Sentence Planning 1: 
Lexical Choice

Lecture 9
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Thanks to Ehud Reiter

Reading: Chapter 5, Reiter and Dale

A WeatherReporter Document Plan

weatherSummary --
TemperatureInformation rainInformation
TemperatureInformation --
monthlyTempMsg [extremeTempInfo] [tempSpellsInfo]
TemperatureInformation --
monthlyRainfallMsg [rainyDaysInfo]
[ELABORATION]
[SEQUENCE]
MONTHLYTEMPMSG cooler than average
MONTHLYRAINMSG drier than average
[CONTRAST]
[ELABORATION]
RAINYDAYSMSG average # rain days
RAINSOFARMSG total below avg
RAINSPELLMSG rain for 8 days
RAINAMOUNTMSG amounts small

A Very Simple Realizer

- Produce one output sentence per message in the document plan using templates
- A specialist fragment of code for each message type determines how that message type is realised

Example: For the MonthlyTemperatureMsg:

\[
\text{TempString} = \text{case } (\text{TEMP} - \text{AVGTEMP})
\]

\[
\begin{align*}
[2.0 .. 2.9] & : \text{`very much warmer than average.'} \\
[1.0 .. 1.9] & : \text{`much warmer than average.'} \\
[0.1 .. 0.9] & : \text{`slightly warmer than average.'} \\
[-0.1 .. -0.9] & : \text{`slightly cooler than average.'} \\
[-1.0 .. -1.9] & : \text{`much cooler than average.'} \\
[-2.0 .. -2.9] & : \text{`very much cooler than average.'}
\end{align*}
\]

endcase

Sentence = `The month was' + TempString
One Message per Sentence

- **The Result:**
  - The month was cooler than average.
  - The month was drier than average.
  - There was the average number of rain days.
  - The total rain for the year so far is well below average.
  - There was rain on every day for 8 days from 11th to 18th. Rainfall amounts were mostly small.

- **What we’d really like:**
  - The month was cooler and drier than average. Even though there was an average number of rain days this month, the total rain for the year so far is well below average. There was rain every day for 8 days from 11th to 18th, but rainfall amounts were mostly small.

We Need

- **Lexicalisation**: choose words/phrases to express concepts and relations
- **Aggregation**: How/when to combine phrases into sentences
- **Referring expression generation**: choose words/phrases to refer to objects

Unfortunately, these tasks are not independent of one another!

Back in the day

- Early (70s & 80s) NLG systems had two stages
  - Strategic component: *What to say*. Text content and structure
  - Tactical component: *How to say it*. Sentence level grammar and morphology

- Why microplanning?
  - Need for generating longer, richer, more fluent text
  - Reasoning systems not guaranteed to deliver info in chunks that correspond neatly to surface form sentences

- Where does referring expression generation belong?
- What about aggregation?

NLG Tasks and Pipeline Architecture
Microplanning Tasks Interact

Sentence planning

Referring Expression Generation

Proto-phrase Specifications

Lexical Choice Aggregation

Phrase Specifications, (or Sentence Plans)

Document Plan

Proto-phrase Specifications

Lexical Choice Aggregation

Sentence planning

Referring Expression Generation

Proto-phrase Specifications

Lexical Choice Aggregation

Phrase Specifications, (or Sentence Plans)

Example:

1 (a) Bob likes fishing and swimming.
   * (b) Bob likes fishing and to swim.

2 (a) Heavy rain fell from the 12th to the 14th.
   * (b) From the 12th to the 14th was the wettest three-day period so far this year.

Pipelined Microplanning

Lexical choice: selects words and syntactic structures to express messages. Result is proto-phrase-spec. PPSs may contain refs to domain entities

Aggregation: combines multiple PPSs into single PPS

REG: takes each PPS and replaces references to domain entities with a phrase spec corresponding to a noun phrase that will uniquely identify that entity to the reader

Example: Weather Reporter Document Plan

The month was slightly warmer than average, with the average number of rain days. Heavy rain fell on the 27th and 28th.
The month was slightly warmer than average, with the average number of rain days. Heavy rain fell on the 27th and 28th.

