



# Generative Models for Ticket Resolution in Expert Networks

---

Gengxin Miao, Louise Moser, Xifeng Yan

University of California, Santa Barbara

Shu Tao

IBM T.J. Watson

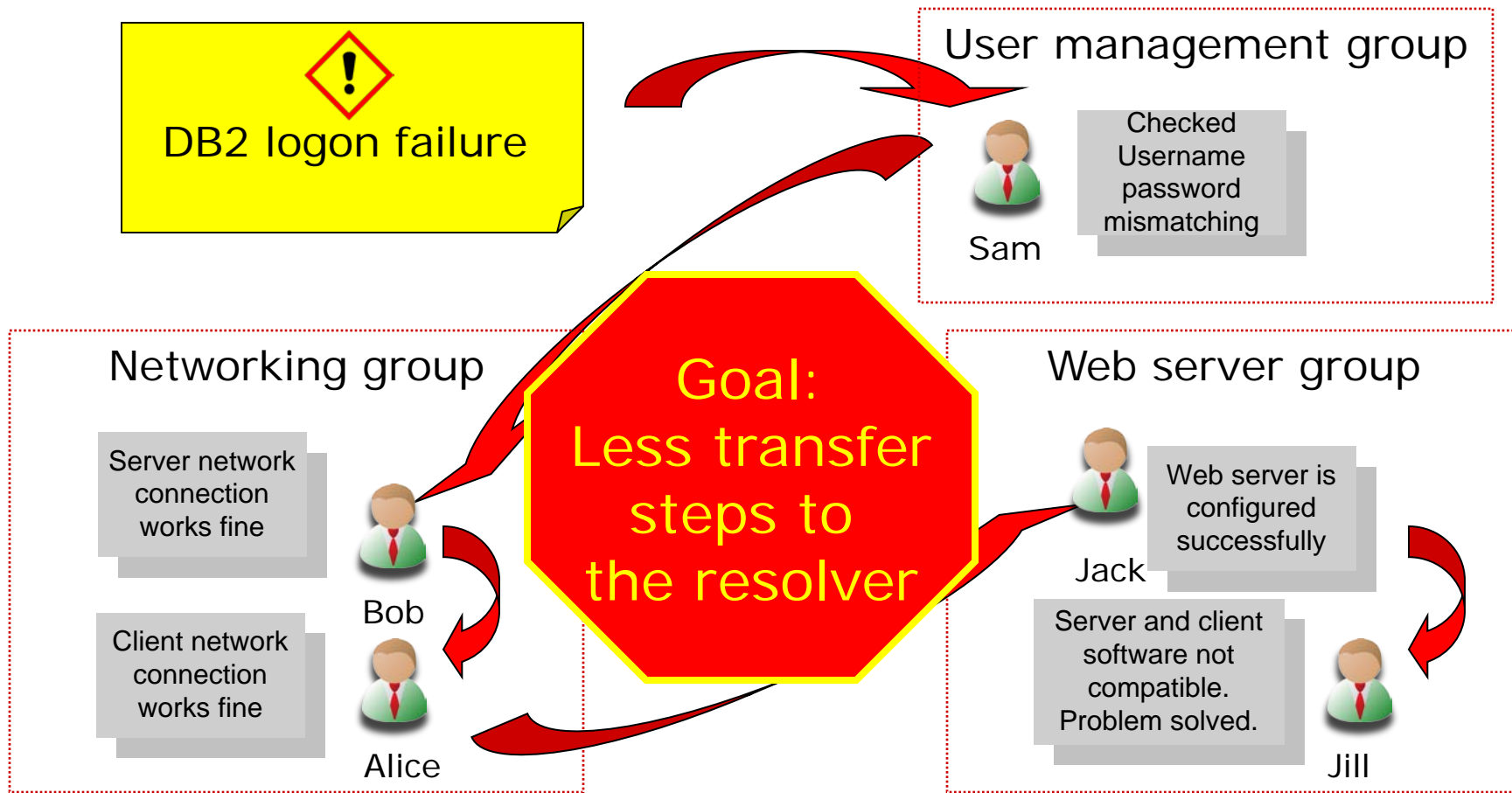
Yi Chen

Arizona State University

Nikos Anerousis

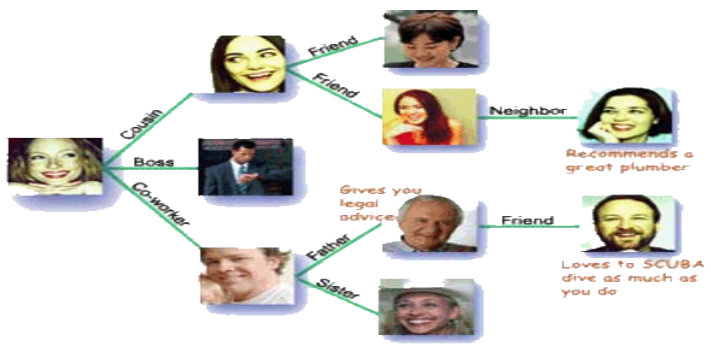
IBM T.J. Watson

# The Life of a Ticket



# Application Scenarios

Question answering  
