Question-Answering: Overview

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Systems & Applications
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Roadmap

- Dimensions of the problem
- A (very) brief history
- Architecture of a QA system
- QA and resources
- Evaluation
- Challenges
- Logistics Check-in

Dimensions of QA

- Basic structure:
  - Question analysis
  - Answer search
  - Answer selection and presentation

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  - Question analysis
  - Answer search
  - Answer selection and presentation
- Rich problem domain: Tasks vary on
  - Applications
  - Users
  - Question types
  - Answer types
  - Evaluation
  - Presentation

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  - Answer sources
    - Structured: e.g., database fields
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      - Specific passage/article (reading comprehension)
  - Media and modality:
    - Within or cross-language; video/images/speech

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  - Understand capabilities/limitations of system

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- Expert
  - Assume familiar with capabilties
  - Wants efficient information access
  - Maybe desirable/willing to set up profile

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  - In the limit -> summarization
    - *What is the book about?*

Evaluation & Presentation

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    - Interactive, support refinement, dialogic

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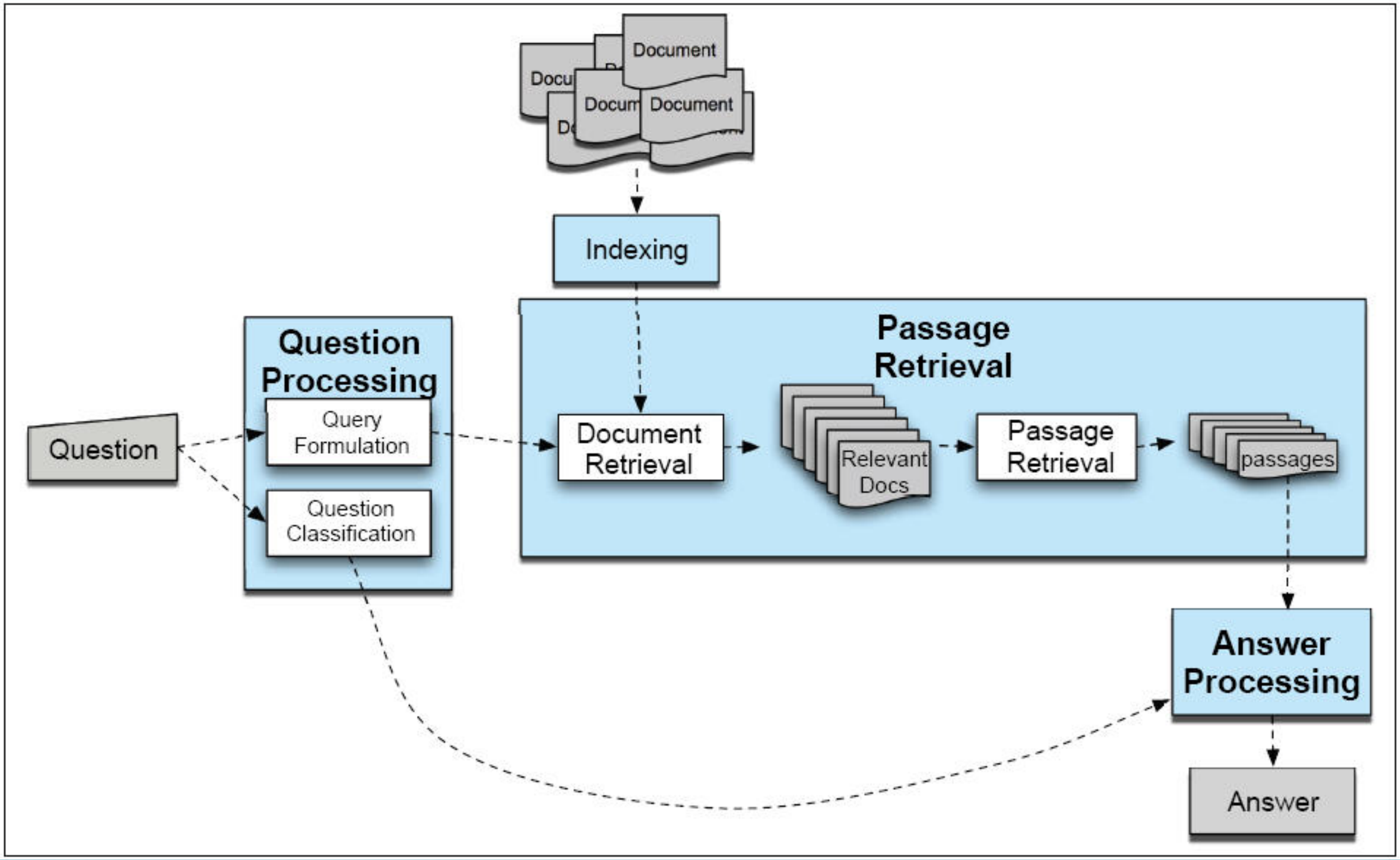
- Information retrieval (TREC); Information extraction (MUC)

