Information Retrieval: Course Introduction CS60092

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Brief Introduction

Prof. Somak Aditya

PI, Tr^2AIL Lab

Building Transparent & Trusted AI systems using Logic

Office: CSE 305

https://cse.iitkgp.ac.in/~saditya/

Course Website

- https://adityasomak.github.io/courses/irspring24/
- Course Timings (**NR 242**)
  - Mon 12:00-12:55 pm,
  - Tue 10-11:55 am
- My Office: CSE 305
- Teaching Assistants
  - Sachin Vashishtha
  - Project Additional Guide: Debrup Das

Books and Materials

- Reference Book
  - Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze. 2008. Introduction to Information Retrieval, Cambridge university press.

- Lecture Materials
  - Lecture Slides
  - Course Notes
  - Slides/lectures by Prof. Subbarao Kambhampati (Ex-AAAI President, Professor ASU http://rakaposhi.eas.asu.edu/cse494/)

Course Evaluation Plan (Tentative)

- Mid-Sem: 20%
- Final Exam: 40%
- Class Performance/Viva: 5-10%
- Term Project: 30-35% (extremely important)

Term Project Dates (Tentative)

- Distribute Project Topics ~ **Jan 12**
- Form groups of 4. Propose 2-3 choices **~ Jan 20**
- Assign projects ~ **Jan 27**

- April 1-7 (Tentative)
  - Submit short 4 page project reports. Submit running code (Google Collab/Jupyter Notebook).
  - Short Presentations (demos: optional, but encouraged)

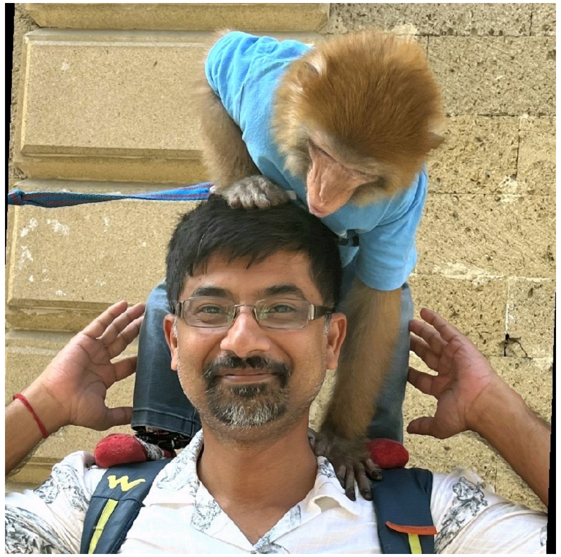
Guest Lecture

Spring 2024

Dr. Swaroop Mishra,
Research Scientist, Google Deepmind
Time: March First/Second Week
Location: Online

Spring 2023

Dr. Aniruddha (Ani) Kembhavi
Director of Computer Vision
Allen Institute of AI (AI2), Seattle, US
https://anikem.github.io/



Spring 2022

Prof. Monojit Choudhury
Principal Researcher, MSR India
(Prof, NLP, MBZUAI, Abu Dhabi)
www.linkedin.com/in/monojit-choudhury-54225898

Information Retrieval (informally)

