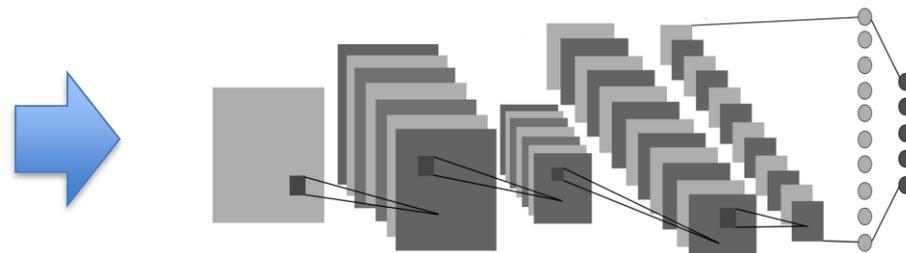


## SentiBank Dataset

<http://www.sentibank.org/>

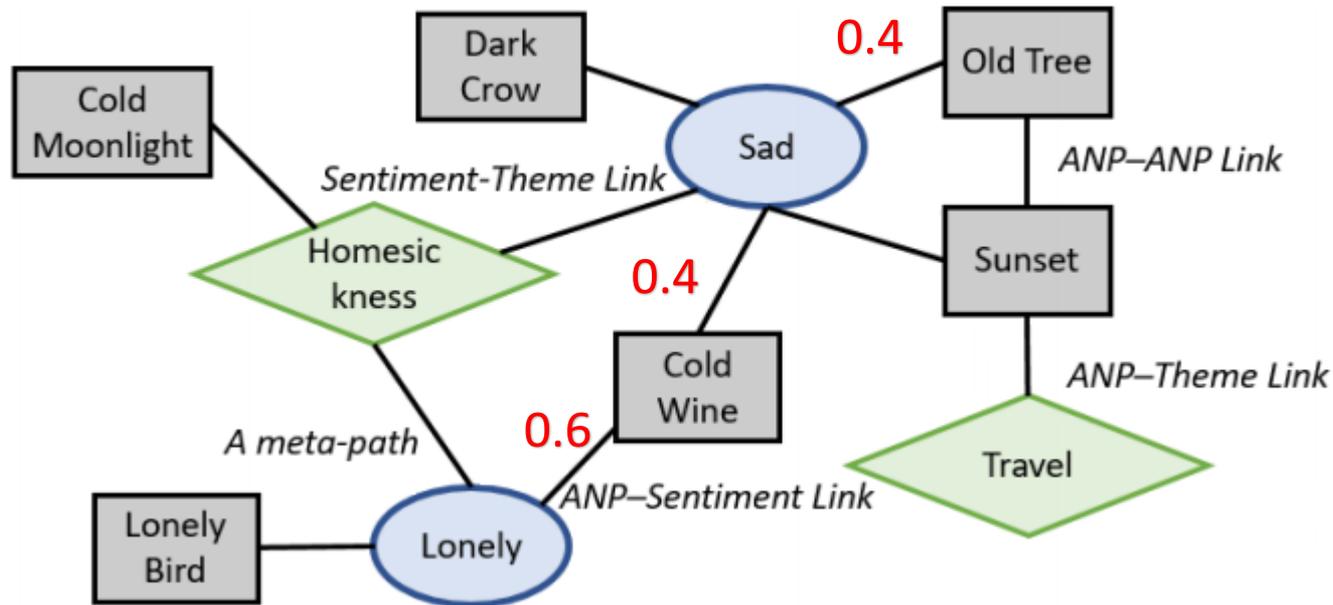


## CNN Classifier



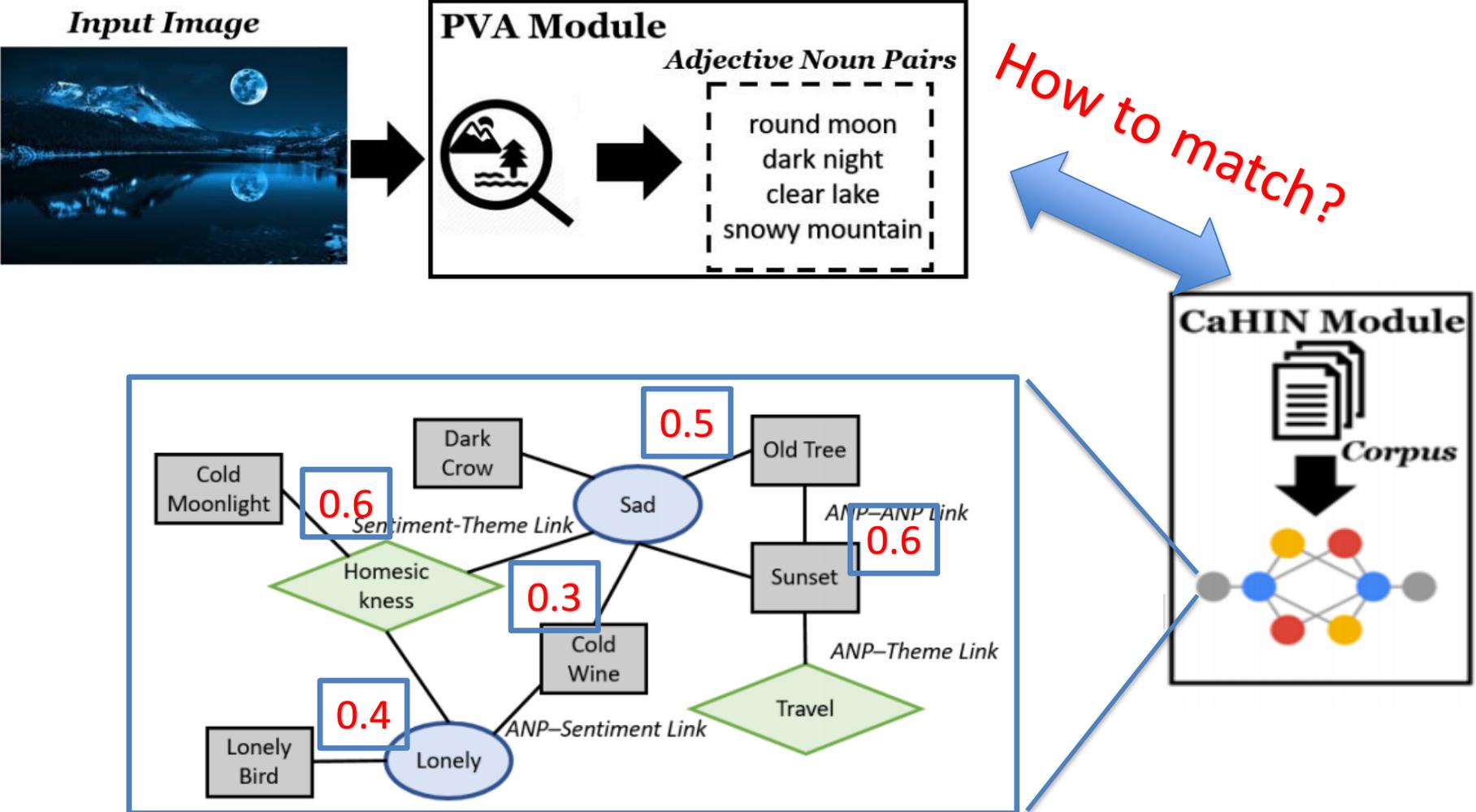
# Poetic Visual Analyzer (PVA) (Cont'd)

- We further rank the visual ANPs based on its “metaphorical degree”.
- Defined as: the sum of the weights of all AS and AT links connected to the ANP in G.
- E.g., the metaphorical degree for “Cold Wine” is  $0.4+0.6$ , for “Old Tree” is  $0.4$ .



