# IN1140: Introduksjon til språkteknologi

## *Forelesning #11*

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# Tema for i dag

- Språkteknologiske applikasjoner
- Se på noen eksempler
  - Teknikker i informasjonsekstraksjon
  - Leksikon for sentimentanalyse
  - Question Answering
  - Dialogsystemer og chatbots

# Språkteknologiske applikasjoner

- Mange språkteknologiske applikasjoner kombinerer teknikker vi har sett på tidligere i kurset.
- Motiverer de teknikkene vi har lært.
- Introdusere nye metoder.

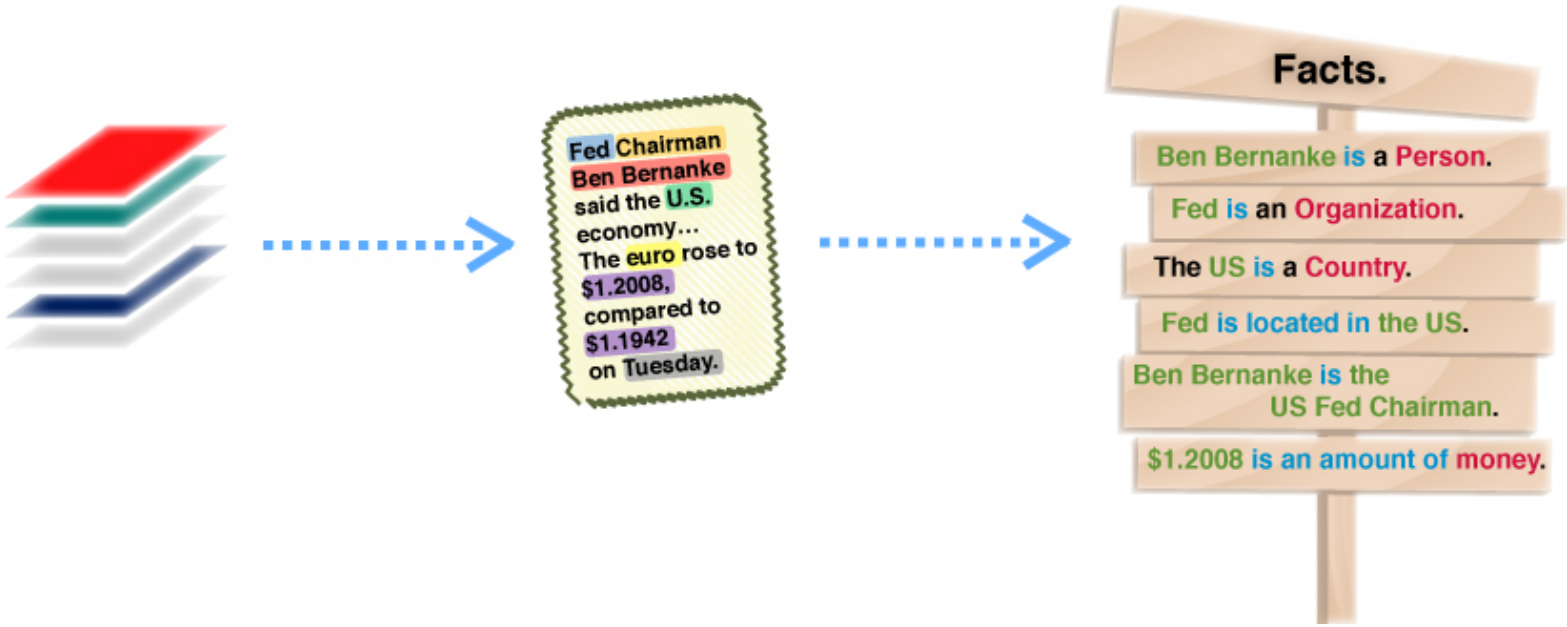
# Informasjonsekstraksjon (IE)