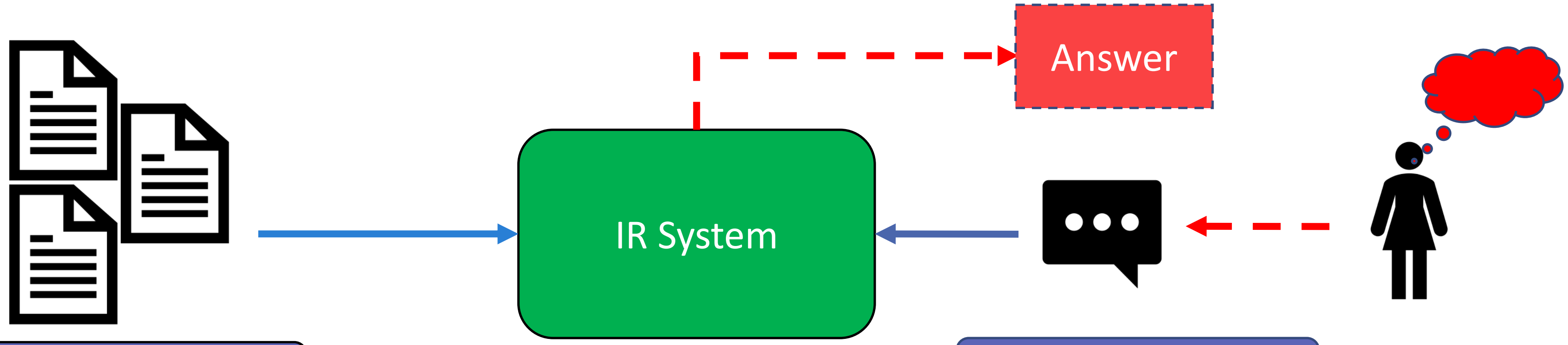
- Read all the web & remember what information is where
- Be able to reason about connections between information
- *Read my mind and answer questions (or better yet) satisfy my needs, even before I articulate them* ☺

How close is this dream to reality?
Are we being too easy on our search engines?

Courtesy: Prof. Subbarao Kambhampati’s slides for CS494

Information Retrieval (formally)

Information Retrieval (IR) is finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need (usually specified using a user query) from within large collections.



What is a document?

web pages, emails, books, news stories, scholarly papers, text messages, Powerpoint, PDF, forum postings, patents, tweets, question answer postings.

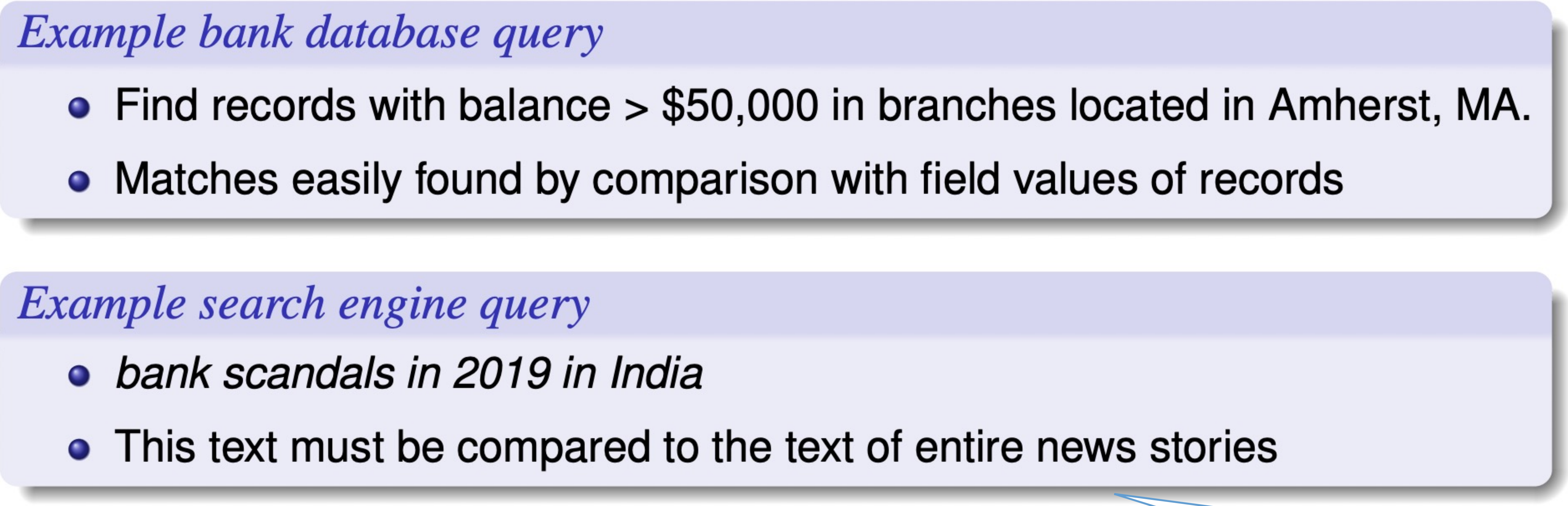
What is a query?

