

Computational Intelligence 696i

Language

Lecture 3

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Administriva

- Has every group managed to install PAPPI?
 - *(see instructions from last Thursday)*
 - **You'll need it to do homework 1**

Last Time

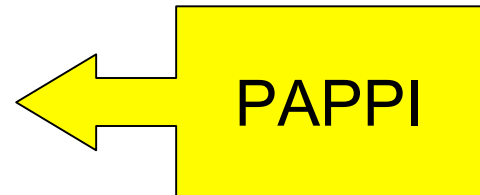
- we talked about the problem of gap filling, a necessary component in the recovery of meaning
- **Examples:**
 - Which report did you file without reading?
 - Which report did you file [the report] without [you] reading [the report]?
 - *Which book did you file the report without reading
 - These papers are easy to file without reading

Last Time

- speakers assume hearers share the same rules or decoding mechanisms
 - *allow gaps to exist in input*
- the gap decoding mechanism is pretty complicated
 - *more soon*
- poverty of stimulus: is it real?
 - if mechanism is really complicated
 - is the mechanism acquired (at all)?
 - is there enough data?
- the decoding mechanism
 - might be part of our genetic endowment
 - or a consequence of the pre-wiring
- possibly part of Universal Grammar (UG)
 - reduce the burden of the language learner

Today

- the very idea of UG is super-cool
 - very provocative hypothesis
 - all languages obey the same rules or have the same structure at some level of abstraction
- but attractive if true
 - e.g. *important consequences for machine translation*
- What might such a theory look like?
- Can it even be formalized?
- Can we compute with UG?
 - e.g. *use it to parse sentences*
- Given UG, can we come up with a mechanism for setting the parameters
 - *are the parameters learnable?*



Today's Lecture

- goal is to take a concrete look at one possible instantiation of UG
 - the principles-and-parameters (P&P) framework
 - **parameter**: language-specific {0,1}
 - e.g. determines things like word-order SVO, SOV, VSO etc.
 - **principle**: e.g. a constraint or architectural feature
 - a primitive of the UG
 - may be parameterized

aka

- **Government-Binding** (GB) Theory
 - best known instantiation being
 - *Lectures on Government and Binding* (Chomsky 1981)

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-specific rules to
- fundamental principles (the atoms of theory)
- explanatory adequacy

Rule-based systems

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

Rule-Based Approach

- to understand the totally revolutionary nature of the paradigm shift in linguistics that occurred around 1980
- we have to first look at pre-existing approaches
- **Examples:**
 - Which report did you file without reading?
 - Which report did you file [the report] without [you] reading [the report]?
 - *Which book did you file the report without reading
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Rule-Based Approach

- Gap filling:
 - Which report did you file without reading?
 - Which report did you file [the report] without [you] reading [the report]?
- Assume some phrase structure:
 - [_S subject [_{VP} V object]] for transitive V
- We have:
 - *wh*-phrase did [_S you [_{VP}[_{VP} file **e**][_{PP} without [_S **e** [_{VP} reading **e**]]]]]
- Construction-specific rule:
 - **if** [_S subject [_{VP}[_{VP} V **e-object**₁][_{PP} P [_S **e-subject** [_{VP} V+ing **e-object**₂]]]]]
 - **then** **e-subject** = subject, **e-object**₂ = **e-object**₁

Rule-Based Approach

- Construction-specific rule:
 - if [_S subject [_{VP}[_{VP} V e-object₁][_{PP} P [_S e-subject [_{VP} V+ing e-object₂]]]]]
 - then e-subject = subject, e-object₂ = e-object₁
- **Where does this rule come from?**
- **How does anyone manage to learn this rule?**
- **Can we generalize this rule to other examples?**
 - These papers are easy to file without reading
 - [_S e-subject [_{VP}[_{VP} file e-object₁][_{PP} without [_S e-subject [_{VP} reading e-object₂]]]]]
- Revised rule:
 - if [_S (e-)subject [_{VP}[_{VP} V e-object₁][_{PP} P [_S e-subject [_{VP} V+ing e-object₂]]]]]
 - then e-subject = (e-)subject, e-object₂ = e-object₁

Rule-Based Approach

- Revised rule:
 - **if** [_S (**e-**)subject [_{VP}[_{VP} V **e-object**₁][_{PP} P [_S **e-subject** [_{VP} V+ing **e-object**₂]]]]]
 - **then** **e-subject** = (**e-**)subject, **e-object**₂ = **e-object**₁
- BTW, **e-object**₂ has to be linked with an **e-object**₁ (*not an overt one*) on the basis of examples like:
 - ***you filed the report without reading**
 - (cf. you filed the report without reading *it*)
 - [_S you [_{VP}[_{VP} filed **the report**][_{PP} without [_S **e** [_{VP} reading **e**]]]]]
- Have to know:
 - **if** [_S subject [_{VP}[_{VP} V object][_{PP} P [_S **e-subject** [_{VP} V+ing **e-object**]]]]]
 - **then gap filling fails**