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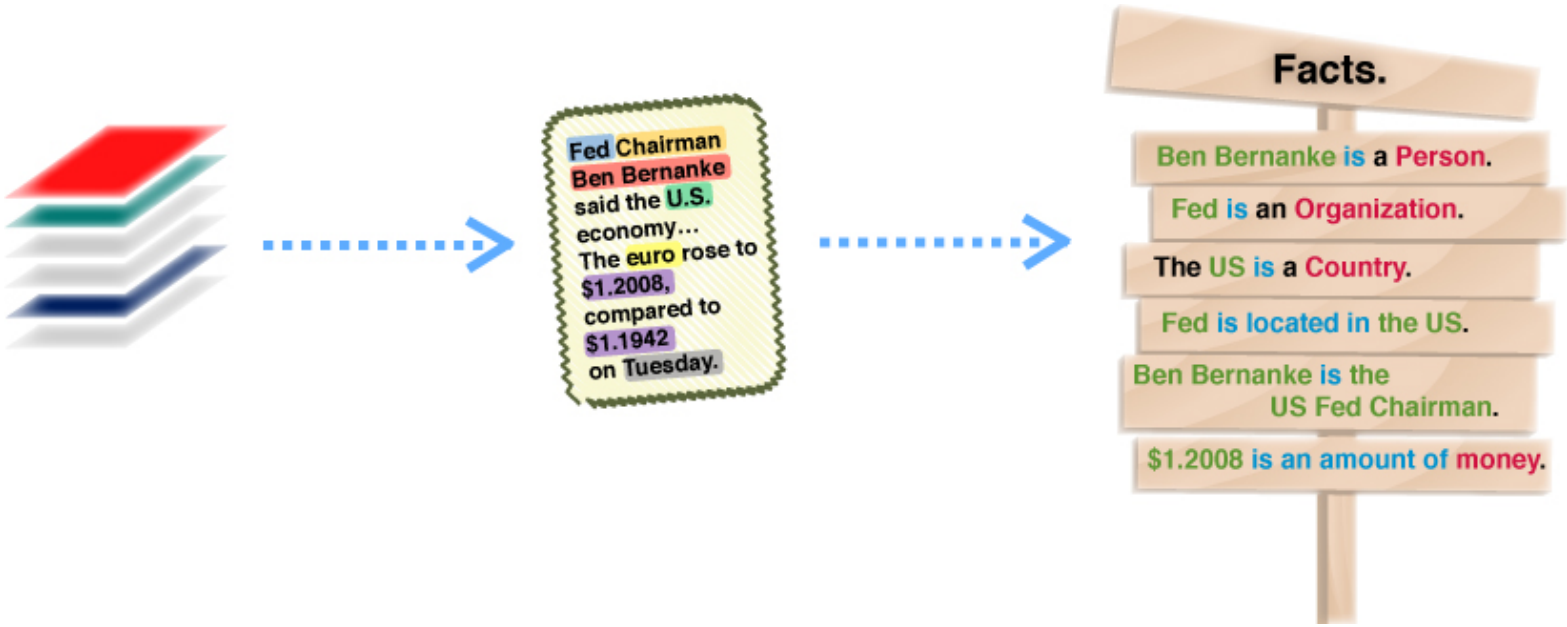
- Samlebegrep for teknikker som henter ut (ekstraherer) forskjellige typer semantisk informasjon fra tekst.
- Ustruktert informasjon $\Rightarrow$ strukturerte data (relasjonsdatabase)
  - F.eks. relasjoner mellom organisasjoner og steder

| **Organisasjon** | **Steder** |
|---|---|
| Omnicom | New York |
| DDB Needham | New York |
| Kaplan Thaler Group | New York |
| BBDO South | Atlanta |
| Georgia Pacific | Atlanta |

# Informasjonsekstraksjon (IE)



# Informasjonsekstraksjon (IE)




- Named entity recognition
- Relation extraction
- Coreference resolution
- Event extraction

# Named Entity Recognition (NER)

Citing high fuel prices, United Airlines said Friday it has increased fares by $6 per round trip on flights to some cities also served by lower-cost carriers. American Airlines, a unit of AMR Corp., immediately matched the move, spokesman Tim Wagner said. United, a unit of UAL Corp. said the increase took effect Thursday and applies to most routes where it competes against discount carriers, such as Chicago to Dallas and Denver to San Francisco.

# Named Entity Recognition (NER)

Citing high fuel prices, [$_{ORG}$ United Airlines] said [$_{TIME}$ Friday] it has increased fares by [$_{MONEY}$ $6] per round trip on flights to some cities also served by lower-cost carriers. [$_{ORG}$ American Airlines], a unit of [$_{ORG}$ AMR Corp.], immediately matched the move, spokesman [$_{PER}$ Tim Wagner] said. [$_{ORG}$ United], a unit of [$_{ORG}$ UAL Corp]. said the increase took effect [$_{TIME}$ Thursday] and applies to most routes where it competes against discount carriers, such as [$_{LOC}$ Chicago] to [$_{LOC}$ Dallas] and [$_{LOC}$ Denver] to [$_{LOC}$ San Francisco].

# Relasjonsekstraksjon

Finne fram til **relasjoner** mellom entitetene i en tekst

## Input

*Citing high fuel prices, [$_{\text{ORG}}$ United Airlines] said [$_{\text{TIME}}$ Friday] it has increased fares by [$_{\text{MONEY}}$ $6] per round trip on flights to some cities also served by lower-cost carriers. [$_{\text{ORG}}$ American Airlines], a unit of [$_{\text{ORG}}$ AMR Corp.], immediately matched the move, spokesman [$_{\text{PER}}$ Tim Wagner] said.*

- PER $\rightarrow$ ORG: spokesman_of(Tim Wagner, American Airlines)
- ORG $\rightarrow$ ORG: unit_of(American Airlines, AMR Corp)

# Metoder for relasjonsekstraksjon

Regulære uttrykk over NE-tagget tekst

- $(X, \alpha, Y)$, der $X, Y$ er egennavn og $\alpha$ er ordstrengen som forekommer mellom dem
- Søke etter spesifikke ord/fraser i $\alpha$, feks *in*
  - $[_{ORG}$ WHYY] 'in' $[_{LOC}$Philadephia]
  - $[_{ORG}$ Brookings Institution] 'the research group in' $[_{LOC}$Washington]
  - $[_{ORG}$ OpenText] 'based in' $[_{LOC}$Waterloo]
  - $[_{ORG}$ Omnicom] 'in' $[_{LOC}$New York]

