Answer Extraction

NLP Systems and Applications
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  - Answer: 310.5 million

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- ISI's answer extraction experiment:
  - Given:
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    - Oracle (any of 3 right): 78.9% (20% miss)

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    - Semantic:
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  - Combine with machine learning to select

Pattern Matching Example

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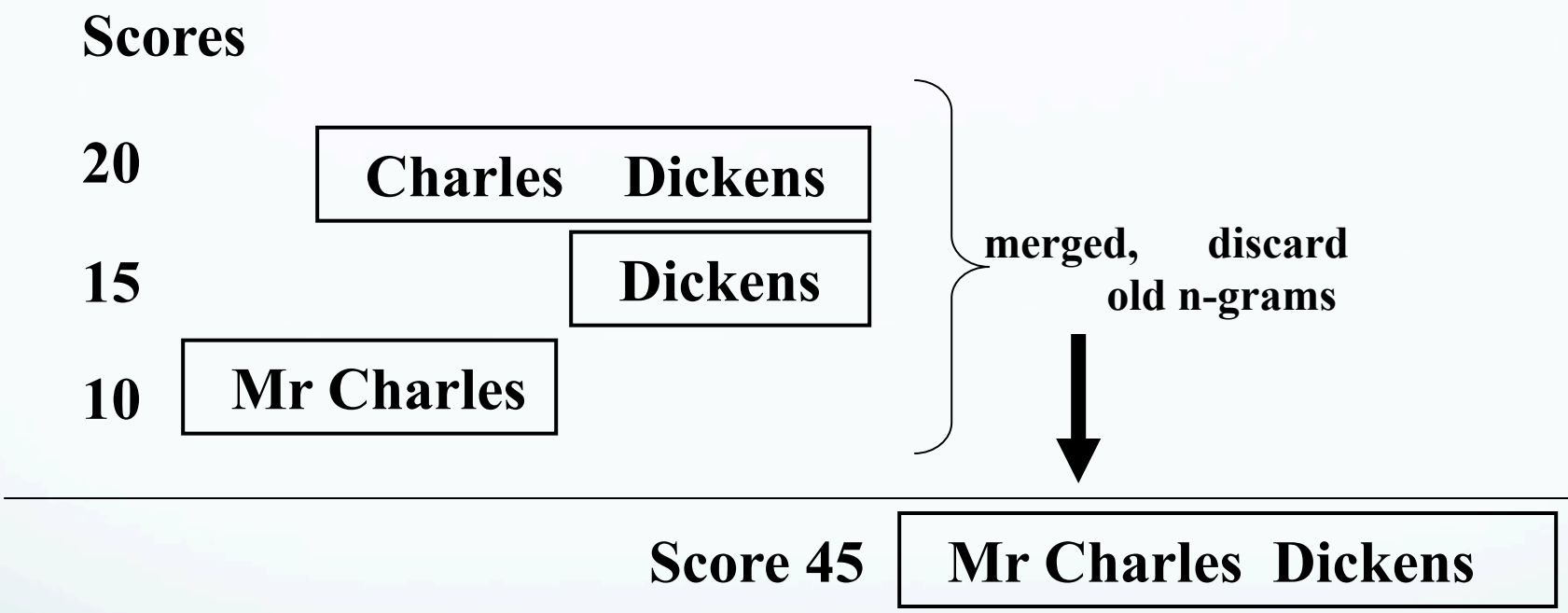
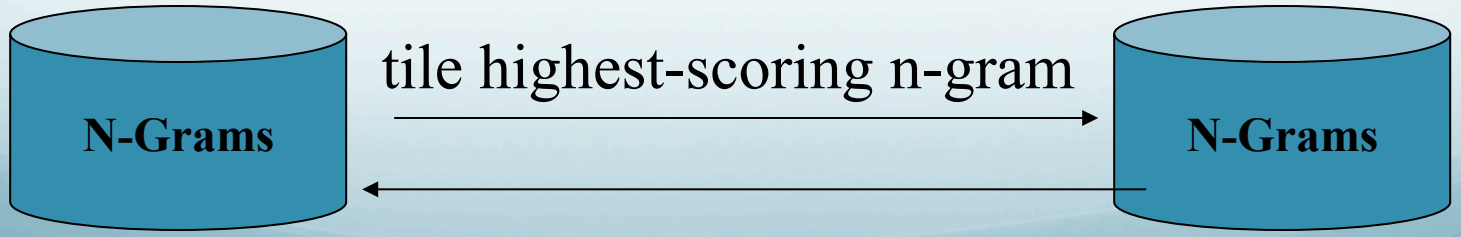
  - Question: When was Mozart born?
  - Answer: Mozart was born on ....
  - Pattern: <QP> was born on <AP>
  - Pattern: <QP> (<AP> - .....)