# Semantic Enriched Meta Path Ranking (SEMPR) Module

- Let's first recap what we have now:



# Semantic Enriched Meta Path Ranking (SEMPR) Module (Cont'd)

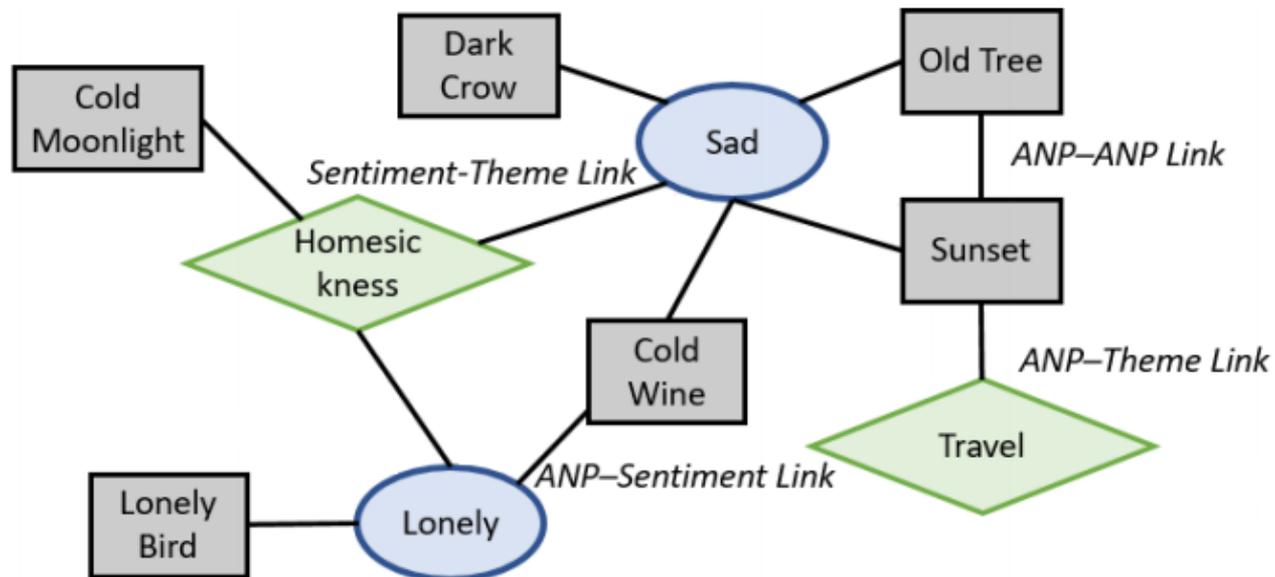
- Intuition – we want the image and the poems to speak the same language!
- Naïve Solution: extract ANPs from both images and poems and compare text similarity.



Again, it misses the artistic conception (sentiment and themes) of the poem and images.

# Semantic Enriched Meta Path Ranking (SEMPR) Module (Cont'd)

- We want to enrich the visual ANPs from image with sentiment and themes.
- Leverage the knowledge graph!
  - Perform meta-path traversal using random walks
  - Embedded the traversed meta-paths