Some form of input by user (an expression of *user intent*) – usually natural language text

Document vs. Database Records

- Database records (or tuples in relational databases) are typically made up of well-defined fields (or attributes),
  - e.g., bank records with account numbers, balances, names, addresses, social security numbers, dates of birth, etc.
- Easy to compare fields with well-defined semantics to queries in order to find matches

Document vs. Database Records



Example bank database query

- Find records with balance > $50,000 in branches located in Amherst, MA.
- Matches easily found by comparison with field values of records

Example search engine query

- *bank scandals in 2019 in India*
- This text must be compared to the text of entire news stories

!!!Some say entire AI (conceptually) is an extension of database systems!!!

What do we do in IR

- The indexing and retrieval of textual documents.
- Concerned first with *retrieving relevant documents* to a query.
- Concerned secondly with retrieving from large se documents efficiently.
- Are there anything else?

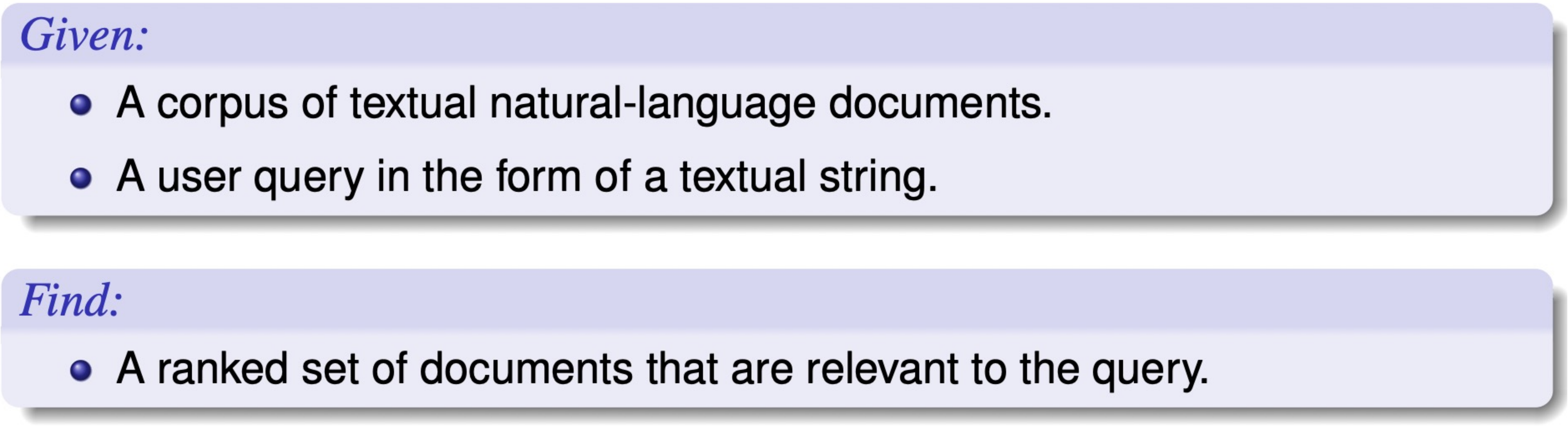
What is relevance?

Efficiency in terms of ..?