in a social network



Customer service

Collaborator finding  
in the academic world



Business referral



# Problem Definition

A set of tickets reported to the expert network

$$\mathcal{T} = \{t_1, t_2, \dots, t_m\}$$

Word description of tickets

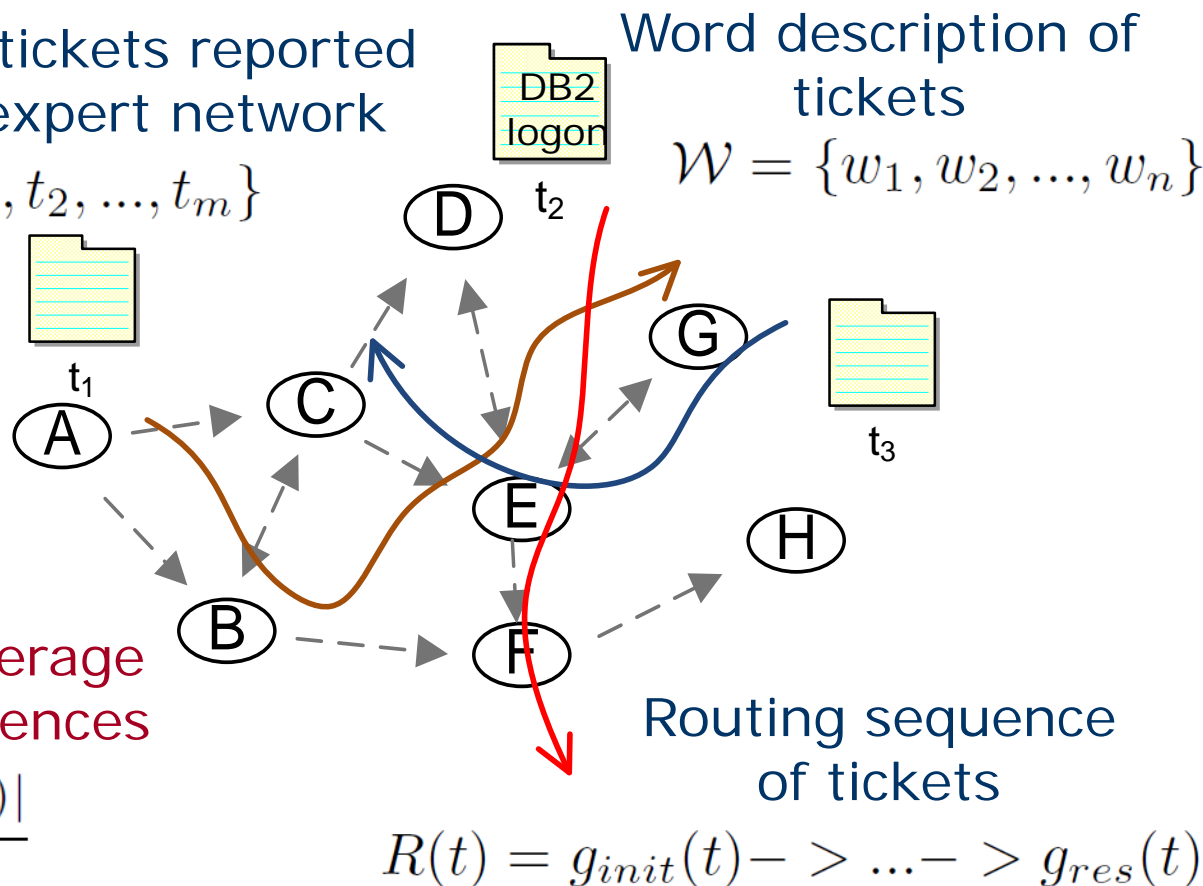
$$\mathcal{W} = \{w_1, w_2, \dots, w_n\}$$