# Metoder for relasjonsekstraksjon

Klassifisering (supervised learning), to oppgaver:

1. Hvorvidt to entiteter står i en relasjon (binær klassifiserer).
2. Tildele kategori til relasjonene.

```
function FindRelations(words) returns relations
    relations ← nil
    entities ← FindEntities(words)
    forall entity pairs <e1, e2> in entities do
      if Related?(e1, e2)
        relations ← relations+ClassifyRelation(e1, e2)
```

# Metoder for relasjonsekstraksjon

- Viktig del er å finne fram til gode **trekk**
  - NE-kategoriene (PER, ORG, LOC etc.)
  - Ord hentet fra konteksten (teksten): bag-of-words, lemmaer, distanse, antall entiteter mellom, etc.
  - Syntaktisk struktur fra konteksten: chunk-kategorier, funksjoner, frasestrukturkategorier (NP, VP, ...), etc.

# Metoder for relasjonsekstraksjon

Kan også bruke:

- **Semisupervised learning via Bootstrapping**: bruke lite treningsdata, liten håndfull regulære uttrykk (RE mønstre), **bootsrap** en klassifiserer.
- **Distant supervision**: bruke en stor database for å hente ut stor andel eksempler av relasjoner og lage flere mønstre (med mye støy) og kombinære dem i en supervised klassifiserer.
- **Unsupervised**: også kjent som **open information extraction**. Bruker ikke annotert treningsdata, men bruker masse data fra f.eks. internet. Relasjonene her anses som strenger av ord som vanligvis begynner med et verb.

# Temporal Expression Extraction

| **Absolute** | **Relative** | **Durations** |
|---|---|---|
| April 24, 1916 | yesterday | four hours |
| The summer of '77 | next semester | three weeks |
| 10:15 AM | two weeks from yesterday | six days |
| The 3rd quarter of 2016 | last quarter | the last three quarters |

# Coreference Resolution



But the little prince could not restrain admiration: “Oh! How beautiful you are!”
“Am I not?” the flower responded, sweetly. “And I was born at the same moment as the sun ...”
The little prince could guess easily enough that she was not any too modest–but how moving–and exciting–she was!
“I think it is time for breakfast,” she added an instant later. “If you would have the kindness to think of my needs–”
And the little prince, completely abashed, went to look for a sprinkling-can of fresh water. So, he tended the flower.

# Event Extraction

- Who did what to whom, when, where, through what methods (instruments) and why.
- Innebærer bruk av NER og relation extraction.