General Architecture



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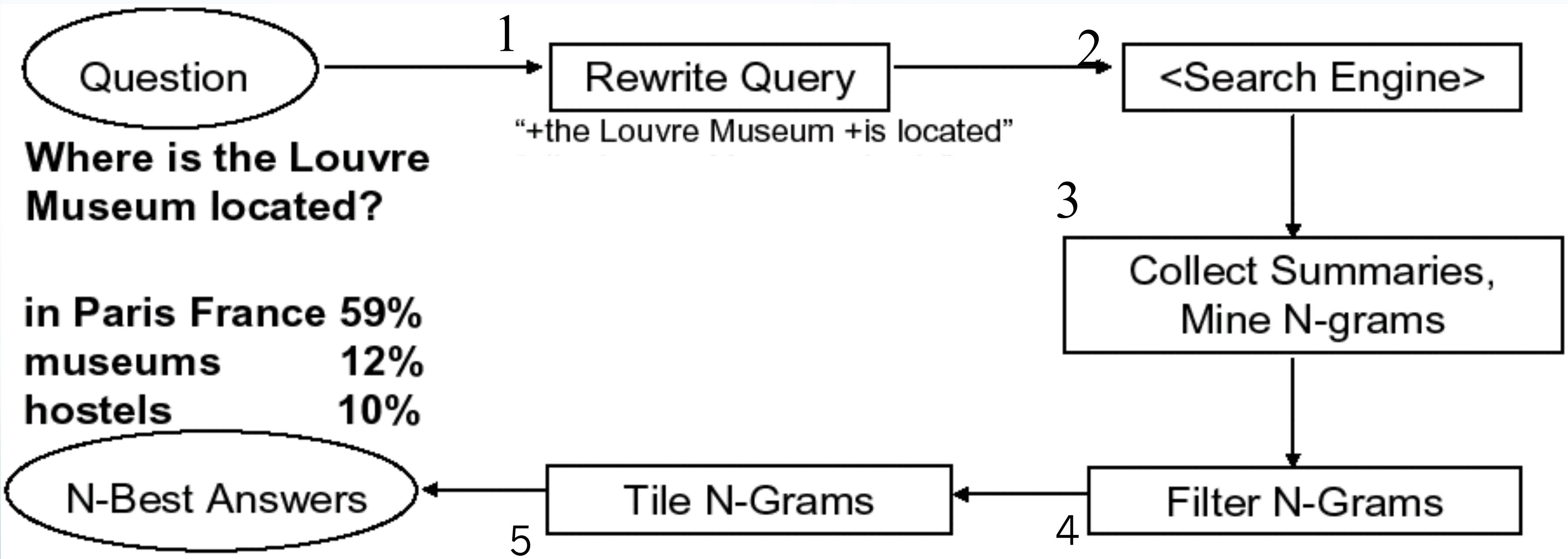
- Systems vary in detailed structure, and complexity