IR over text and other modes

- IR does not necessarily deal with text data.
  - Images, text, speech, what else?
- Both documents and queries can be in other modes.
- In this course, we will concentrate on textual IR.
  - Term project, image search might be included (optional).
  - Multi-lingual/cross-lingual search

Typical IR Tasks



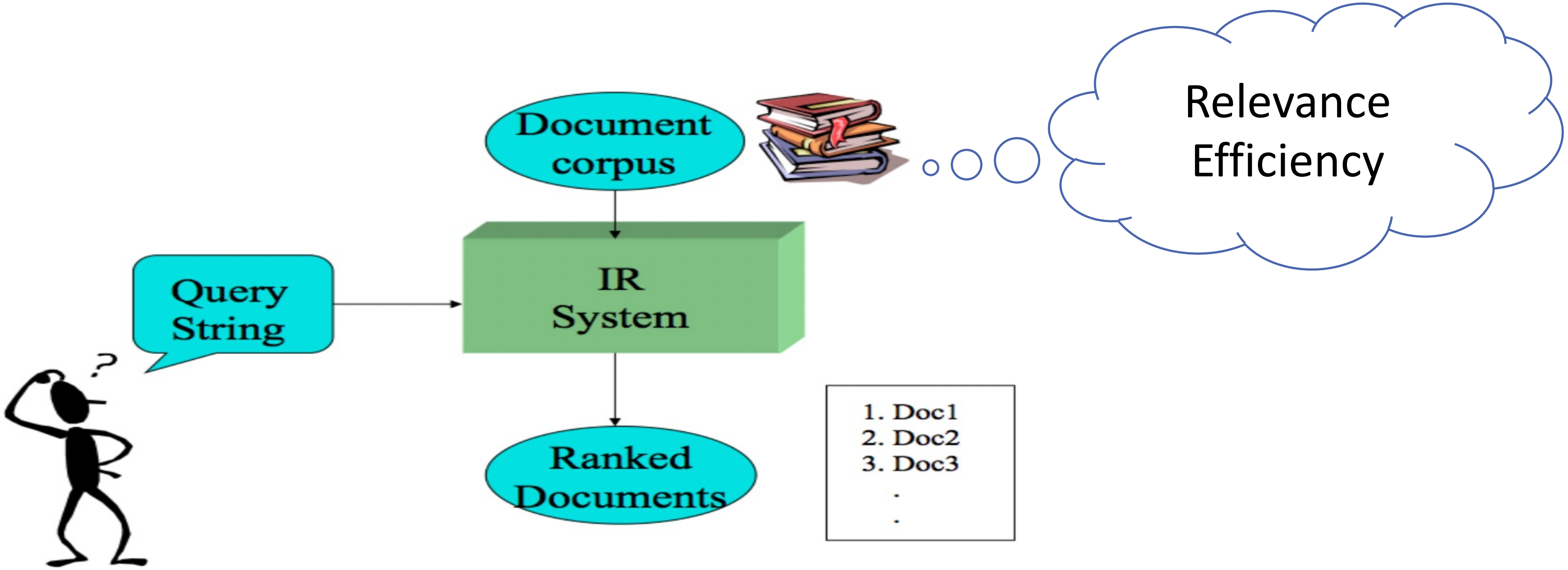
Given:

- A corpus of textual natural-language documents.
- A user query in the form of a textual string.

Find:

- A ranked set of documents that are relevant to the query.

IR system



Document corpus

Query String

IR System

Ranked Documents

1. Doc1
2. Doc2
3. Doc3

.

.

Relevance

Efficiency

*The system should be able to retrieve the **relevant** docs **efficiently***

What is relevance?

Relevant document contains the information that a person was looking for when they submitted the query.

This may include:

- Being on the proper subject.
- Being timely (recent information).
- Being authoritative (from a trusted source).
- Satisfying the goals of the user and his/her intended use of the information (information need).

Simpl(er) Notion of Relevance

Keyword Search

- Simplest notion of relevance is that the *query string appears verbatim* in the document.
- Slightly less strict notion is that (most of) the *words in the query appear frequently* in the document, in any order (bag of words).