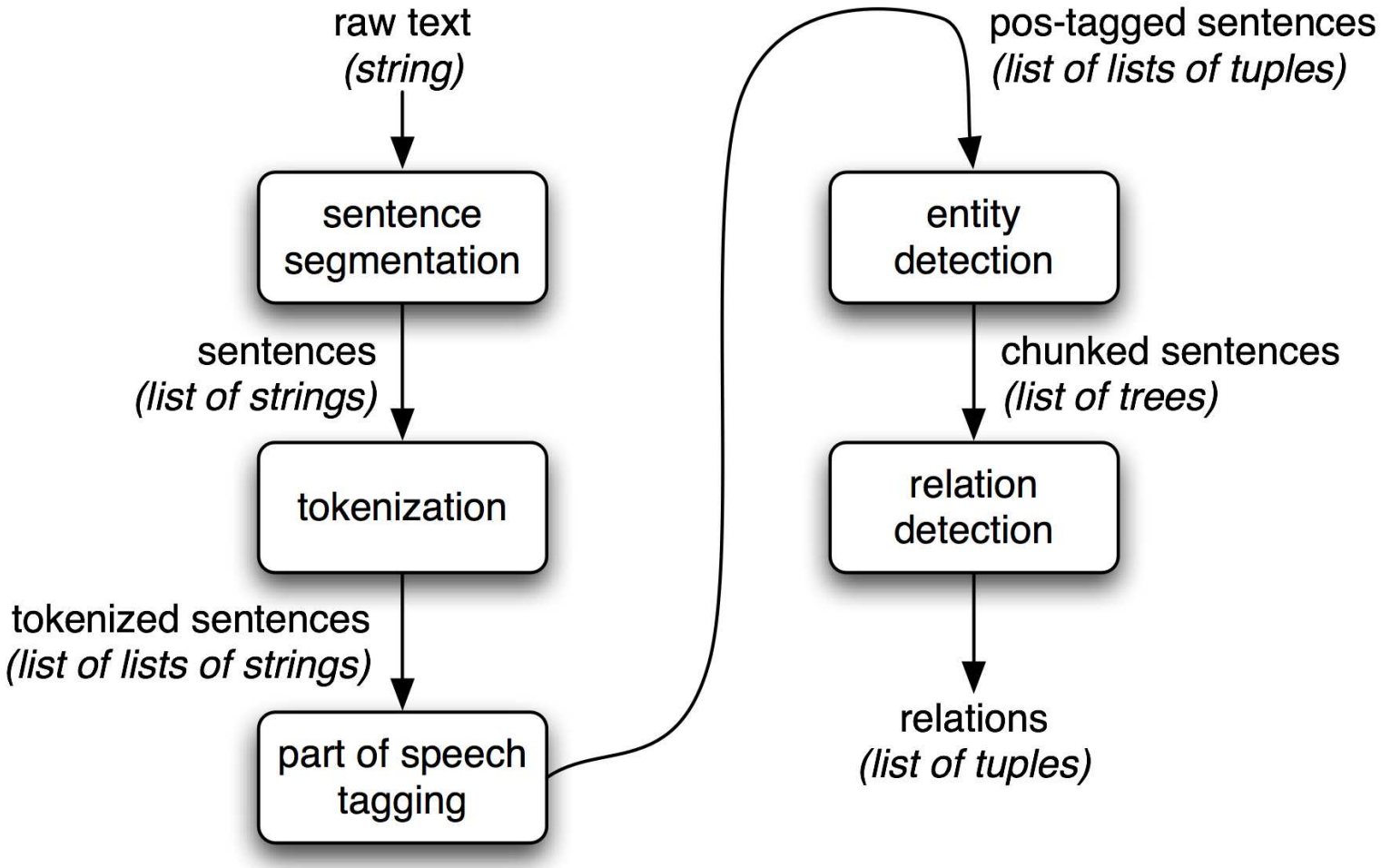
# Event Extraction

- Who did what to whom, when, where, through what methods (instruments) and why.
- Innebærer bruk av NER og relation extraction.

"Masked gunmen armed with assault rifles and grenades attacked a wedding party in mainly Kurdish southeast Turkey, killing at least 44 people."

| | |
|---|---|
| *perpetrators* | masked gunmen |
| *victims* | people |
| *number of killed/injured* | at least 44 |
| *weapons and means used* | rifles and grenades |
| *location* | southeast Turkey |
| *event* | attacked |

# Informasjonsekstraksjon (IE)



# Leksikon for sentimentanalyse

# Sentiment Analaysis




https://www.clickworker.de/wp-content/uploads/2017/02/Sentiment-Analyse.jpg

# Sentiment leksikon

- General Inquirer: eldste, 1966. Inneholder 1915 positive ord og 2291 negative ord.
- MPQA (2005): 2718 positive og 4912 negative ord.
- Hu and Liu (2004): 2006 positive og 4783 negative ord.
- NRC Valence, Arousal, Dominance (VAD, 2018): 20.000 ord.
- EmoLex (2013): 14.000 ord (8 emotions).
- Norsk sentiment leksikon (2019): 1.601 positive og 3.917 negative ord. Fullform: 6.103 positive og 14.839 negative ord. `https://github.com/ltgoslo/norsentlex`

# Å lage sentiment-leksikoner

- **Manuelt**: eksperter lager lister av positive og negative ord.
- **Semi-supervised**: starte med "seed words" f.eks. *god* og *dålig*. Regne ut hvorvidt hvert ord $w$ som skal bli klassifisert, er lik ordet *god*, og hvorvidt det er annerledes fra ordet *dårlig*
- **Supervised**: bruke anmeldelser (f.eks terningkast, stjerner) for å lage leksion av positive og negative ord.

# Supervised

| | |
|---|---|
| | **Movie review excerpts (IMDb)** |
| **10** | A great movie. This film is just a wonderful experience. It's surreal, zany, witty and slapstick all at the same time. And terrific performances too. |
| **1** | This was probably the worst movie I have ever seen. The story went nowhere even though they could have done some interesting stuff with it. |
| | **Restaurant review excerpts (Yelp)** |
| **5** | The service was impeccable. The food was cooked and seasoned perfectly... The watermelon was perfectly square ... The grilled octopus was ... mouthwatering... |
| **2** | ...it took a while to get our waters, we got our entree before our starter, and we never received silverware or napkins until we requested them... |
| | **Book review excerpts (GoodReads)** |
| **1** | I am going to try and stop being deceived by eye-catching titles. I so wanted to like this book and was so disappointed by it. |
| **5** | This book is hilarious. I would recommend it to anyone looking for a satirical read with a romantic twist and a narrator that keeps butting in |
| | **Product review excerpts (Amazon)** |
| **5** | The lid on this blender though is probably what I like the best about it... enables you to pour into something without even taking the lid off! ... the perfect pitcher! ... works fantastic. |
| **1** | I hate this blender... It is nearly impossible to get frozen fruit and ice to turn into a smoothie... You have to add a TON of liquid. I also wish it had a spout ... |

**Figure 20.9** Excerpts from some reviews from various review websites, all on a scale of 1 to 5 stars except IMDb, which is on a scale of 1 to 10 stars.

`https://web.stanford.edu/~jurafsky/slp3/20.pdf`

- Kan bruke anmeldelser: positive ord forekommer mest sannsynlig i 5-stjerners anmeldelser, negative ord i 1-stjerners anmeldelser.
- Slike anmeldelser kan brukes for mer enn kun binære klassifisseringer.
- Vi kan identifisere fordeling over stjerner/terningkast for hvert ord.

