

Computational Intelligence 696i

Language

Lecture 2

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Administriva

- Did people manage to install PAPPI?
 - (*see instructions from last Thursday*)

The Puzzle of Language

- Language is a complex system
 - in terms of shades of meaning
 - in terms of the syntax
 - in terms of what is allowed and what is not
- Language is part of a generative system
 - you can compose constructions and create new sentences
 - people can have razor-sharp judgments about data they have never encountered before
 - not just in terms of grammaticality/ungrammaticality
 - but also in terms of semantic interpretation

The Puzzle of Language

- **Compositionality of constructions**
 - active: The militia arrested John
 - **passive**: John was arrested
 - simple: John is sad
 - **raising**: John seems to be sad
 - **raising+passive**: John seems to have been arrested
 - ***passive+raising**: John was seemed to be arrested
- Note:
 - * indicates ungrammaticality (judgments are relative)

The Puzzle of Language

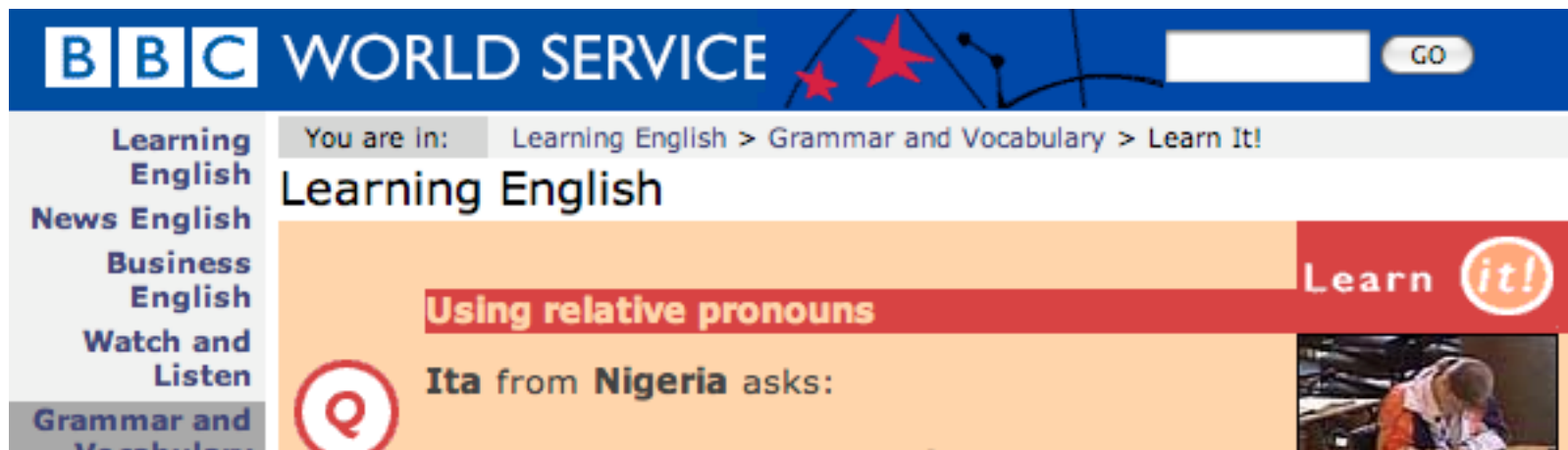
- **What's allowed and what's not**
 - **subject relative clause:** the man that knows me (*is not a liar*)
 - **object relative clause:** the man that I know ...
- **Omission of the relative pronoun**
 - **subject relative clause:** *the man knows me (*is not a liar*)
 - **object relative clause:** the man I know ...
- Why?

The Puzzle of Language

- (*The King's English*: Fowler 1908)
 - The omission of the relative in isolated clauses (as opposed to coordinates) is a question not of correctness but of taste, so far as there is any question at all. [...]
 - The **omission** of a defining **relative subject** is often effective in verse, but in prose is either an archaism or a provincialism. It may, moreover, result in obscurity ...
 - *Now it would be some fresh insect won its way to a temporary fatal new development.* H. G. Wells.
 - But when the defining relative is **object**, or has a preposition, **there is no limit to the omission** ...

The Puzzle of Language

- 2nd language learners of English worry about these rules a lot



- This is the student did it
- ‘zero’-subject relatives common in Hong Kong English (Gisborne 2000)

The Puzzle of Language

- For semantics, we're not just talking about (famous) sentences like
 - colorless green ideas sleep furiously(Chomsky 1957)
- but also many sentences for which we take the rules of interpretation for granted
 - *suggests we're operating with rules or principles which we're not conscious or aware of*

An Example

- Consider the *wh*-question:
 - Which report did you file without reading?



An Example

- The *wh*-question:
 - Which report did you file without reading?
- is actually a pretty complicated sentence for a computer program to deal with
- let's look at one problem for interpretation: **gaps**
 - *file* is a verb, there is a *filer* and *something* being filed
 - the *thing* being *filed* is the *report* in question

An Example

- Consider the *wh*-question:
 - Which report did you file without reading?
- Also
 - *read* is a verb, there is a *reader* and *something* being read
 - the *reader* must be the same person referred to by the pronoun *you*
 - the *thing* being *read* must be the same thing being *filed*, which must be the *report* in question
- **there are no other possible interpretations (in this case)**

An Example

- Consider the *wh*-question:
 - Which report did you file without reading?
- **there are no other possible interpretations (in this case)**
- meaning for example that:
 - we cannot be asking about some report that you filed but someone else read

An Example

- Which report did you file without reading?
- So only interpretation is:
 - Which report did you file [the report] without [you] reading [the report]?
- Can be viewed as a form of “compression”:
 - Which report did you file [the report] without [you] reading [the report]?
 - there is an understanding between speaker and hearer that the hearer can decode and recover the missing bits because they share the same “grammar”

An Example

- Which report did you file without reading?
- So only interpretation is:
 - Which report did you file [the report] without [you] reading [the report]?
- A computer program has to know the rules of gap filling
 - (*for this so-called **parasitic gap** sentence*)
 - What are the rules of gap filling?
 - Were you taught these rules in school?
 - Can you find them in a grammar book?