Basic Strategies

- N-gram tiling:
  - Typically as part of answer validation/verification
  - Integrated with web-based retrieval
  - Based on retrieval of search 'snippets'
  - Identifies frequently occurring, overlapping n-grams
    - Of correct type

N-gram Tiling





Repeat, until no more overlap

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- Inspiration (Soubottin and Soubottin '01)
  - Best TREC 2001 system:
    - Based on extensive list of surface patterns
      - Mostly manually created
  - Many patterns strongly associated with answer types
    - E.g. <NAME> (<DATE>-<DATE>)
      - Person's birth and death

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  - Bootstrapping approaches:
    - Promising:
      - Guidance from small number of seed samples
      - Can use answer data from web

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  - Identify an example with qterm and aterm

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  - Submit to a search engine
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Finding Candidate Patterns

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  - Download top N web docs (N=1000)
  - Select only sentences w/qterm and aterm
  - Identify all substrings and their counts
    - Implemented using suffix trees for efficiency
  - Select only phrases with qterm AND aterm
  - Replace qterm and aterm instances w/generics

Example

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- A: Mozart (1756-....

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- A: Mozart (1756 –
- Qterm: Mozart; Aterm: 1756
  - The great composer Mozart (1756–1791) achieved fame
  - Mozart (1756–1791) was a genius
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- Convert to : <Name> (<ANSWER>

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- Collect more patterns:
  - E.g. for Birthdate
    - a. born in <ANSWER> , <NAME>
    - b. <NAME> was born on <ANSWER> ,
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- Is this enough?

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- Is this enough?
  - No – some good patterns, but
    - Probably lots of junk, too; need to filter

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  - Select only sentences w/qterm
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    - a) matches w/any aterm; C_o
    - b) matches/w right aterm: C_a
  - Compute precision $P = C_a/C_o$
  - Retain if match > 5 examples

Pattern Precision Example

- Qterm: Mozart
- Pattern: <NAME> was born in <ANSWER>

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- Match: Mozart born in 1756.
- Precisions:
  - 1.0 <NAME> (<ANSWER> -)
  - 0.6 <NAME> was born in <ANSWER>
  - ....

Nuances

- Alternative forms:
  - Need to allow for alternate forms of question or answer
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- Precision assessment:
  - Use other examples of same type to compute
  - Cross-checks patterns

Answer Selection by Pattern

- Identify question types and terms
- Filter retrieved passages, replace qterm by tag
- Try to match patterns and answer spans
- Discard duplicates and sort by pattern precision

Pattern Sets

- WHY-FAMOUS
  - 1.0 <ANSWER> <NAME> called
  - 1.0 laureate <ANSWER> <NAME>
  - 1.0 by the <ANSWER> , <NAME> ,
  - 1.0 <NAME> - the <ANSWER> of
  - 1.0 <NAME> was the <ANSWER> of
- BIRTHYEAR
  - 1.0 <NAME> (<ANSWER> -)
  - 0.85 <NAME> was born on <ANSWER> ,
  - 0.6 <NAME> was born in <ANSWER>
  - 0.59 <NAME> was born <ANSWER>
  - 0.53 <ANSWER> <NAME> was born

Results

- Improves, though better with web data

TREC Corpus

Question type	Number of questions	MRR on TREC docs
BIRTHYEAR	8	0.48
INVENTOR	6	0.17
DISCOVERER	4	0.13
DEFINITION	102	0.34
WHY-FAMOUS	3	0.33
LOCATION	16	0.75

Web

Question type	Number of questions	MRR on the Web
BIRTHYEAR	8	0.69
INVENTOR	6	0.58
DISCOVERER	4	0.88
DEFINITION	102	0.39
WHY-FAMOUS	3	0.00
LOCATION	16	0.86

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- Long-distance dependencies not practical
  - Less of an issue in Web search
    - Web highly redundant, many local dependencies
    - Many systems (LCC) use web to **validate** answers

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- Also,
  - Can only handle single continuous qterms
  - Ignores case
  - Needs handle canonicalization, e.g of names/dates

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- More robust solution:
  - Not JUST patterns
  - Integrate with machine learning
    - MAXENT!!!
    - Re-ranking approach

Answering w/Maxent

$$P(a \mid \{a_1, a_2, \ldots a_A\}, q) = \frac{\exp[\sum_{m=1}^{M} \lambda_m f_m(a, \{a_1, a_2, \ldots a_A\}, q)]}{\sum_{a'} \exp[\sum_{m=1}^{M} \lambda_m f_m(a', \{a_1, a_2, \ldots a_A\}, q)]}$$

$$\hat{a} = \underset{a}{\operatorname{argmax}}[\sum_{m=1}^{M} \lambda_m f_m(a, \{a_1, a_2, \ldots a_A\}, q)]$$

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- Word match:
  - Sum of ITF of words matching b/t questions & sent

Training & Testing

- Trained on NIST QA questions
  - Train: TREC 8,9;
  - Cross-validation: TREC-10
- 5000 candidate answers/question
- Positive examples:
  - NIST pattern matches
- Negative examples:
  - NIST pattern doesn't match
- Test: TREC-2003: MRR: 28.6%; 35.6% exact top 5

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- Intuition:
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- 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?