Document Plans Specify Info Abstractly

**Do specify**
- Content to be included
- General semantic similarity
  - Constituent 1 includes general info messages
  - Constituent 2 includes all significant event messages

**Don’t specify**
- Words to be used to communicate the notion of average temperature
- How to package content into sentences
- How to refer to fifth month of 1996

Microplanner transforms document plans into a text specification made up phrase specifications

Continuing our example:

```
Type: TextSpecification
Constituent1: <Sentence1>
Constituent2: <Sentence2>
```

Consists of two phrase specifications (sentences)
Phrase Specification for Sentence 1

- **Aggregation**: combines 2 messages from doc plan
- **Lexical Choice**: Expresses avg temp for month is 2 degrees higher than usual as: “slightly warmer than average”
- **REG**: uses “the month” to refer to May 1996

Phrase Specs can be transformed to input to most realizers, e.g., HLDS

Sentence planning is hard

Problem: Many ways to express a message in words

Example:

```
John gave the book to Mary.

- John gave Mary the book.
- Mary took the book from John.
- John gave the book. Mary took it.
- ...
```

Which one should we use?

So many choices...

- Lexical choice: *sold* vs. *bought* vs. *purchased*
- Aggregation: one sentence vs. two
- Referring Expression Generation: 
  - the book, it, a novel, Emma, Jan Austen’s fourth novel ?

How do we make these choices?

- Rule-based
- Statistically

Which text is best?

- Easiest to comprehend?
- Most likely to be remembered?
- Most persuasive?
- Most appropriate style?

How to Decide

- **Theoretical**
  - Define what “best” means, make microplanning choices that optimise it
  - Hard to do in practice because we don’t have good models of the effects of choices
    - *bought* vs. *purchased*
- **Pragmatic**
  - Imitate corpus
  - Problems:
    - corpus texts may not be ideal from a microplanning perspective
    - authors may produce what’s easy for them to write, not what’s easy for others to read (Shaw 1998)
Lexical choice

- Which word/phrase should be used to communicate a given domain concept or relation?
  - bought vs. sold
  - took vs. bought
  - took vs. stole
  - bought vs. purchased
  - ascended vs. rose vs. surfaced
  - too fast vs. too rapidly
  - recommend vs. suggest
  - food vs. grub

Near Synonyms

- Near synonyms grouped into clusters
  - Do-something-wrong: Mistake, error, blunder, ...
  - Same core meaning
  - Peripheral distinctions
    - Blunder implies stupidity
    - Distinctions are usually semantic (meaning)
- No empirical testing or corpus work
  - Based on synonym dictionary

(Edmonds & Hirst, 2002)

Issues that affect lexical choice

- Frequency (affects readability)
  - lie vs. prevarication
- Formality:
  - Error vs. howler
- Connotation
  - Error vs. mistake
- Focus, expectations, alignment
  - not many, few, a few, only a few [students failed the exam]
- Technical terms
  - (statistics) standard error, not
  - standard mistake

Yet More Issues

- Linguistic context
  - Answered questions correctly vs.
  - Answers are correct
- Convention
  - Temperature falls, Wind speed eases
- Variation between users
  - Grammar mistake includes spelling?
  - By evening means 6PM or midnight?
  - Blue baby means skin is blue or O2 low
- Vary words to make texts interesting?
  - Standard writing advice
    - I met John and then I ran into Joan
    - I met John and then I met Joan
Example: Contextual and Pragmatic Factors

a. It rained for seven days from the 20th to the 26th.
b. It rained for seven days from the 20th.
c. It rained from the 20th to the 26th.
d. It rained on the 20th, 21st, 22nd, 23rd, 24th, 25th, and 26th.
e. It rained all of Thanksgiving week.

Default is c.

Pragmatic Goal: Use d to emphasize unusual rainy period this month

User knowledge: Use e if user knows when Thanksgiving week is

Repetition vs. conciseness: Use a to reduce possibility of misunderstanding. But, use b or c where space is limited

Weather Reporter Example - Cont’d

f. It snowed for five days from the 10th, and it rained from the 20th to the 26th.
g. It snowed for five days from the 10th, and it rained for seven days from the 20th.

Consistency with previous text:
• Use realization that has been used in a previous message for another instance of the same concept, as in g
• Allows user to compare the two spells
• May also make aggregation easier

Expressing Discourse Relations

h. The month was much wetter than average, but rainfall for the year is still very depleted.
i. The month was much wetter than average, however rainfall for the year is still very depleted.
j. The month was much wetter than average, although rainfall for the year is still very depleted.
k. Although the month was much wetter than average, rainfall for the year is still very depleted.
l. * However the month was much wetter than average, rainfall for the year is still very depleted.