An interconnected network of experts

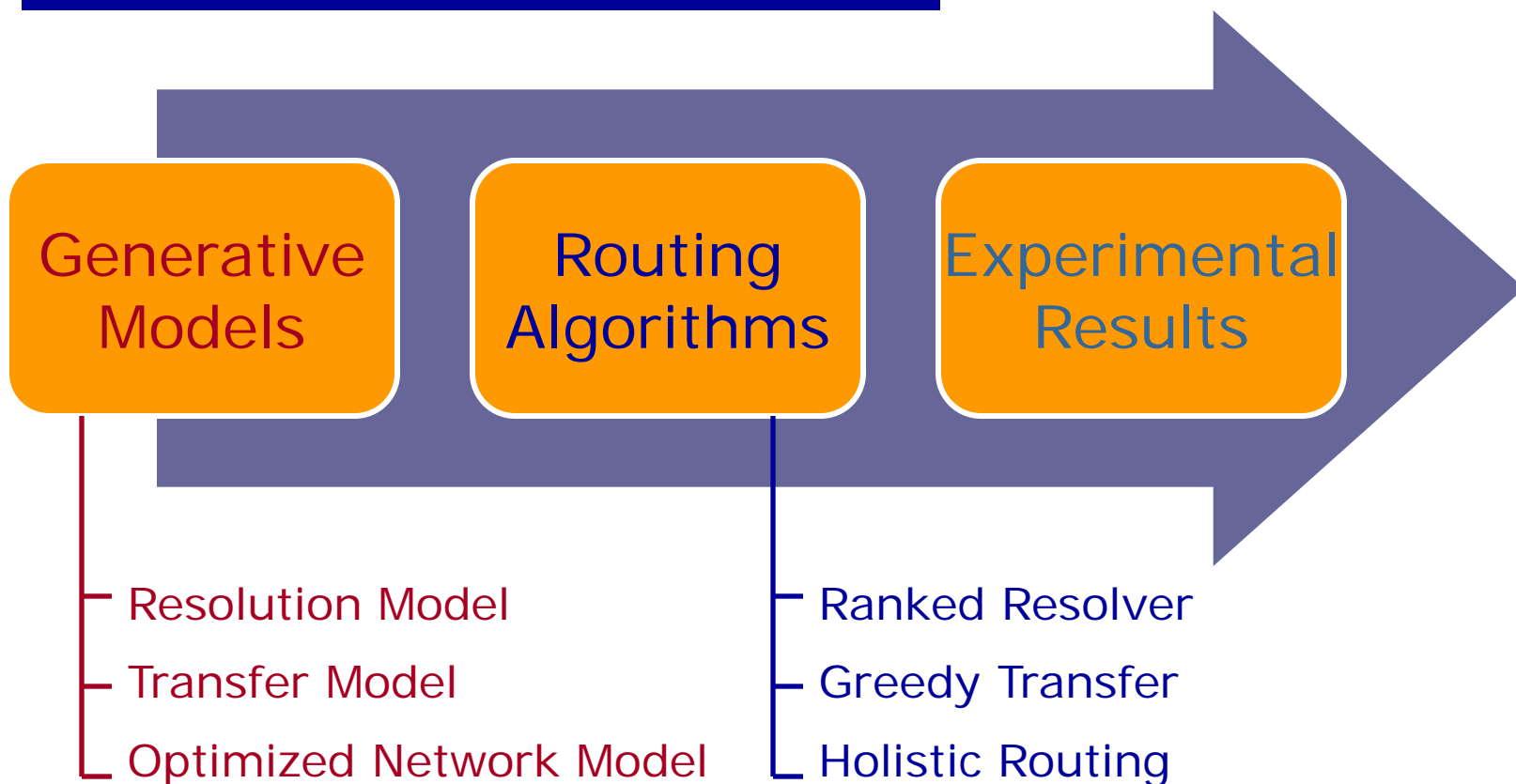
$$\mathcal{G} = \{g_1, g_2, \dots, g_L\}$$