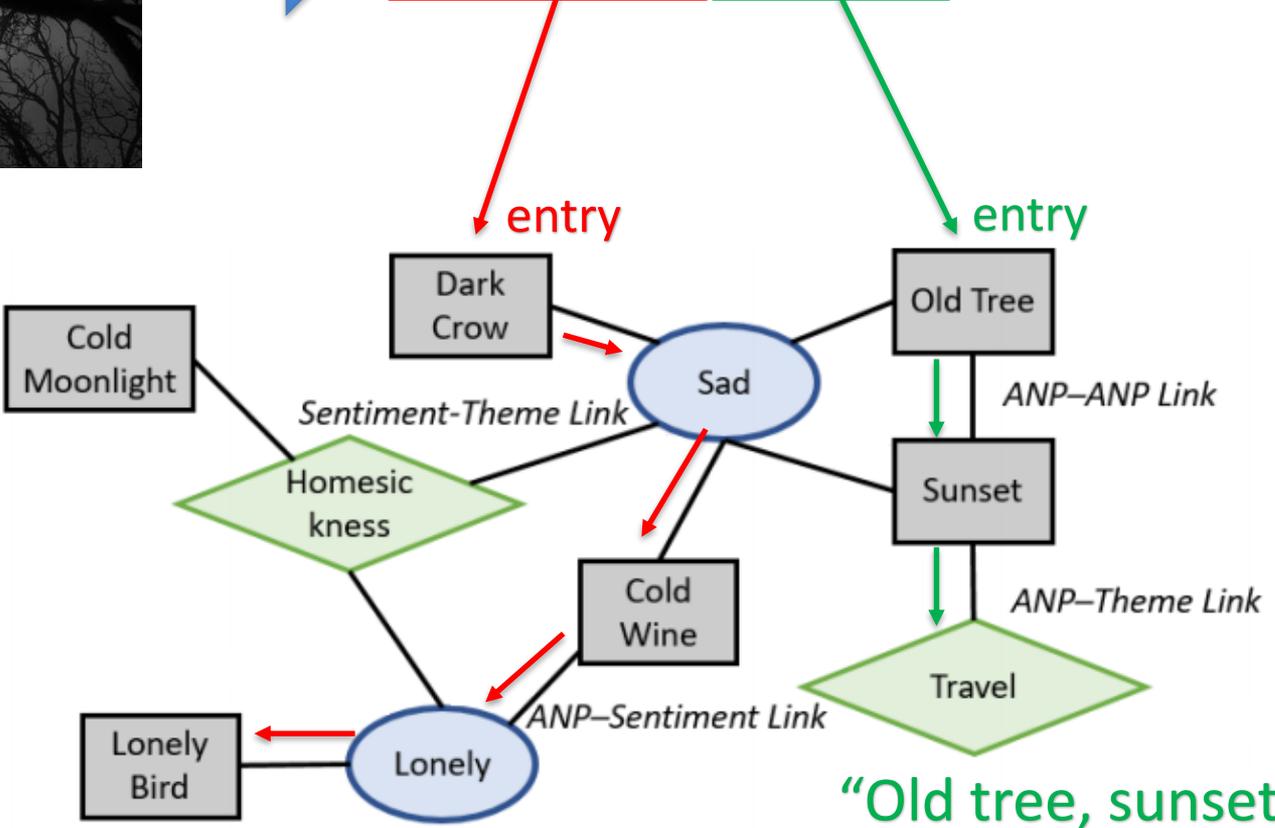


# Semantic Enriched Meta Path Ranking (SEMPR) Module (Cont'd)



visual ANPs

Black Crow, Old Tree, Full moon

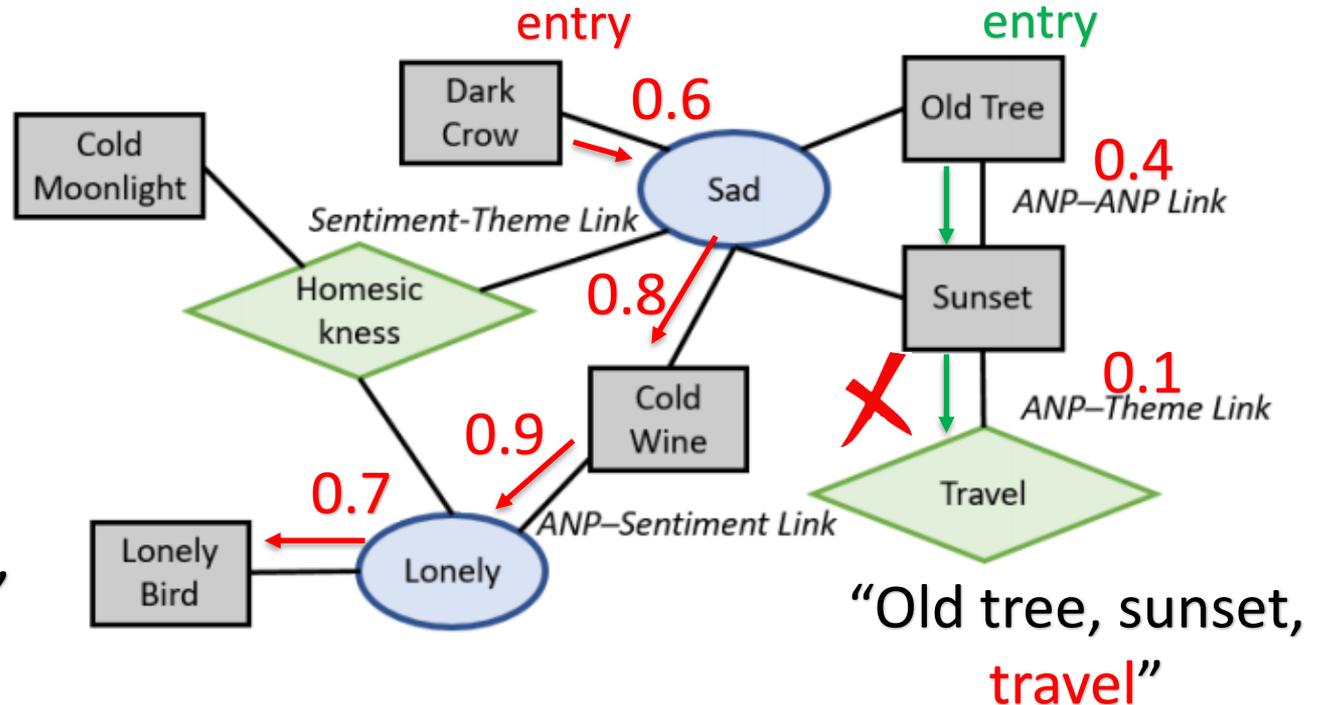


“Dark crow, sad, cold wine, lonely, lonely bird”

“Old tree, sunset, travel”

# Semantic Enriched Meta Path Ranking (SEMPR) Module (Cont'd)

- When the depth of the walk increases, irrelevant entities can be introduced.
- If the accumulated weight < threshold, stop the walk.



“Dark crow, sad,  
cold wine, lonely,  
lonely bird”

“Old tree, sunset,  
travel”

# Semantic Enriched Meta Path Ranking (SEMPR) Module (Cont'd)

- Now each image is represented by a set of meta-paths, each path consists of terms (ANPs, sentiments, themes)



“ Path 1 - Dark crow, sad, cold wine, lonely, lonely bird”

“Path 2 - Old tree, sunset”