Problems with Keywords Search

May not retrieve relevant documents that include *synonymous terms* –

- PRC vs. China
- car vs. automobile

Ambiguity - May retrieve irrelevant document that include ambiguous terms (due to *polysemy*)

- ‘Apple’ (company vs. fruit)
- ‘Java’ (programming language vs. Island vs. Coffee)
- ‘Fall’ (season/verb)

An Intelligent IR system will

- Take into account the *meaning* of the words used.
- Adapt to the user based on *direct* or *indirect feedback*.
- Take into account the *importance* of the page.
- Estimate your "*thoughts*" (user intent)
- …
- *Fair, ethical, transparent, privacy-preserving, secure …*

What will you learn in this IR?

- (Some basic idea about) How search engines work
  - The Software/algorithm side.
  - Hardware side: http://videolectures.net/wsdm09_dean_cblirs/
  - How to make money out of it?

- Can web be seen as a collection of (semi)structured data/knowledge bases?
  - Unstructured → semi-structured

- Can we exploit the *connectedness* of the web pages? And How?

- (Will touch upon) Connections between NLP and IR.

Where to keep the tab on?

- Top Conferences in the field
  - SIGIR
  - WWW
  - ISDM
  - ECIR

- Language Conferences
  - EMNLP
  - ACL
  - CoNLL

Active Areas of Research (Workshop Titles)

- What to Retrieve
- Search Experience
- Personalization, Behavior, Conversation, Social, etc.
- *Cross-lingual/Multi-lingual search*
- *Multi-modal search*
- *Image Search*
- *Video Search*
- *Semantic Search*
- *ML/DL Efficiency for Web*
- *FATES*

WWW 2023 Workshops (a snapshot)

- Workshop on Cyber Social Threats
- Trusting Decentralised Knowledge Graphs and Web Data
- Multisensory Data and knowledge
- Knowledge Graphs for Online Discourse Analysis
- The Web and Smart Cities
- Knowledge Graphs on Sustainability
- Personalization and Recommendation in Search (PARIS)
- ML for Streaming Media
- Temporal Web Analytics Workshop
- FinTech for Web
- Interactive and Scalable IR for eCommerce
- Scientifica Knowledge Representation, Discovery
- Digital Twin for Smart Health

What to Retrieve

- Leveraging User Reviews to Improve Accuracy for Mobile App Retrieval. SIGIR 2015.
- On Application of Learning to Rank for E-Commerce Search. SIGIR 2017.
- Concept Embedded Convolutional Semantic Model for Question Retrieval. WSDM 2017.
- Multi-Stage Math Formula Search: Using Appearance-Based Similarity Metrics at Scale. SIGIR 2016.
- Toward an Interactive Patent Retrieval Framework based on Distributed Representations. SIGIR 2018.
- ANNE: Improving Source Code Search using Entity Retrieval Approach. WSDM 2017.
- Exploiting Food Choice Biases for Healthier Recipe Recommendation. SIGIR 2017.
- Cross-Modal Interaction Networks for Query-Based Moment Retrieval in Videos. SIGIR 2019.

Search Experience

- *Engaged or Frustrated? Disambiguating Emotional State in Search*. SIGIR 2017.
- *Between Clicks and Satisfaction: Study on Multi-Phase User Preferences and Satisfaction for Online News Reading*. SIGIR 2018.
- *Understanding and Modeling Success in Email Search*. SIGIR 2017.
- *Using Information Scent to Understand Mobile and Desktop Web Search Behavior.* SIGIR 2017.