Note:
Rules for deciding which cue word to use to express a discourse relation depend on subtle pragmatic and domain factors

But and although cannot be used interchangeably (Knott, 1996)

Approaches

• Rule-based
  – Use knowledge of word meaning to choose one that best fits context
• Corpus-based
  – Identify words human authors use in corpus of texts of the kind to be generated
  – Use frequencies from large, domain independent corpus (e.g., BNC, ANC, Switchboard, WSJ, …)
• Statistical
  – Collocations
  – N-gram language models
Rule Based Approach: Example

RainSpellMsg Template

To lexicalise(spell):

if spell.begin.day = spell.end.day then 
  return a proto-phrase spec for on the ith
else if spell.begin.day is day before spell.end.day then 
  return a proto-phrase spec for on the ith and jth
else 
  return a proto-phrase spec for from the ith to the jth

Proto-phase spec for on the ith

Proto-phase spec for on the ith and jth

Other syntactic categories?

- What if we need to express the concept of spell as a different syntactic category, e.g.,
  
  The 12th, 13th and 14th was the wettest three-day period seen so far this year.

- Need lexicalisation templates that express spell as a noun phrase, in addition to those for expressing spell as a prepositional phrase
Another Rule-Based Approach: Decision Trees

ACT = INGEST

Obj = solid?
  y  “eat” (7264)
  n  “consume” (515)

Obj = liquid?
  y  “drink” (7674)
  n  “quaff” (9)

Obj = gas?
  y  “imbibe” (11)
  n  “ingest” (31)

Obj = air?
  y  “breathe” (1061)
  n  “inhale” (73)

From BNC Online
http://bncweb.info/

Decision Tree for Realising CONTRAST Relation

Clauses aggregated within one sentence?

Yes

“but” used for last CONTRAST?

Yes

lex = “although”

No

lex = “but”

Yes

“In contrast” used for last CONTRAST?

lex = “however”

No

lex = “in contrast”

Rule Based Approach: Problems

- Hard to get to work in practice
  - Hard to get good data about context, user, level of formality, etc
  - Unexpected results

- Example: Application that tests language ability of low-skilled readers and generates report (Williams and Reiter, 2008)
  - Should it generate
    - You got 15 questions right or
    - You got 15 questions correct
  - Authors thought right would be better (13x more common)
  - But, 90% of users preferred correct

Corpus-Based

- Works OK, not ideal (Reiter et al. 2005)
  - Problem: many domain experts use words that readers may not interpret correctly
    - Use words not familiar to reader (e.g., grammar)
    - Use words idiosyncratically (e.g., later)

- Need to check whether readers understand the generated text
**Reiter et al. approach**

- Initially imitate words in corpus
- Look for problem cases
  - Words that users may not understand
  - Words that different authors use differently
- Check these with users, change if appropriate
- Vary connectives, nothing else

**Statistical Approach: Collocations**

- Collocation: a sequence of words or terms that co-occur more often than would be expected by chance
- Restrictions on how words can be used together, e.g.,
  - which prepositions are used with particular verbs
  - which adjectives and nouns are used together
- Example:
  - *strong tea* vs. *powerful tea*
  - *strong computers* vs. *powerful computers*

**Determining collocations**

- Measure of association evaluates whether the co-occurrence is purely by chance or statistically significant
- Association scores used to rank results
- Commonly used measures of association
  - mutual information
  - t-test
  - log-likelihood

**Bake vs. Roast**

**roast**

- Beef, pork, chicken, *ham, *gammon
- Potato, chestnuts
- Turnip, crab apples, ?apple
- Coffee beans
- Metal oar

**bake**

- Bread, cake, pies
- Ham, fish
- Apple, potato
- Pork chops with apple
- Clay, concrete, pottery
N-grams for generation

- N-gram statistics can be used to make many decisions
  - Tense
  - Gender, number agreement
  - Syntactic subcategorization decisions
  - Word choice

  *(Langkilde & Knight, 1998)*

- Lots more about this when we talk about statistical approaches to NLG

Summary: Lexical Choice

- Involves mapping domain concepts and relations to words or phrases
- Many issues affect lexical choice
- Use corpora with caution!

References


Document Plan as Feature Structure

Second constituent of document plan on previous slide
What affects lexical choice?

- Edmonds and Hirst (2002)
  - Error, mistake, blunder, slip, lapse, faux pas, howler
  - Lie, fib, misrepresentation, untruth, prevarication, falsehood
  - Correct, correctly, right
- Class’s opinions on choosing between these?

Case Creation

- Additional structure is required to realize the meaning of the semantic representation

(*A-KICK
  (AGENT *O-JOHN)
  (PATIENT *O-BALL))

"John propelled the ball with his foot"

Case Absorption

- Word chosen to realize a semantic head also implies the meaning conveyed by a semantic role

(*A-FILE-LEGAL-ACTION
  (AGENT *O-BOB)
  (PATIENT *O-SUIT)
  (RECIPIENT *O-ACME))

"Bob sued Acme"