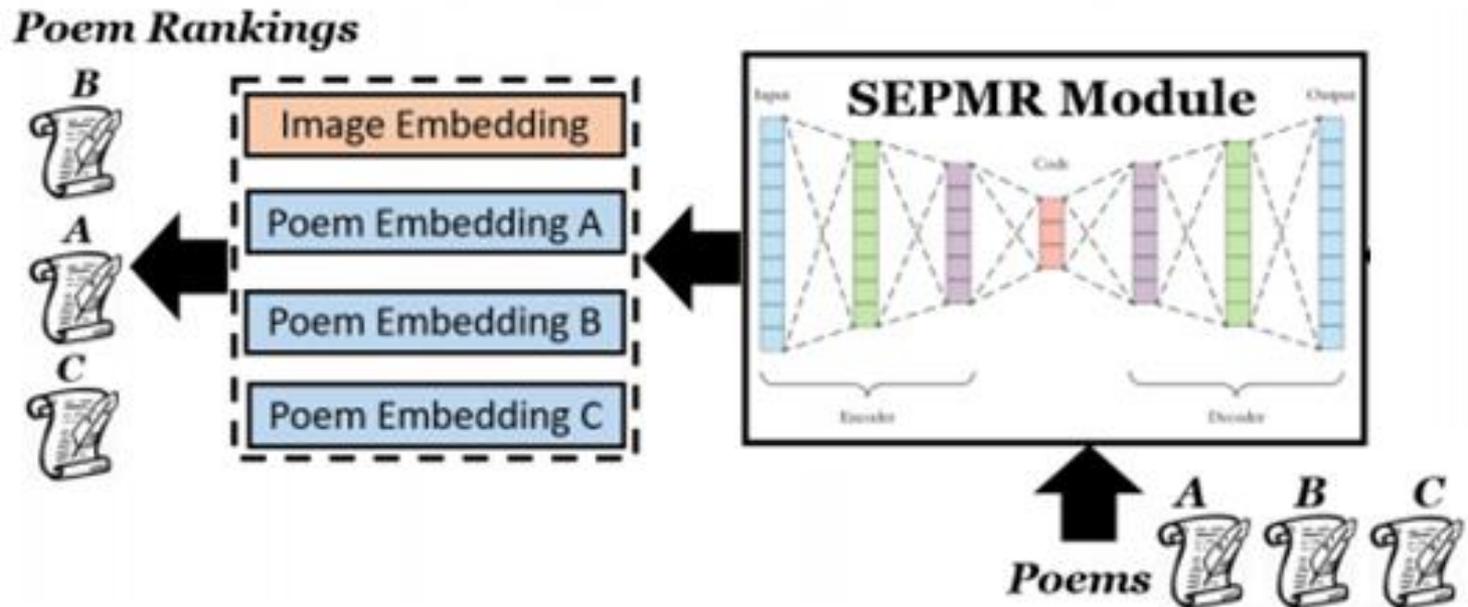
“Path 3 – Cold moonlight, homesickness, lonely”

“Path 4 – Dark crow, sad, homesickness ”

...

# Semantic Enriched Meta Path Ranking (SEMPR) Module (Cont'd)

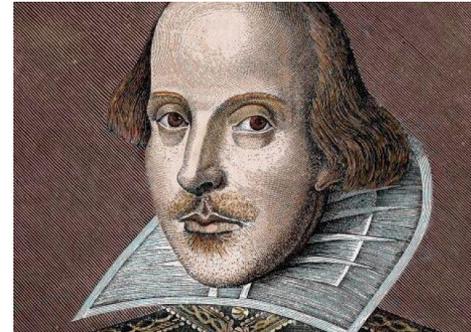
- We do the exact same thing for the poems, so poems are represented as meta-paths as well.
- Perform embedding to map the meta-paths of poems and meta-paths of images into the same subspace (see paper for more details).



# Evaluation

## Dataset

- Chinese poetry dataset consists of 870 poems from Tang Dynasty.
- English poetry dataset consist of 140 Shakespeare's Sonnets.



## Baselines

- **Word2Vec**: simply perform object matching.
- **Image2Caption**: recommend most similar poems to automatically generated image caption.
- **SCAN**: STOA cross-modal matching scheme for texts and images
- **SentiBank**: directly matching poems with ANPS generated from SentiBank dataset.

# Evaluation - Crowdsourcing-based Evaluation

- 100 landscape images from Instagram
- 5 recommended poems for each image using each scheme
- 3 people label the **relevance score** and **overall rating** of each poem