# Potts Score

Potts Score (Potts, 2011):

$$P(w|c) = \frac{count(w,c)}{\sum_{w \in C} count(w,c)}$$

$$PottsScore(w) = \frac{P(w|c)}{\sum_{c} P(w|c)}$$

# Potts Score

For eksempel:
Vi kan beregne IMDB sannsynligheten av forekomsten av ordet *disapointing* i en 1-stjerners anmeldelse.

$$P(disapointing|1) = \frac{count(disapointing, 1)}{\sum_{w \in 1} count(w, 1)} = \frac{8557}{25395214} = 0.0003$$

$$PottsScore(disapointing) = \frac{0.0003}{\sum_c P(w|C)} = 0.10$$

Og ordet *disapointing* er da assosiert med vektoren *[0.10, 0.12, 0.14, 0.14, 0.13, 0.11, 0.08, 0.06, 0.06, 0.05]* som representerer Potts score for hver klasse fra 1-10.

# Potts Score

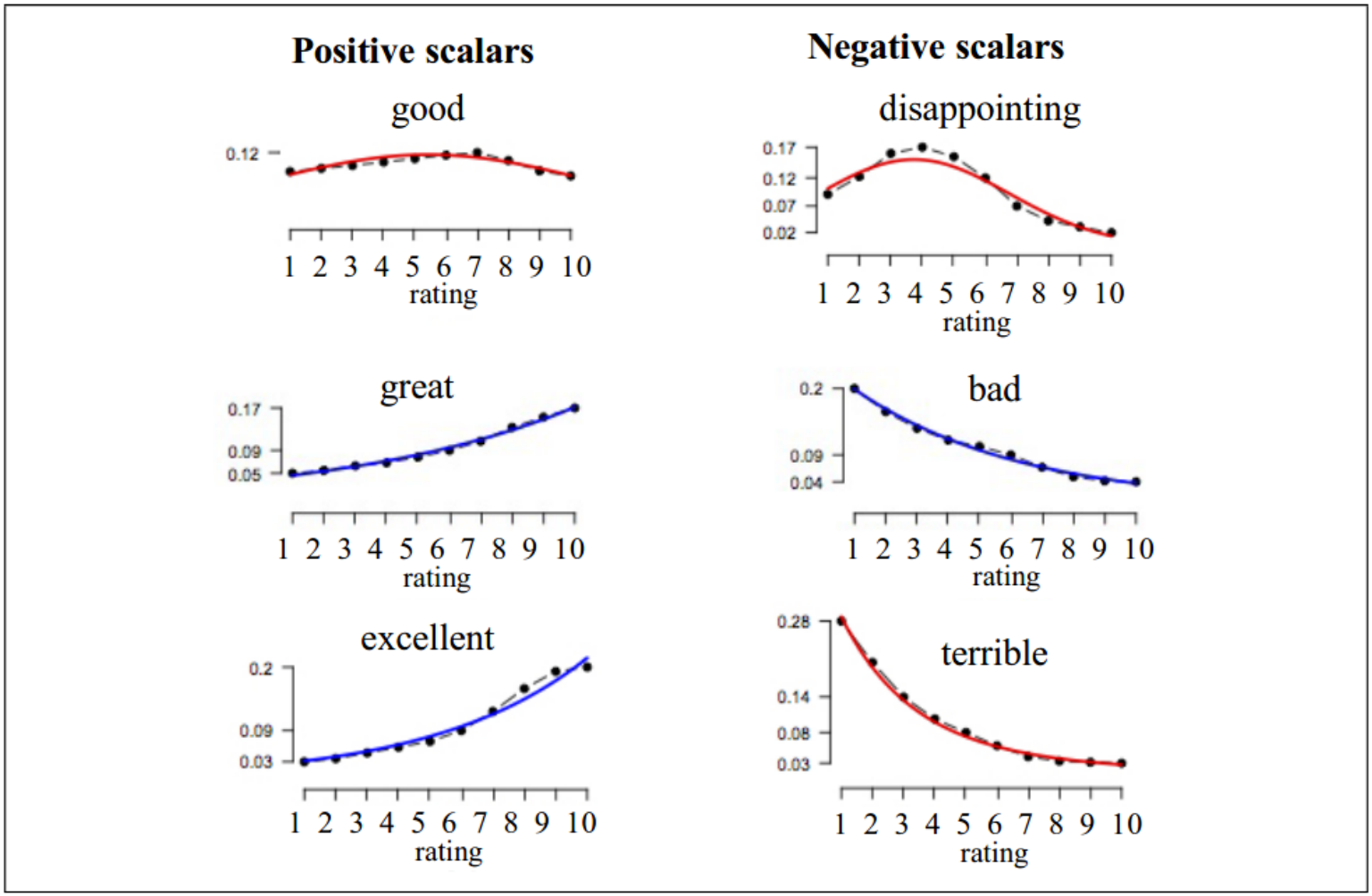



**Figure 20.10** Potts diagrams (Potts, 2011) for positive and negative scalar adjectives, showing the J-shape and reverse J-shape for strongly positive and negative adjectives, and the hump-shape for more weakly polarized adjectives.

https://web.stanford.edu/~jurafsky/slp3/20.pdf

# Bruk av leksikon

Sentiment leksikon kan:

- brukes direkte ved å telle forekomster av ord.
- brukes som trekk i en Naive Bayes klassifissering.
- brukes med andre maskinlæringsalgoritmer.