Rule-Based Approach

- Have to know:
 - if [_S subject [_{VP}[_{VP} V object][_{PP} P [_S e-subject [_{VP} V+ing e-object]]]]]
 - **then gap filling fails**
- Note:
 - *I'm using negative data to refine my rule*
- Also works for:
 - *Which book did you file the report without reading
 - [_S you [_{VP}[_{VP} filed **the report**][_{PP} without [_S e [_{VP} reading e]]]]]
- **Generalization (simplified):**
 - (final) e-object requires another e-object to be present
 - e-object is a *parasitic gap*

Rule-Based Approach

- Consider:
 - *Which book did you file the report without reading
- How to say it in English?
 - assuming underlying structure is
 - you filed the report without reading which book

Rule-Based Approach

- repeat process for all constructions in the language
- end up with a huge number of complex rules
- *(repeat for next language...)*
- (Some) linguists found such construction-specific “rule-based” systems unsatisfactory
 - too many rules
 - rules seem somewhat arbitrary (*rule systems too powerful*)
 - can’t possibly be learned (*maybe*)
 - lack of conceptual elegance
 - is there a better way?
 - can the apparent complexity be derived from more fundamental (and simpler) systems?

The “Rules”



Minimalist Program (MP)

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Principles-and-Parameters Framework (GB)

- reduction of construction-specific rules to
- fundamental principles (the atoms of theory)
- explanatory adequacy

Rule-based systems

- *construction-based*
- huge number of rules

Principles-and-Parameters

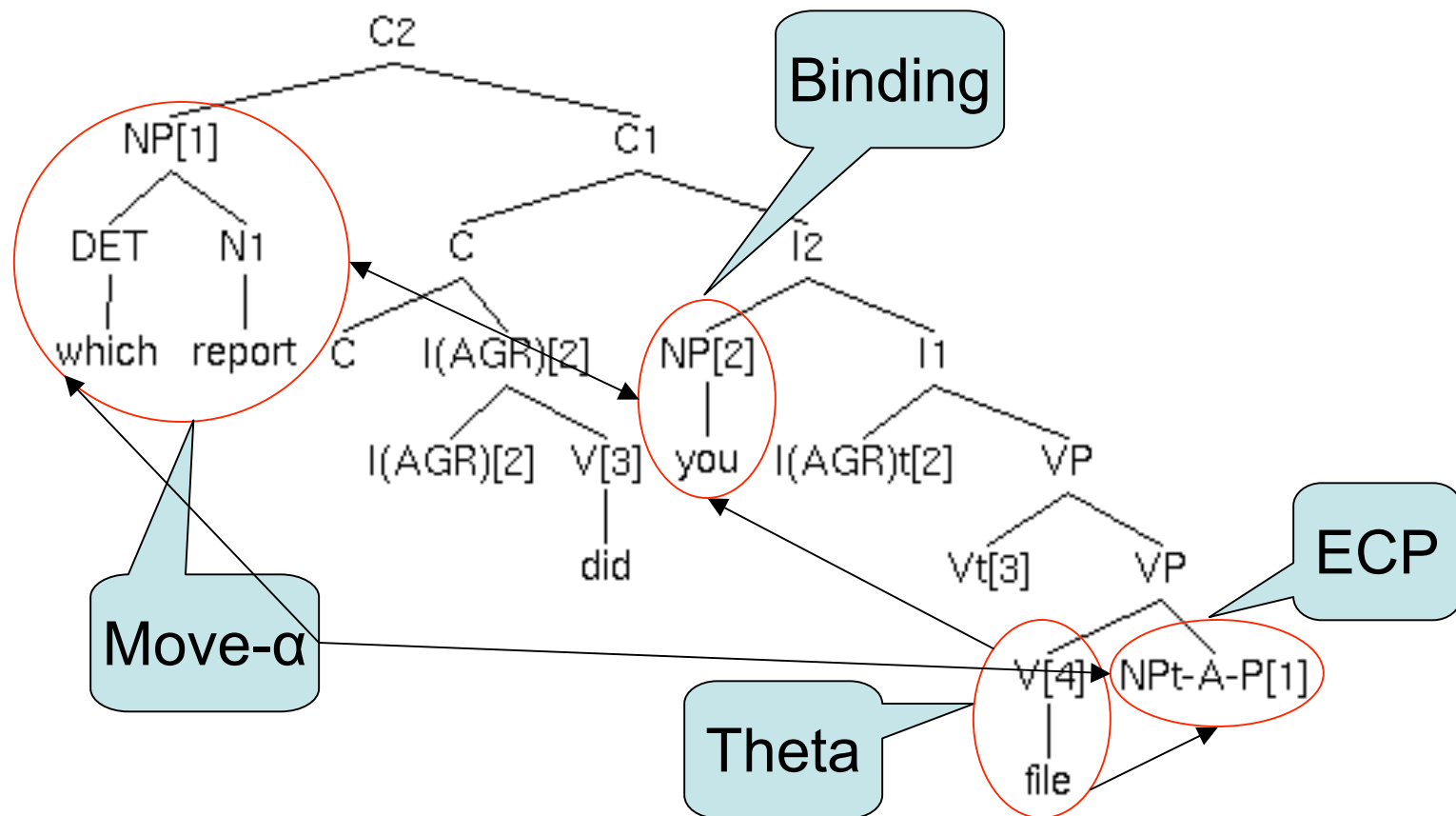
- No construction-specific pattern-matching rules
 - if [_S (e-)subject [_{VP}[_{VP} V e-object₁][_{PP} P [_S e-subject [_{VP} V+ing e-object₂]]]]]
 - then e-subject = (e-)subject, e-object₂ = e-object₁
- Not even generalizations like
 - (final) e-object requires another e-object to be present
- Won't find any principle in the system directly resembling these rules
- These are all lemmas (or generalizations) derivable from more primitive properties of grammar