Personalization, Behavior, Conversation, Social, Bias, Fairness

- The Utility and Privacy Effects of a Click. SIGIR 2017.
- Predicting Which Topics You Will Join in Future on Social Media, SIGIR 2017
- Why People Search for Images using Web Search Engines. WSDM 2018.
- Asking Clarifying Questions in Open-Domain Information-Seeking Conversations. SIGIR 2019.
- How do Biased Search Result Rankings Affect User Attitudes on Debated Topics?. SIGIR 2021
- *(Slightly Different – SM) Engagement Patterns of Peer-to-Peer Interactions on Mental Health Platforms, ICWSM 2020*

What will we cover?

- Boolean retrieval
- The term vocabulary & postings lists
- Skip Pointers, Phrase Queries and Positional Indexing
- Scoring, term weighting & the vector space model
- Dictionaries and Tolerant Retrieval
- Evaluation in information retrieval
- Index Construction and Compression
- Relevance feedback & query expansion
- *Probabilistic information retrieval*
- *Language models for information retrieval (+Current LM Primer)*

Course Contents (Tentative)

- Link analysis – HITS, PageRank
- Word Vectors
- Classification and Clustering with Vectors
- Learning to Rank
- Neural IR

Tutorial: DL/NLP/PyTorch Primer

- Excluded (due to time)
  - Semantic Web, OWL, Image Retrieval, Cross-lingual/Cross-modal retrieval, Mathematical formula search

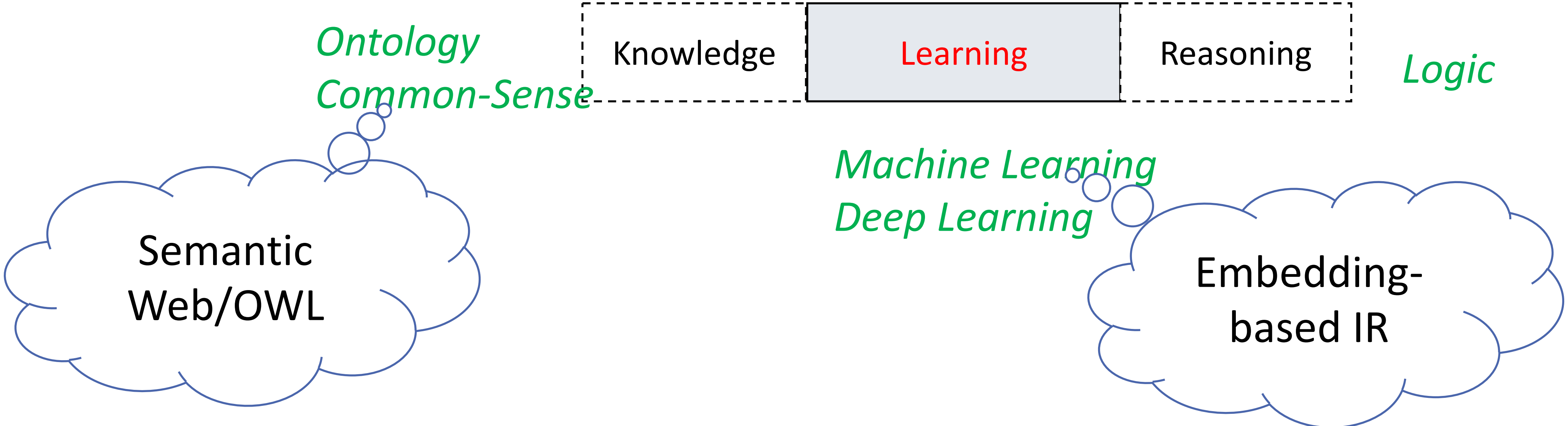
Intelligent Logical Trusted Agents

CVIU ‘17, AAAI ’18, IJCAI (‘15, ‘19)
UAI ’18, WACV ‘19

See

Read

TaxiNLI, CoNLL 2020
TaxiXNLI, EMNLP MRL ‘21
*CheckList NLI**
*Multi-Hop NLI**


Ontology
Common-Sense
Knowledge
Learning
Reasoning
Logic
Machine Learning
Deep Learning
Semantic Web/OWL
Embedding-based IR