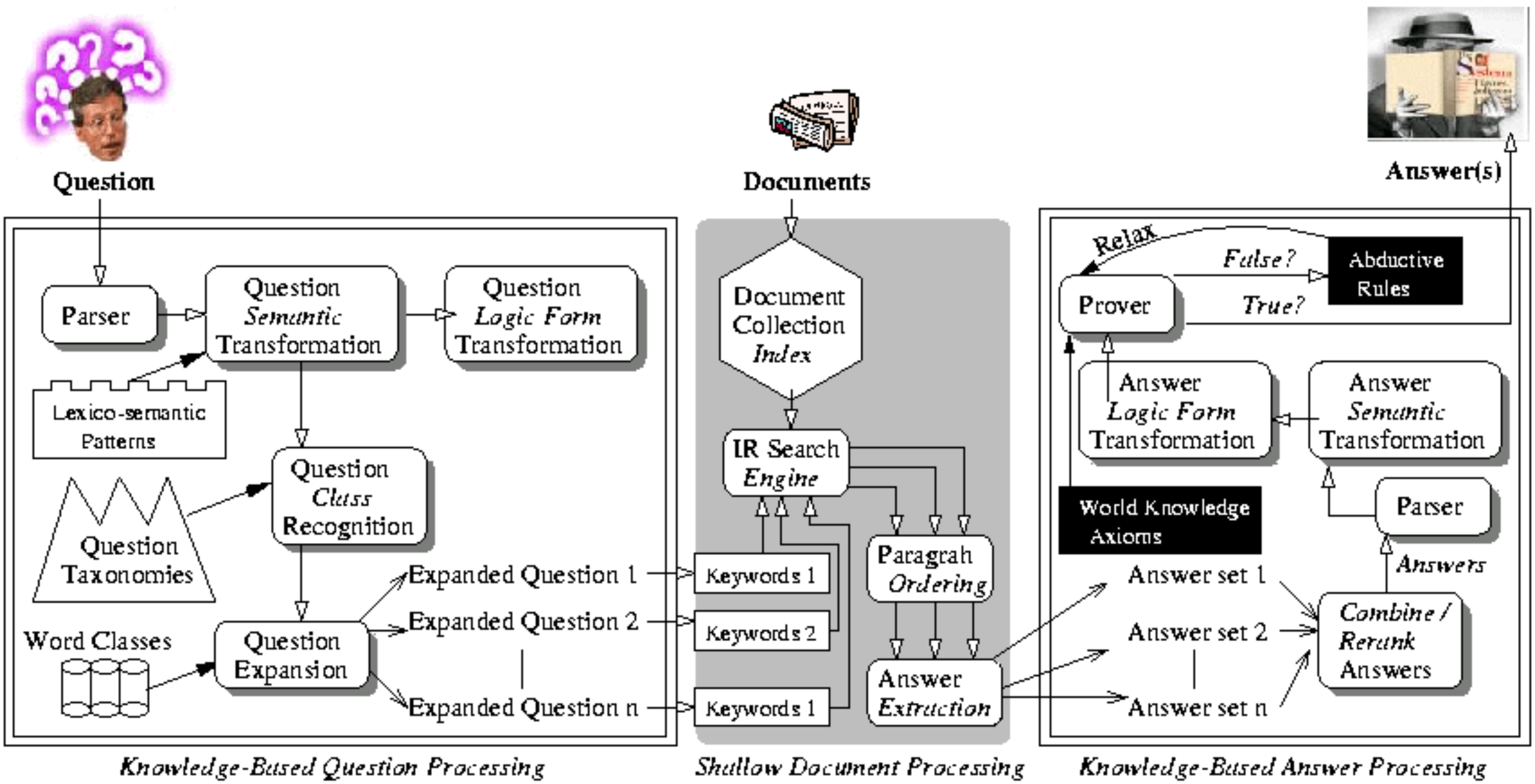
AskMSR

- Shallow Processing for QA



Deep Processing Technique for QA

- LCC (Moldovan, Harabagiu, et al)



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      - Add morphological variants, WordNet as thesaurus
      - Reformulate as declarative: rule-based
        - Where is X located -> X is located in

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  - Synsets, hyper/hypo-nyms

Tag	Example
ABBREVIATION	
abb	What's the abbreviation for limited partnership?
exp	What does the "c" stand for in the equation E=mc2?
DESCRIPTION	
definition	What are tannins?
description	What are the words to the Canadian National anthem?
manner	How can you get rust stains out of clothing?
reason	What caused the Titanic to sink ?
ENTITY	
animal	What are the names of Odin's ravens?
body	What part of your body contains the corpus callosum?
color	What colors make up a rainbow ?
creative	In what book can I find the story of Aladdin?
currency	What currency is used in China?
disease/medicine	What does Salk vaccine prevent?
event	What war involved the battle of Chapultepec?
food	What kind of nuts are used in marzipan?
instrument	What instrument does Max Roach play?
lang	What's the official language of Algeria?
letter	What letter appears on the cold-water tap in Spain?
other	What is the name of King Arthur's sword?
plant	What are some fragrant white climbing roses?
product	What is the fastest computer?
religion	What religion has the most members?
sport	What was the name of the ball game played by the Mayans?
substance	What fuel do airplanes use?
symbol	What is the chemical symbol for nitrogen?
technique	What is the best way to remove wallpaper?
term	How do you say " Grandma " in Irish?
vehicle	What was the name of Captain Bligh's ship?
word	What's the singular of dice?