Goal: Minimize the average length of routing sequences

$$S = \frac{\sum_{i=1}^m |R(t_i)|}{m}$$



# Outline



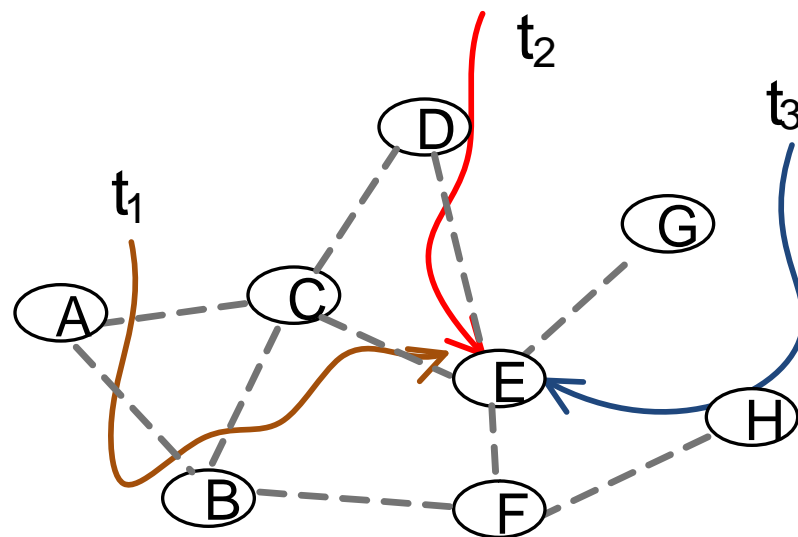
# Resolution Model (RM)

Generative Models

Routing Algorithms

Experiment

- Each expert has an expertise profile
  - An expert is likely to be able to resolve tickets similar to what he/she has resolved previously



Tickets resolved by expert E

$$P_{g_i} = [P(w_1|g_i), P(w_2|g_i), \dots, P(w_n|g_i)]^T$$

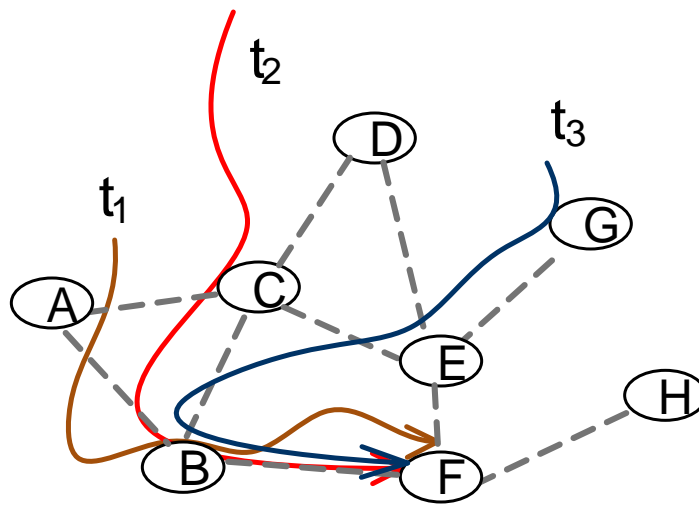
# Transfer Model (TM)

Generative Models

Routing Algorithms

Experiment

- Expertise awareness between experts
  - An expert transfers similar tickets to another expert