# Question Answering

# Question Answering

- Begynnelsen av 1960-tallet: systemene brukte de to store paradigmene – informasjonsinnhentingsbasert (Information Retrieval) og kunnskapsbasert – for å svare på spørsmål om baseballstatistikk eller vitenskapelige fakta.
- Uekte maskiner: *Deep Thought*, datamaskinen i "The Hitchhiker's Guide to the Galaxy" klarte å svare på "*The Ultimate Question Of Life, The Universe, and Everything*"[1]
- 2011: IBMs **Watson** question-answering system (bruker en hybridarkitektur) vant TV-showet Jeopardy!

[1] 42!

# Question Answering

- De fleste Question-Answering (QA) systemer fokuserer på fakta-basert spørsmål, spørsmål som kan besvares med enkle fakta uttrykt i korte tekster.

- Svarene på spørsmålene nedenfor kan uttrykkes med navn, tidsmessig uttrykk, eller sted:
  1. Hvem grunnla Virgin Airlines?
  2. Hva er gjennomsnittsalderen i Real Madrid?
  3. Hvor er SAS basert?

# Question Answering – IR-based

- informasjonsinnhentingsbasert eller IR-basert QA er avhengig av store mengder tekster fra f.eks. nettet.
- Gitt et brukerspørsmål:
  - finner relevante dokumenter og avsnitt.
  - systemene deretter bruker (feature-based, nevrale eller mix av begge) "reading comprehension" algoritmer for å lese hentede dokumenter/avsnitter.
  - hente svar direkte fra tekstene (sekvenser av strengene).

# Question Answering – IR-based

| Question | Answer |
|---|---|
| Where is the Louvre Museum located? | in Paris, France |
| What are the names of Odin's ravens? | Huginn and Muninn |
| What kind of nuts are used in marzipan? | almonds |
| What instrument did Max Roach play? | drums |
| What's the official language of Algeria? | Arabic |

**Figure 23.9** Some factoid questions and their answers.

https://web.stanford.edu/~jurafsky/slp3/23.pdf

# Question Answering – IR-based

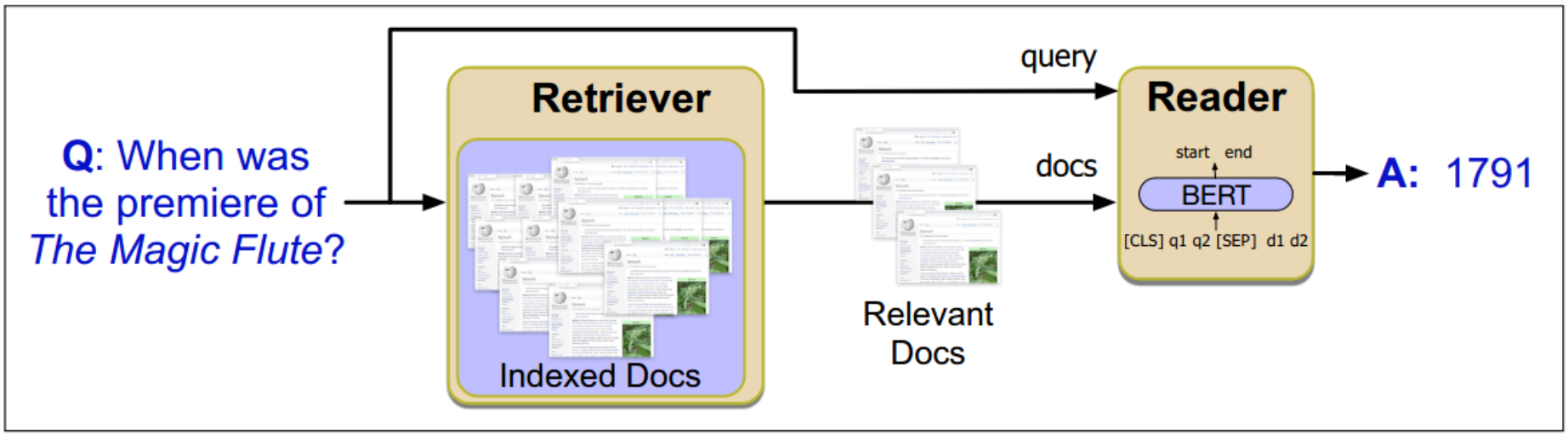



**Figure 23.10** IR-based factoid question answering has two stages: **retrieval**, which returns relevant documents from the collection, and **reading**, in which a neural reading comprehension system extracts answer spans.

