Roadmap

- Noisy-channel Question-Answering
- Answer selection by reranking
- Redundancy-based Answer Selection
Noisy Channel QA

- Employed for speech, POS tagging, MT, summ, etc
- Intuition:
  - Question is a noisy representation of the answer
Noisy Channel QA

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• Intuition:
  • Question is a noisy representation of the answer

• Basic approach:
  • Given a corpus of (Q,S_A) pairs
  • Train P(Q|S_A)
  • Find sentence with answer as
    • S_{i,Aij} that maximize P(Q|S_{i,Aij})
QA Noisy Channel

- A: Presley died of heart disease at Graceland in 1977, and..
- Q: When did Elvis Presley die?
QA Noisy Channel

- A: Presley died of heart disease at Graceland in 1977, and..
- Q: When did Elvis Presley die?

Goal:
- Align parts of Ans parse tree to question
  - Mark candidate answers
  - Find highest probability answer
Approach

- Alignment issue:
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  - Answer sentences longer than questions
  - Minimize length gap
    - Represent answer as mix of words/syn/sem/NE units
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    - Every word –or an ancestor – in cut
    - Only one element on path from root to word
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Presley died of heart disease at Graceland in 1977, and..
Presley died PP PP in DATE, and..
When did Elvis Presley die?
Approach (Cont’d)

- Assign one element in cut to be ‘Answer’
- Issue: Cut STILL may not be same length as Q
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- Solution: (typical MT)
  - Assign each element a fertility
    - 0 – delete the word; > 1: repeat word that many times
- Replace A words with Q words based on alignment
- Permute result to match original Question
- Everything except cut computed with OTS MT code
Schematic

- Assume cut, answer guess all equally likely
Training Sample Generation

- Given question and answer sentences
- Parse answer sentence
- Create cut s.t.:
  - Words in both Q & A are preserved
  - Answer reduced to ‘A_’ syn/sem class label
  - Nodes with no surface children reduced to syn class
  - Keep surface form of all other nodes
- 20K TREC QA pairs; 6.5K web question pairs
Selecting Answers

- For any candidate answer sentence:
  - Do same cut process
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  - Generate all candidate answer nodes:
    - Syntactic/Semantic nodes in tree
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  - Generate all candidate answer nodes:
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    - Stopwords
    - Question words!
  - Create cuts with each answer candidate annotated
  - Select one with highest probability by model
Example Answer Cuts

- **Q**: When did Elvis Presley die?
- \( S_{A1} \): Presley died A_PP PP PP, and ...
- \( S_{A2} \): Presley died PP A_PP PP, and ....
- \( S_{A3} \): Presley died PP PP in A_DATE, and ...

- Results: MRR: 24.8%; 31.2% in top 5
Error Analysis

- Component specific errors:
  - Patterns:
    - Some question types work better with patterns
    - Typically specific NE categories (NAM, LOC, ORG..)
    - Bad if ‘vague’
  - Stats based:
    - No restrictions on answer type – frequently ‘it’
  - Patterns and stats:
    - ‘Blatant’ errors:
      - Select ‘bad’ strings (esp. pronouns) if fit position/pattern
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Combining Units

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  - Problematic:
    - Misses different strengths/weaknesses
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- Learning! (of course)
  - Maxent re-ranking
    - Linear
Feature Functions

- 48 in total
- Component-specific:
  - Scores, ranks from different modules
  - Patterns, Stats, IR, even QA word overlap
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  - Some components better for certain types: type+mod
- Blatant ‘errors’: no pronouns, when NOT DoW
Experiments

- Per-module reranking:
  - Use redundancy, qtype, blatant, and feature from mod
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- Combined reranking:
  - All features (after feature selection to 31)
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- Patterns: Exact in top 5: 35.6% -> 43.1%
- Stats: Exact in top 5: 31.2% -> 41%
- Manual/knowledge based: 57%
Redundancy-based QA