HUMAN	
description	Who was Confucius?
group	What are the major companies that are part of Dow Jones?
ind	Who was the first Russian astronaut to do a spacewalk?
title	What was Queen Victoria's title regarding India?
LOCATION	
city	What's the oldest capital city in the Americas?
country	What country borders the most others?
mountain	What is the highest peak in Africa?
other	What river runs through Liverpool?
state	What states do not have state income tax?
NUMERIC	
code	What is the telephone number for the University of Colorado?
count	About how many soldiers died in World War II?
date	What is the date of Boxing Day?
distance	How long was Mao's 1930s Long March?
money	How much did a McDonald's hamburger cost in 1963?
order	Where does Shanghai rank among world cities in population?
other	What is the population of Mexico?
period	What was the average life expectancy during the Stone Age?
percent	What fraction of a beaver's life is spent swimming?
speed	What is the speed of the Mississippi River?
temp	How fast must a spacecraft travel to escape Earth's gravity?
size	What is the size of Argentina?
weight	How many pounds are there in a stone?

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  - For web search, use result snippets

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Pattern	**Question**	**Answer**
<AP> such as <QP>	What is autism?	", developmental disorders such as autism"
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      - E.g. date-of-birth/person name; term/definition
        - Can use bootstrap strategy for contexts
        - <NAME> (<BD>-<DD>) or <NAME> was born on <BD>

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      - Multiple choice tests (IP???)
      - Partial data: Web logs – queries and click-throughs

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  - Web itself
  - ....
- Term management:
  - Acronym lists
  - Gazetteers
  - ....

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  - Parsing?
- Answer extraction:
  - NER, IE (patterns)

Evaluation

- Candidate criteria:
  - Relevance
  - Correctness
  - Conciseness:
    - No extra information
  - Completeness:
    - Penalize partial answers
  - Coherence:
    - Easily readable
  - Justification
- Tension among criteria

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    - Short answer answer keys
      - Litkowski's patterns

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  - Measure: Mean Reciprocal Rank (MRR)
    - For each question,
      - Get reciprocal of rank of first correct answer
        - E.g. correct answer is 4 => ¼
        - None correct => 0
    - Average over all questions

$$MRR = \frac{\sum_{i=1}^{N} \frac{1}{rank_i}}{N}$$

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  - Official: human; proxy: patterns
- Presentation: One interactive track

Watson & Jeopardy!™ vs QA

- QA vs Jeopardy!
- TREC QA systems on Jeopardy! task
- Design strategies
- Watson components
- DeepQA on TREC

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- Jeopardy!:
  - Timing, confidence key; betting
  - Board; Known question categories; Clues & puzzles
  - No live Web access, no fixed doc set

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- Applied to 500 random Jeopardy questions
  - Both systems under 15% overall
    - PIQUANT ~45% when 'highly confident'

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- Integrate shallow/deep processing approaches

Watson Components: Content

- Content acquisition:
  - Corpora: encyclopedias, news articles, thesauri, etc
  - Automatic corpus expansion via web search
  - Knowledge bases: DBs, dbPedia, Yago, WordNet, etc

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- Focus & LAT detection:
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- Relation detection: Syntactic or semantic rel's in Q
- Decomposition: Breaks up complex Qs to solve

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- Applies question analysis results to support search in resources and selection of answer candidates
- 'Primary search':
  - Recall-oriented search returning 250 candidates
  - Document- & passage-retrieval as well as KB search
- Candidate answer generation:
  - Recall-oriented extracted of specific answer strings
    - E.g. NER-based extraction from passages

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- Previous stages generated 100s of candidates
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- Hypothesis & Evidence scoring:
  - Find more evidence to support candidate
    - E.g. by passage retrieval augmenting query with candidate
  - Many scoring fns and features, including IDF-weighted overlap, sequence matching, logical form alignment, temporal and spatial reasoning, etc, etc..

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- Also tuned for speed, trained for strategy, betting

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  - 2008: Unadapted: 35% -> Adapted: 60%
  - 2010: Unadapted: 51% -> Adapted: 67%

Summary

- Many components, analyses similar to TREC QA
  - Question analysis →Passage Retrieval → Answer extr.
    - May differ in detail, e.g. complex puzzle questions
- Some additional:
  - Intensive confidence scoring, strategizing, betting
- Some interesting assets:
  - Lots of QA training data, sparring matches
- Interesting approaches:
  - Parallel mixtures of experts; breadth, depth of NLP