An Example

- Rules of gap filling
 - Which report did you file without reading?
 - *Which book did you file the report without reading
 - *The report was filed without reading
 - *The report was filed after Bill read
 - These papers are easy to file without reading
 - This book is not worth reading without attempting to analyze deeply
- Can you come up with the right rules?

The “Rules”

- What do the rules look like?
- Are we sure we covered all the cases?
- How about
 - *Who left without insulting?
 - Who left without insulting John?
- Debate:
 - How come “everyone” acquired the same rules?
 - Are these rules innate knowledge or learnt?

The “Rules”

- *How is the knowledge of language acquired?*
- From (Chomsky 1986)
- Standard belief 30+ years ago
 - language acquisition is a case of “overlearning”
 - language is a habit system assumed to be overdetermined by available evidence
- Plato’s Problem
 - the problem of “poverty of stimulus”
 - accounting for the richness, complexity and specificity of shared knowledge given the limitations of the data available
 - poverty of evidence

The “Rules”

- Idea then that
 - we’re pre-wired to learn language
 - data like the sentences we’ve been looking at are (in part) determined by the architecture and machinery of the language faculty
 - we’re not acquiring these rules from scratch
 - the pre-wiring is part of our genetic endowment
 - reasonable to assume what is pre-wired must be universal
 - if so, the pre-wiring must be flexible enough to account for language variation
 - yet reduce the learning burden

The “Rules”



Minimalist Program (MP)

- current linguistic technology (*research area*)
- language is a computational system
- even fewer mechanisms

Principles-and-Parameters Framework (GB)

- reduction of construction rules to
- fundamental principles (the atoms of theory)
- explanatory adequacy
- *we'll be using such a system for homework 1*

Rule-based systems

- *construction-based*
- monostratal, e.g. context-free grammars
- multiple levels. e.g. transformational grammars

Discussion



Interesting things to Google™

- Example:
 - **colorless green ideas** sleep furiously
- First hit:

Web

[Colorless green ideas sleep furiously](#)

Chomsky's famous sentence '**Colorless green ideas** sleep furiously' is examined and is shown to be a specimen of irony rather being meaningless.

home.tiac.net/~cri/1997/chomsky.html - 4k - [Cached](#) - [Similar pages](#)

Interesting things to Google™

- Example:
 - **colorless green ideas** sleep furiously
- First hit:
 - A **green idea** is, according to well established usage of the word "green" is one that is an idea that is **new and untried**.
 - Again, a **colorless idea** is one **without vividness, dull and unexciting**.
 - So it follows that a **colorless green idea** is a **new, untried idea that is without vividness, dull and unexciting**.
 - To **sleep** is, among other things, is to be in a state of dormancy or inactivity, or in a state of unconsciousness.
 - To **sleep furiously** may seem a puzzling turn of phrase but one reflects that **the mind in sleep often indeed moves furiously with ideas and images flickering in and out**.

Interesting things to Google™

- Example:
 - **colorless green ideas** sleep furiously
- Another hit: (a story)
 - "So this is our ranking system," said Chomsky. "As you can see, the highest rank is yellow."
 - "And the **new ideas**?"
 - "The **green ones**? Oh, the **green ones don't get a color until they've had some seasoning**. These ones, anyway, are still too angry. **Even when they're asleep, they're furious**. We've had to kick them out of the dormitories - they're just unmanageable."
 - "So where are they?"
 - "Look," said Chomsky, and pointed out of the window. There below, on the lawn, the colorless green ideas slept, furiously.

Interesting things to Google™

- Examples:
 - (1) **colorless green ideas** sleep furiously
 - (2) furiously sleep ideas green colorless
- Chomsky (1957):
 - . . . It is fair to assume that neither sentence (1) nor (2) (nor indeed any part of these sentences) has ever occurred in an English discourse. Hence, **in any statistical model for grammaticality**, these sentences will be ruled out on identical grounds as equally `remote' from English. Yet (1), though nonsensical, is grammatical, while (2) is not.
- Statistical Experiment (Pereira 2002)

Interesting things to Google™

- Examples:
 - (1) **colorless green ideas** sleep furiously
 - (2) furiously sleep ideas green colorless
- Statistical Experiment (Pereira 2002)

$$p(w_1 \cdots w_n) = p(w_1) \prod_{i=2}^n p(w_i | w_{i-1}) \quad .$$

Using this estimate for the probability of a string and an aggregate model with $C = 16$ trained on newspaper text using the expectation-maximization (EM) method (Dempster, Laird, & Rubin, 1977), we find that

$$\frac{p(\text{Colorless green ideas sleep furiously})}{p(\text{Furiously sleep ideas green colorless})} \approx 2 \times 10^5 \quad .$$

Thus, a suitably constrained statistical model, even a very simple one, can meet Chomsky's particular challenge.