https://web.stanford.edu/~jurafsky/slp3/23.pdf

# Watson – IBM

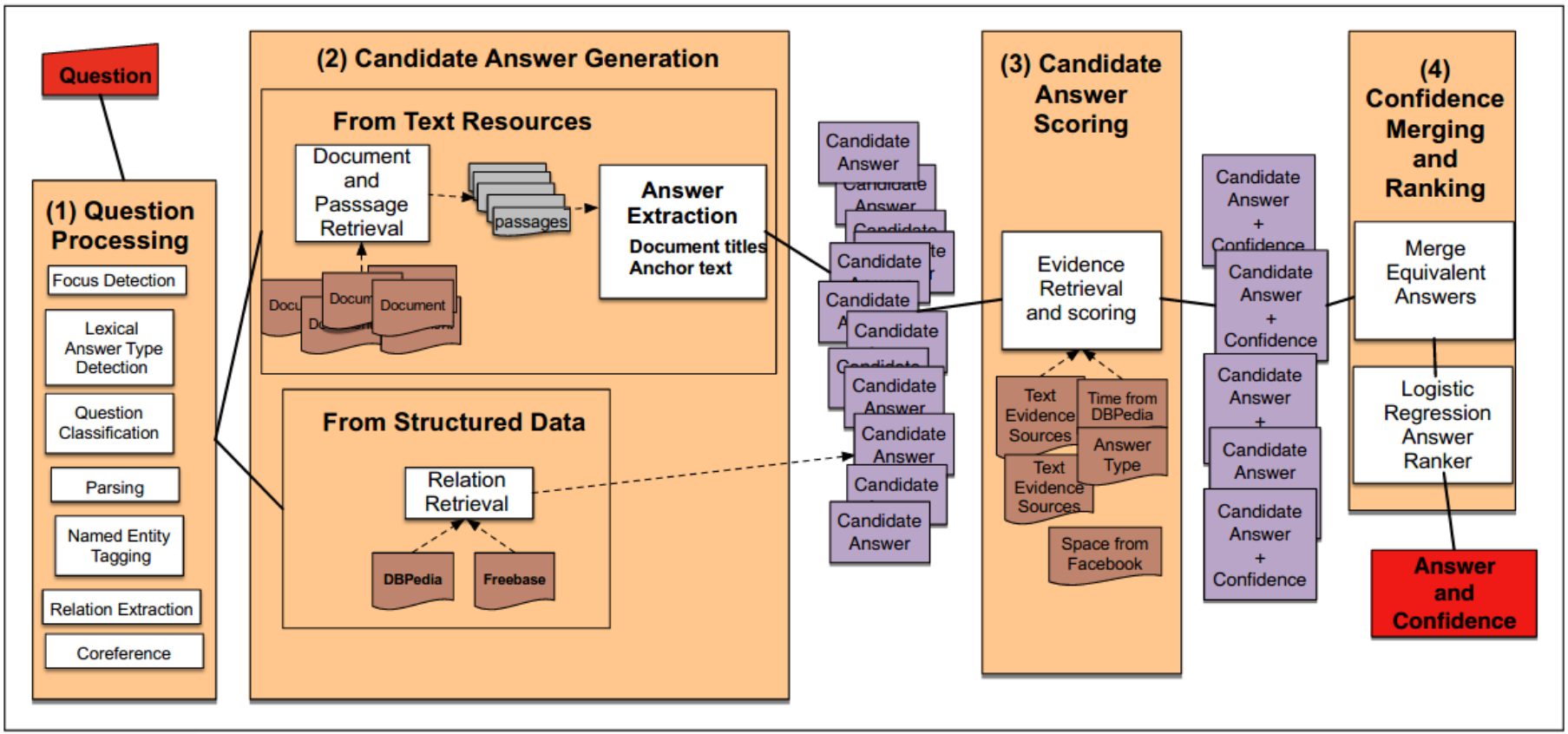



**Figure 23.17** The 4 broad stages of Watson QA: (1) Question Processing, (2) Candidate Answer Generation, (3) Candidate Answer Scoring, and (4) Answer Merging and Confidence Scoring.

https://web.stanford.edu/~jurafsky/slp3/23.pdf

# Dialogsystemer og chatbots

# Dialogsystemer

- To hovedalgoritmer av dialogsystemer:
  1. Oppgaveorienterte dialogagenter.
  2. Chatbots.

# Egenskaper av menneskelig samtaler

| | |
|---|---|
| $C_1$: | . . . I need to travel in May. |
| $A_2$: | And, what day in May did you want to travel? |
| $C_3$: | OK uh I need to be there for a meeting that's from the 12th to the 15th. |
| $A_4$: | And you're flying into what city? |
| $C_5$: | Seattle. |
| $A_6$: | And what time would you like to leave Pittsburgh? |
| $C_7$: | Uh hmm I don't think there's many options for non-stop. |
| $A_8$: | Right. There's three non-stops today. |
| $C_9$: | What are they? |
| $A_{10}$: | The first one departs PGH at 10:00am arrives Seattle at 12:05 their time. The second flight departs PGH at 5:55pm, arrives Seattle at 8pm. And the last flight departs PGH at 8:15pm arrives Seattle at 10:28pm. |
| $C_{11}$: | OK I'll take the 5ish flight on the night before on the 11th. |
| $A_{12}$: | On the 11th? OK. Departing at 5:55pm arrives Seattle at 8pm, U.S. Air flight 115. |
| $C_{13}$: | OK. |
| $A_{14}$: | And you said returning on May 15th? |
| $C_{15}$: | Uh, yeah, at the end of the day. |
| $A_{16}$: | OK. There's #two non-stops . . . # |
| $C_{17}$: | #Act. . . actually #, what day of the week is the 15th? |
| $A_{18}$: | It's a Friday. |
| $C_{19}$: | Uh hmm. I would consider staying there an extra day til Sunday. |
| $A_{20}$: | OK. . . OK. On Sunday I have . . . |