Principles-and-Parameters

- can't explain all the details in a few lectures
- there are dozens of principles
- ... *give just a sketch of the general system*
- the P&P framework is a modular system
 - of simple sub-theories, i.e. modules
 - each module is responsible for constraining or licensing of some class of element(s), e.g. *e-elements*
 - these simple modules interact in complex ways to explain complex behavior

Principles-and-Parameters

which report did you file?



Principles-and-Parameters

- Some modules
 - **X-bar theory**
 - **universal phrase structure**
 - [X'' specifier [X' X complement]]
 - binary-branching only
 - X ranging over {N,V,A,P,I,C,neg *and a few others*}
 - order of specifier and complement vary for particular languages
 - **parameters**: head-complement order etc.

Principles-and-Parameters

- Some modules
 - **Move-alpha (Move- α)**
 - **universal displacement property**
 - what did John see
 - John see **what**
 - what did John see *trace*
 - **principle**: move any phrase anywhere
 - don't worry about cases where we can't displace a phrase (*other modules will take care of that*)
 - ***what** does Bill wonder who saw?
 - who did you mention that Bill believes that you saw?
 - ***who** did you mention Bill's belief that you saw?

Principles-and-Parameters

- Some modules
 - **Subjacency**
 - **locality of displacement: things can't move too far in one hop**
 - interaction with X-bar theory (*phrase structure*)
 - ***what does Bill wonder who saw?**
 - who did you mention that Bill believes that you saw?
 - ***who did you mention Bill's belief that you saw?**
 - **parameter:** bounding node IP (English), CP (Italian)

Principles-and-Parameters

- Some modules
 - **Theta theory**
 - **who did what to whom**
 - file: (filer,filed) read:(reader,read)
 - **theta-roles**: filer/reader => agent..
 - (patient, theme, experiencer)
 - **arguments**: *the report, you*
 - [V'' specifier [V' V complement]]
 - **principle**: theta-criterion
 - every arguments needs one theta-role
 - every theta-role needs to be expressed
 - don't worry about e-elements (*other modules' responsibility*)

Principles-and-Parameters

- Some modules
 - **Case Theory**
 - John is likely to be here
 - It is likely that John is here
 - *It is likely John to be here (cf. I believe John to be here)
 - **Empty Category Principle (ECP)**
 - *subject/object asymmetry for e-elements*
 - who do you think (that) John saw?
 - who do you think saw John?
 - *who do you think that saw John?
 - **Binding Theory** (*anaphors and pronouns*)
 - *interaction of displacement and binding theory*
 - who that John knows does he like? (*ambiguous*)
 - He likes everyone that John knows (*not ambiguous*)

House of Cards Analogy



- a system of modules
 - *delicate*
 - *hard to build*
 - rely on each other
 - interact in complex ways
- independent justification
 - principles affect many different kinds of constructions
 - theoretically more satisfying