Generative Models for Ticket Resolution in Expert Networks

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The Life of a Ticket

DB2 logon failure

Goal: Less transfer steps to the resolver

Networking group
- Server network connection works fine
- Client network connection works fine

User management group
- Checked Username password mismatching
  - Sam

Web server group
- Web server is configured successfully
  - Jack

- Server and client software not compatible. Problem solved.
  - Jill

Bob
Alice
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
\[ \mathcal{T} = \{t_1, t_2, \ldots, t_m\} \]

An interconnected network of experts
\[ \mathcal{G} = \{g_1, g_2, \ldots, g_L\} \]

Word description of tickets
\[ \mathcal{W} = \{w_1, w_2, \ldots, w_n\} \]

Routing sequence of tickets
\[ R(t) = g_{\text{init}}(t) \rightarrow \ldots \rightarrow g_{\text{res}}(t) \]

Goal: Minimize the average length of routing sequences
\[ S = \frac{\sum_{i=1}^{m} \left| R(t_i) \right|}{m} \]
Outline

Generative Models
- Resolution Model
- Transfer Model
- Optimized Network Model

Routing Algorithms
- Ranked Resolver
- Greedy Transfer
- Holistic Routing

Experimental Results
Resolution Model (RM)

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

\[ P_{gi} = [P(w_1|g_i), P(w_2|g_i), \ldots, P(w_n|g_i)]^T \]
Transfer Model (TM)

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

![Diagram showing tickets transferred from expert B to expert F]

\[ P_{e_{ij}} = [P(w_1|e_{ij}), P(w_2|e_{ij}), ..., P(w_n|e_{ij})]^T \]
Optimized Network Model (ONM)

- Transfer profiles optimized for the entire expert network

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

\[
P(R(t)|t) = P(g_1|t)P(g_2|t, g_1)P(g_3|t, g_2)P(g_3|t, g_3)
\]

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

\[
= \frac{\left( \prod_{w_k \in t} P(w_k|e_{ij}) f(w_k, t) \right) P(g_j|g_i)}{Z(t, g_i)}
\]

\[
Z(t, g_i) = \sum_{g_j \in g} P(t|e_{ij}) P(g_j|g_i)
\]
Optimized Network Model (ONM)

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

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

TM model as initial values
Use steepest descent method until convergence
Routing Algorithms

- Ranked resolver
- Greedy transfer
- Holistic routing
Ranked Resolver

- 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

\[ \text{Rank}\left(g_j\right) \propto \max_{g_i \in R(t)} P(g_j|t, g_i) \]

\[ P(g_j|t, g_i) = \frac{P(g_j|g_i) \prod_{w_k \in t} P(w_k|e_{ij}) f(w_k,t)}{\sum_{g_l \in g} P(g_l|g_i) \prod_{w_k \in t} P(w_k|e_{il}) f(w_k,t)} \]
Holistic Routing

All possibilities are explored
Experimental Results

- 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

| Generative Models | Routing Algorithms | Experiment |

Problem Category AIX

- VMS
- RM
- TM
- ONM

MSTR

Number of steps in log

Generative models for ticket resolution in expert networks
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?