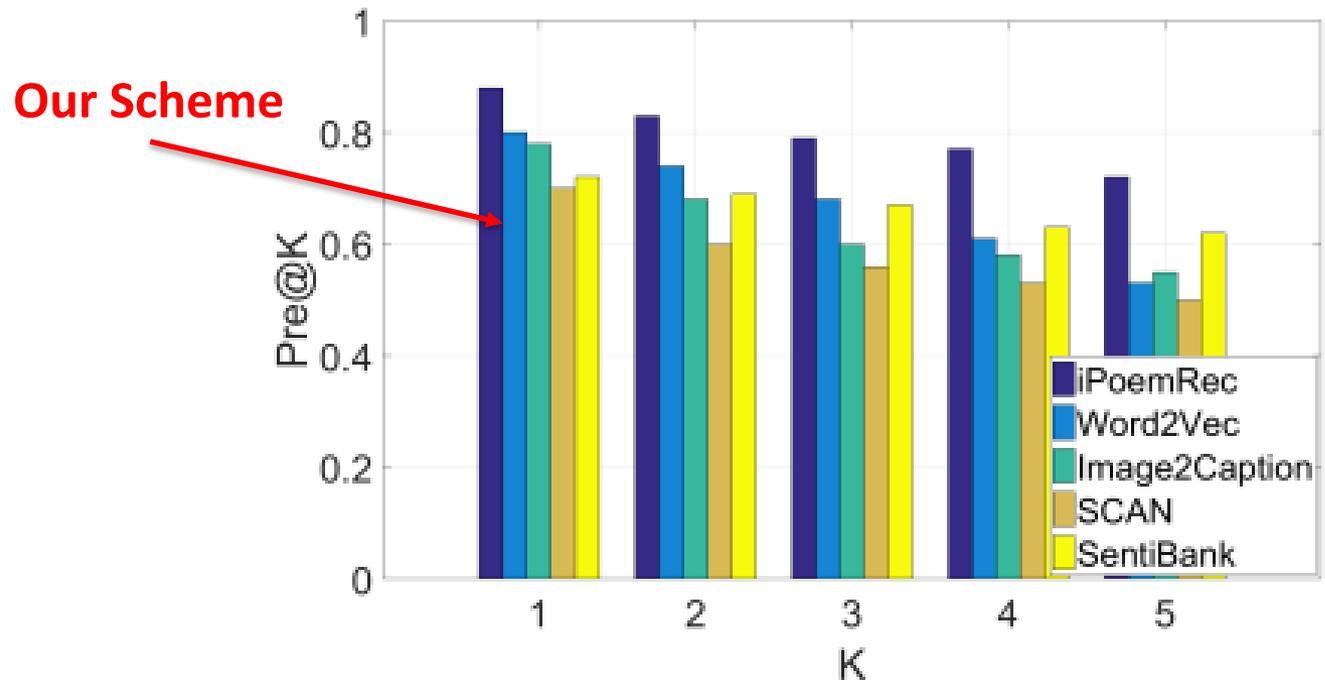


Figure : Precision@K for all Schemes

# Evaluation – Average Relevance

- MOR – Mean Overall Rating
- Overall, the recommendation provided by iPoemRec is more appreciated by users.