Tickets transferred from expert B to expert F

$$P_{e_{ij}} = [P(w_1|e_{ij}), P(w_2|e_{ij}), \dots, P(w_n|e_{ij})]^T$$



# Optimized Network Model (ONM)

Generative Models

Routing Algorithms

Experiment

- Transfer profiles optimized for the entire expert network

$$\mathcal{L} = \prod_{t \in \mathcal{T}} P(R(t)|t)$$

$$P(R(t)|t) = P(g_1|t)P(g_2|t, g_1)P(g_3|t, g_2)P(g_3|t, g_3)$$

$$P(g_j|t, g_i) = \frac{P(t|e_{ij})P(g_j|g_i)}{Z(t, g_i)}$$

$$= \frac{(\prod_{w_k \in t} P(w_k|e_{ij})^{f(w_k, t)})P(g_j|g_i)}{Z(t, g_i)}$$

$$Z(t, g_i) = \sum_{g_j \in \mathcal{G}} P(t|e_{ij})P(g_j|g_i)$$



# Optimized Network Model (ONM)

Generative Models

Routing Algorithms

Experiment

$$\begin{aligned} \log \mathcal{L} \geq [\log \mathcal{L}] &= \sum_{e_{ij}} \sum_{t \in T_{ij}} (\log(P(t|e_{ij})) + \log(P(g_j|g_i))) \\ &- \sum_{g_i \in \mathcal{G}} \sum_{t' \in T_i} \sum_{w_k \in t'} \log\left(\sum_{g_\ell \in \mathcal{G}} (P(g_\ell|g_i) \times P(w_k|e_{i\ell}))\right) \end{aligned}$$

$$\begin{aligned} \nabla[\log(\mathcal{L})] &= \frac{\partial[\log \mathcal{L}]}{\partial P(w_k|e_{ij})} \\ &= \frac{\sum_{t \in T_{ij}} n(w_k, t)}{P(w_k|e_{ij})} \\ &= \frac{P(g_j|g_i) \times \sum_{t' \in T_i} n(w_k, t')}{\sum_{g_\ell \in \mathcal{G}} P(g_\ell|g_i) \times P(w_k|e_{i\ell})} \end{aligned}$$