**Figure 24.1** Part of a phone conversation between a human travel agent (A) and human client (C). The passages framed by # in $A_{16}$ and $C_{17}$ indicate overlaps in speech.

https://web.stanford.edu/~jurafsky/slp3/24.pdf

# Samtaler

- Hver sin tur til å snakke.
  - Men hvordan vet vi at den andre er ferdig med å snakke?
- Talehandling: be noen å gjøre noe, stille et spørsmål som krever et svar, gi en begrensning, takke. f.eks linje $C_2$ og $C_1$ i forrige bilde.
- Forankring: å si ok, eller repetere det den andre sa. f.eks. linje $A_1$, $A_8$, $A_{10}$.
- Struktur: rekkefølgende er ikke alltid konsekvent, av og til ombestemmer vi oss. f.eks. fra $C_9$ til $A_{10}$.
- Inferens og implikasjon: f.eks. $A_1$ og $C_2$.

# Regelbasert chatbot

- Første: Eliza (Weizenbaum, 1966).
- Regelbasert: bruk av regulære utrykk-lignende regler.

| | |
|---|---|
| User: | *Men are all alike* |
| ELIZA: | IN WHAT WAY? |
| User: | *They're always bugging us about something* |
| ELIZA: | CAN YOU THINK OF AN EXAMPLE? |
| User: | *Well, my boyfriend made me come here* |
| ELIZA: | YOUR BOYFRIEND MADE YOU COME HERE. |
| User: | *He says I am depressed much of the time* |
| ELIZA: | I'M SORRY TO HEAR THAT YOU ARE DEPRESSED. |

# Chatbots

- Finnes også korpus-basert chatbots.
- Krever stor dataset av menneske – menneske samtaler.
- Bruker blant annet maskinlæringsmetoder for å trene modeller.
- Fokuset er å generere setninger, og de fleste chatbots sliter fortsatt med å beholde en sammenhengde samtale.

# Ramme-basert dialogsystemer

| Slot | Type | Question Template |
|---|---|---|
| ORIGIN CITY | city | "From what city are you leaving?" |
| DESTINATION CITY | city | "Where are you going?" |
| DEPARTURE TIME | time | "When would you like to leave?" |
| DEPARTURE DATE | date | "What day would you like to leave?" |
| ARRIVAL TIME | time | "When do you want to arrive?" |
| ARRIVAL DATE | date | "What day would you like to arrive?" |

**Figure 24.10** A frame in a frame-based dialogue system, showing the type of each slot and a question used to fill the slot.

# Ramme-basert dialogsystemer

| | |
|---|---|
| GUS: | Hello. My name is GUS. I can help you plan a simple trip by air. Where do you want to go ? |
| Client: | I want to go to San Diego on May 28 |
| GUS: | What time do you want to leave? |
| Client: | I must be in San Diego before 10 am |
| GUS: | Would you like P.S.A. flight 102 that arrives at 9.15 am ? |
| Client: | What is the next flight ? |
| GUS: | Air California flight 310 that leaves at 8.30am and arrives at 10.00am |
| Client: | I'll take the first one |
| GUS: | In what name should I make a reservation, please? |
| Client: | Dan Bobrow |
| GUS: | I have confirmed the following flight: P.S.A. flight 102 on Wednesday May 28 from San Jose to San Diego that leaves at 7.30 am and arrives at 9.15 am. |
| GUS: | What date do you want to return on ? |
| Client: | On Friday in the evening. |
| GUS: | Would you like the flight that leaves at 7.45 pm ? |
| Client: | That's fine. |
| GUS: | I have confirmed the following flight: P.S.A. flight 307 on Friday May 30 from San Diego to San Jose that leaves at 7.45 pm and arrives at 9.30 pm Thank you for calling. Goodbye |

**Figure 24.9** The travel domain: A transcript of an actual dialogue with the GUS system of Bobrow et al. (1977). P.S.A. and Air California were airlines of that period.

# Evaulering

# Evaulering




**Figure 24.19** The ACUTE-EVAL method asks annotators to compare two dialogues and choose between Speaker 1 (light blue) and Speaker 2 (dark blue), independent of the gray speaker. Figure from Li et al. (2019).

# Oppsummering

- Sett på en rekke språkteknologiske applikasjoner
- Berører kjente **lingvistiske nivåer**:
  - Morfologi
  - Ordklasser
  - Syntaks
  - Semantikk
- Berører kjente **språkteknologiske oppgaver**:
  - Tokenisering/stemming
  - Ordklassetagging
  - Morfologisk analyse
  - Chunking

# Oppsummering

- Berører kjente **metoder/modeller**:
  - Regulære uttrykk
  - Klassifisering

# Oppsummering

- Ser på en rekke applikasjoner:
  - Teknikker i informasjonsekstraksjon
  - Leksikon for sentimentanalyse
  - Question Answering
  - Dialogsystemer og chatbots