- AskMSR (2001, 2002); Aranea (Lin, 2007)
Redundancy-based QA

- Systems exploit statistical regularity to find “easy” answers to factoid questions on the Web
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  - When did Alaska become a state?
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    • Present in many passages
      • Uses n-gram generation and processing
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Redundancy approach:
- Answer should have high correlation w/query terms
  - Present in many passages
    - Uses n-gram generation and processing
  - In ‘easy’ passages, simple string match effective
Redundancy Approaches

- AskMSR (2001):
  - Lenient: 0.43; Rank: 6/36; Strict: 0.35; Rank: 9/36
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  - Lenient: 45%; Rank: 5; Strict: 30%; Rank: 6-8
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- Many systems incorporate some redundancy
  - Answer validation
  - Answer reranking
  - LCC: huge knowledge-based system, redundancy improved
Redundancy-based Answer Extraction

- Prior processing:
  - Question formulation (class 6)
  - Web search
  - Retrieve snippets – top 100
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- N-grams:
  - Generation
  - Voting
  - Filtering
  - Combining
  - Scoring
  - Reranking
N-gram Generation & Voting

- N-gram generation from unique snippets:
  - Approximate chunking – without syntax
  - All uni-, bi-, tri-, tetra- grams
    - Concordia added 5-grams (prior errors)
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    - Specific, frequent: Question terms, stopwords
N-gram Filtering

- Throws out ‘blatant’ errors
- Conservative or aggressive?
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  - Exclude if begin/end with stopword
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- Question-type-specific filters:
  - ‘how far’, ‘how fast’: exclude if no numeric
  - ‘who’, ‘where’: exclude if not NE (first & last caps)
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- Example after filtering:
  - Who was the first person to run a sub-four-minute mile?

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bannister</td>
<td>137</td>
</tr>
<tr>
<td>Roger</td>
<td>114</td>
</tr>
<tr>
<td>Roger Bannister</td>
<td>103</td>
</tr>
<tr>
<td>English</td>
<td>26</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
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  - Type-neutral only: drops 15%
  - Type-neutral & Type-specific: drops 5%
N-gram Combining

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- E.g. Roger or Bannister or Roger Bannister or Mr.....
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- Possible issues:
  - Bad units: Roger Bannister was – blocked by filters
    - Also, increments score so long bad spans lower

- Improves significantly
N-gram Scoring

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  - Also disprefer non-units

- Solution
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<tbody>
<tr>
<td>Roger Bannister</td>
<td>354</td>
</tr>
<tr>
<td>Sir Roger Gilbert Bannister</td>
<td>286</td>
</tr>
<tr>
<td>Sir Roger Bannister</td>
<td>280</td>
</tr>
<tr>
<td>Bannister Sir Roger</td>
<td>278</td>
</tr>
<tr>
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<td>...</td>
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<th>Score</th>
<th>After scoring</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Roger Bannister</td>
<td>354</td>
<td>Roger Bannister</td>
<td>2377</td>
</tr>
<tr>
<td>Sir Roger Gilbert Bannister</td>
<td>286</td>
<td>Englishman Roger Bannister</td>
<td>1853</td>
</tr>
<tr>
<td>Sir Roger Bannister</td>
<td>280</td>
<td>Sir Roger Gilbert Bannister</td>
<td>1775</td>
</tr>
<tr>
<td>Bannister Sir Roger</td>
<td>278</td>
<td>Sir Roger Bannister</td>
<td>1768</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
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N-gram Reranking

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- Promote best answer candidates:
  - Filter any answers not in at least two snippets
N-gram Reranking

- Promote best answer candidates:
  - Filter any answers not in at least two snippets
  - Use answer type specific forms to raise matches
    - E.g. ‘where’ -> boosts ‘city, state’

- Small improvement depending on answer type
Summary

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- Aranea download:
  - http://www.umiacs.umd.edu/~jimmylin/resources.html