TM model as initial values  
Use steepest descent method  
until convergence

# Routing Algorithms

---

- Ranked resolver
- Greedy transfer
- Holistic routing

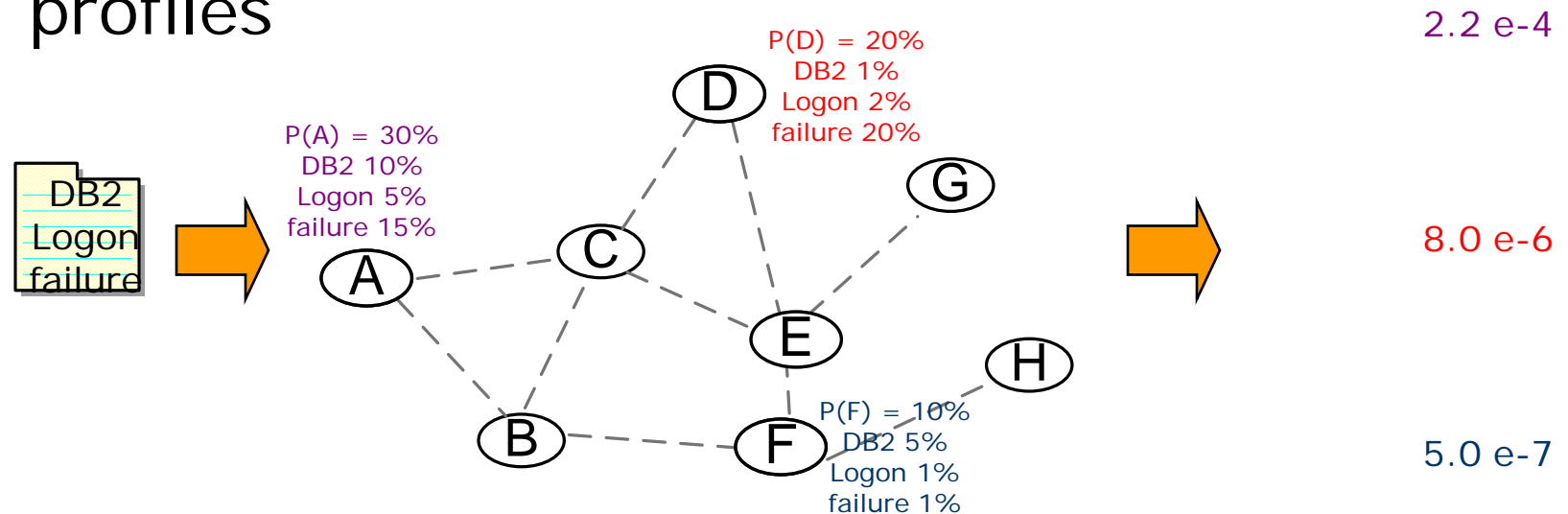
# Ranked Resolver

Generative Models

Routing Algorithms

Experiment

- Match the ticket content with the expertise profiles

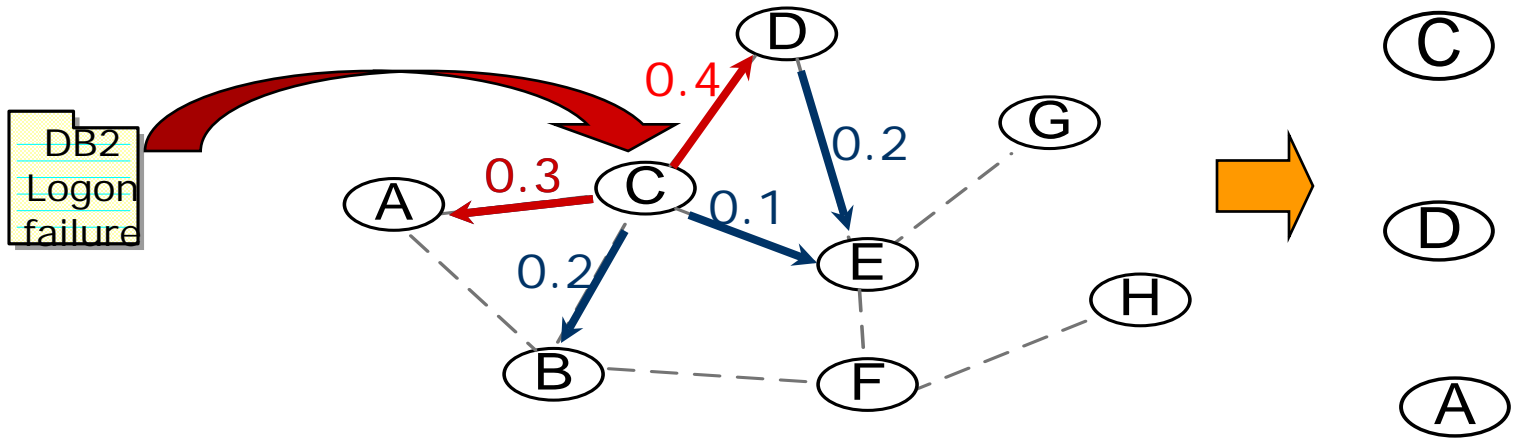


$$P(g_i|t) = \frac{P(g_i)P(t|g_i)}{P(t)} \propto P(g_i) \prod_{w_k \in t} P(w_k|g_i)^{f(w_k,t)}$$



# Greedy Transfer

Match the ticket with the transfer profiles



$$Rank(g_j) \propto \max_{g_i \in R(t)} P(g_j | t, g_i)$$

$$P(g_j | t, g_i) = \frac{P(g_j | g_i) \prod_{w_k \in t} P(w_k | e_{ij})^{f(w_k, t)}}{\sum_{g_l \in \mathcal{G}} P(g_l | g_i) \prod_{w_k \in t} P(w_k | e_{il})^{f(w_k, t)}}$$