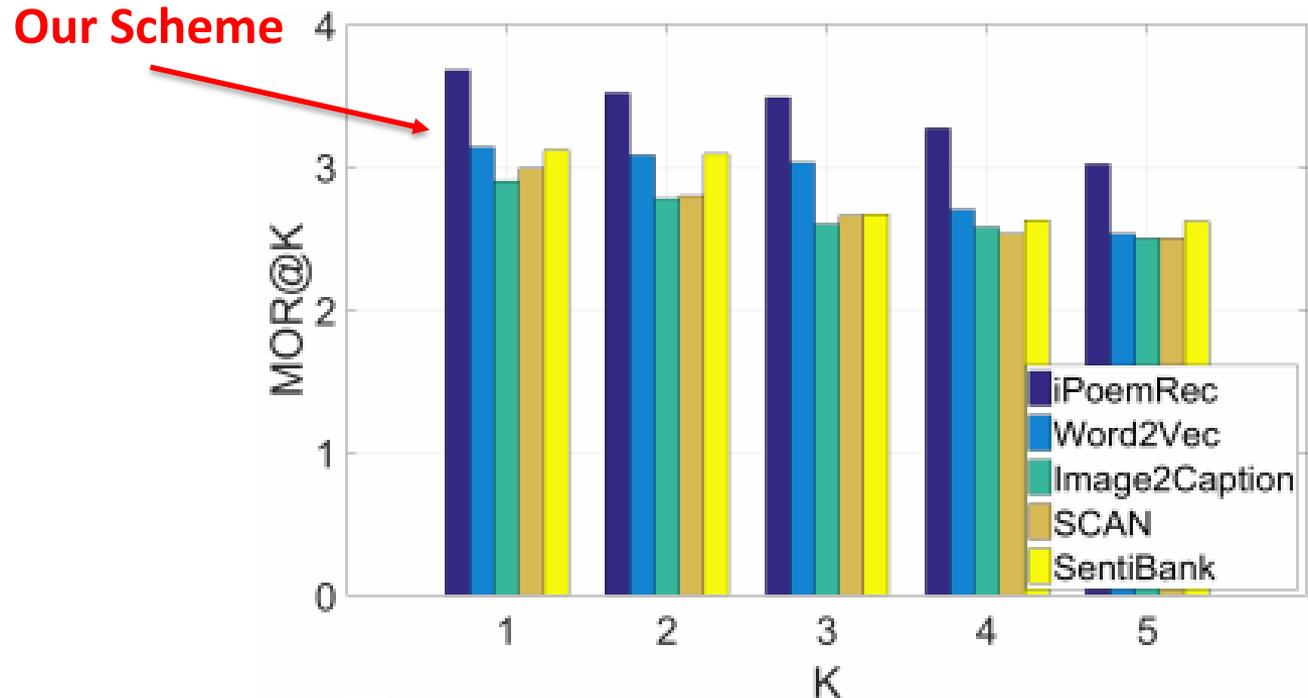


Figure: MOR@K for all Schemes

# Evaluation – User Study

- We put the recommendation system online and allow user to directly use our tool
- The users are allowed to upload whatever image they prefer
- A total of 297 user are recruited

Table: Evaluation Results for an Online User Study

		Pre@1	Pre@3	MOR@1	MOR@3	NDCG@3
<b>iPoemRec</b>		<b>0.881</b>	<b>0.855</b>	<b>3.513</b>	<b>3.421</b>	<b>0.816</b>
<b>Word2Vec</b>		0.796	0.722	3.074	2.907	0.778
<b>Image2Caption</b>		0.785	0.714	2.696	2.536	0.750
<b>SCAN</b>		0.714	0.698	2.444	2.127	0.698
<b>SentiBank</b>		0.792	0.708	3.145	3.021	0.729

# Evaluation – Cross Lingual

- We further evaluate our scheme on classical English poetry
- ipoemRec continue to outperform

Table : Evaluation Results for Classical English Poetry

		Pre@1	Pre@3	MOR@1	MOR@3	NDCG@3
<b>iPoemRec</b>		<b>0.894</b>	<b>0.848</b>	<b>3.470</b>	<b>3.212</b>	<b>0.864</b>
<b>Word2Vec</b>		0.846	0.807	3.211	3.019	0.827
<b>Image2Caption</b>		0.805	0.787	2.914	2.702	0.787
<b>SCAN</b>		0.791	0.729	2.812	2.396	0.750
<b>SentiBank</b>		0.800	0.781	3.254	3.127	0.763

# Limitations and Future Work

- **Unsupervised -> Supervised**
  - The user feedback is not directly leveraged to improve recommendation
  - Incorporate learning mechanism to iPoemRec
- **Limited Dataset**
  - Collect more data
  - Explore other types of poems (e.g., modern poetry, multilingual poems)
- **Other types of images**
  - Can only handle landscape images
  - Extend to handle other types of images such as portraits, architectural, etc.

# Thank You!

## Question?

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