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- 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

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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?

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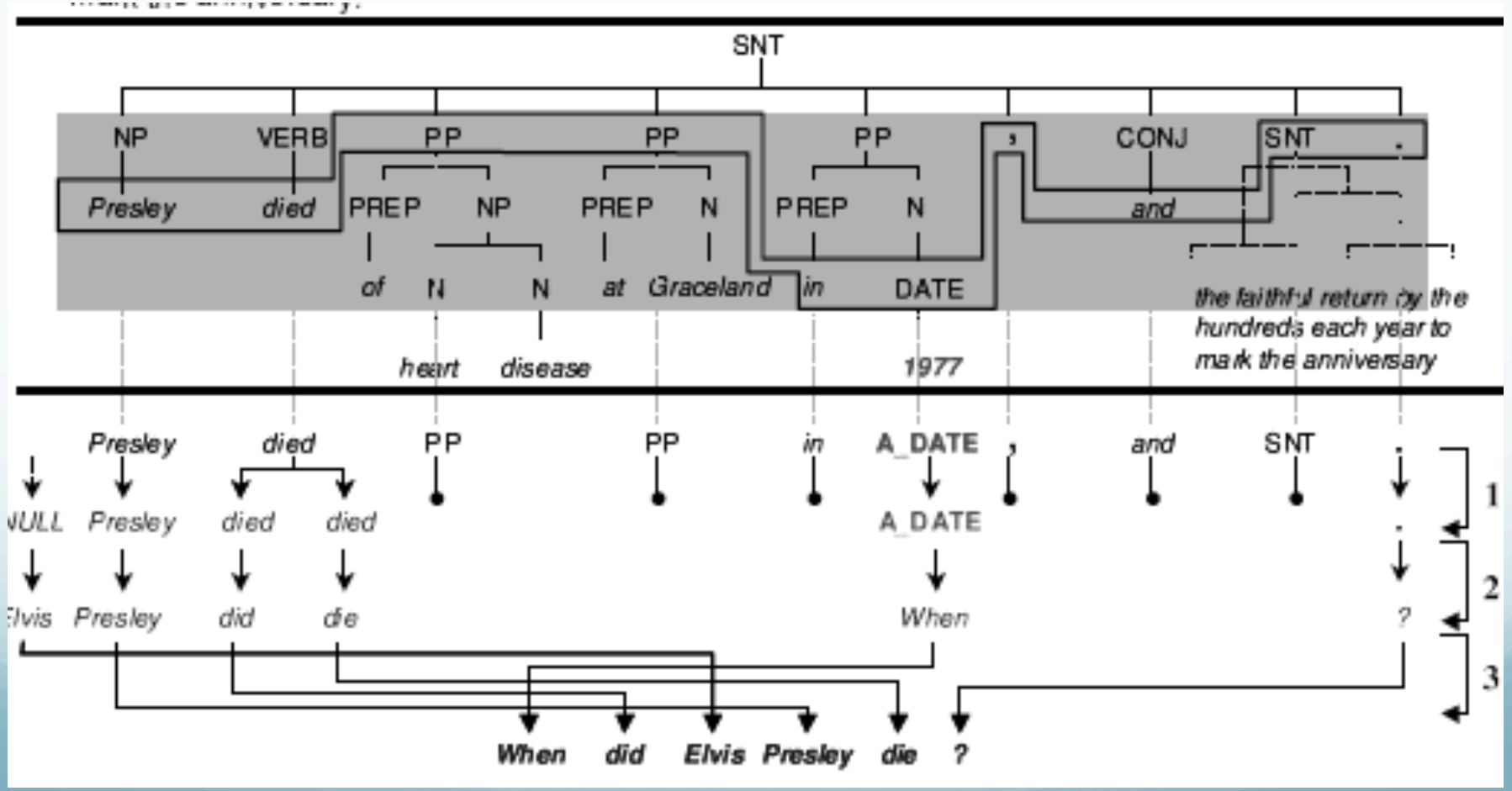
- Solution: (typical MT)
  - Assign each element a fertility
    - 0 – delete the word; > 1: repeat word that many times
- Replace A words with Q words based on alignment
- Permute result to match original Question
- Everything except cut computed with OTS MT code

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

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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

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    - 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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  - Problematic:
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- Learning! (of course)
  - Maxent re-ranking
    - Linear

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- Qtype-specific:
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- Blatant ‘errors’: no pronouns, when NOT DoW

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- Combined reranking:
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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%

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