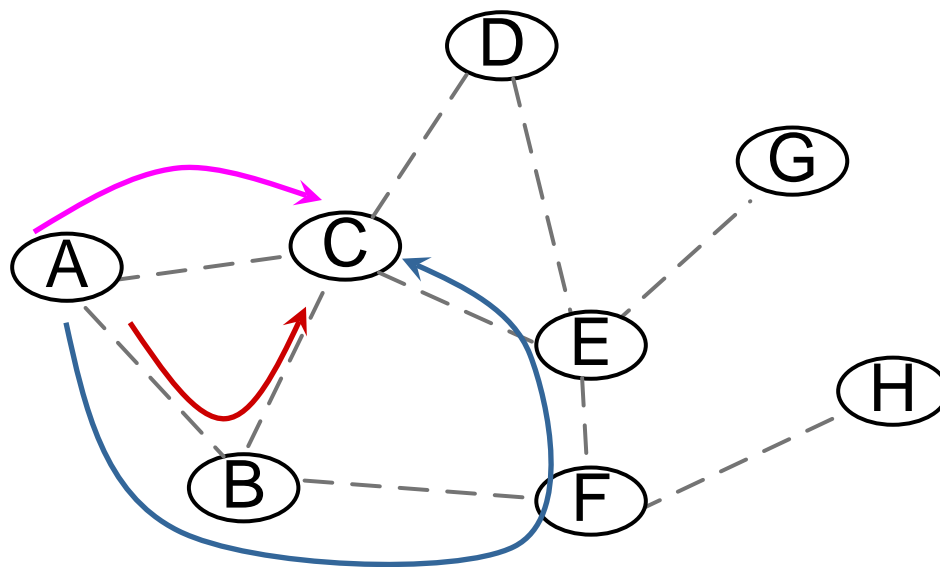
# Holistic Routing

Generative Models

Routing Algorithms

Experiment

- All possibilities are explored



# Experimental Results

Generative Models

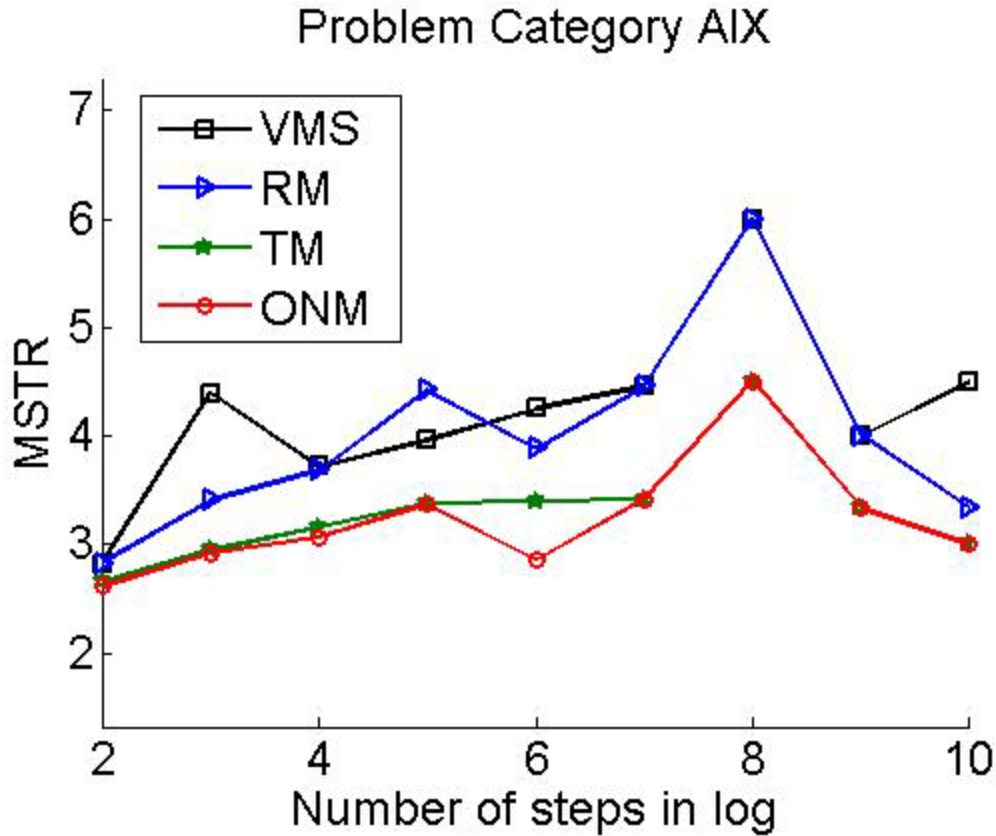
Routing Algorithms

Experiment

- AIX ticket data
  - 18,426 tickets
  - 16,065 words
  - 847 expert groups
  
- Evaluation
  - 75% training data
  - 25% testing data
  - Data items are divided randomly



# Experimental Results





# Conclusion

---

- We presented generative models to characterize the ticket resolution process
  - Historical routing sequence and ticket content are integrated together into generative models
  - Both expertise profiles and transfer profiles are captured
  - Model parameters are optimized either locally or globally
  
- We investigated ticket routing algorithms
  - Experiments show that the algorithms are efficient
  
- Other applications of the generative models
  - Expertise awareness assessment
  - Network organizational structure investigation



Thanks! Questions?

---