Phonological Theories

Optimality Theory

Session 7

Grammar as an Input-Output Mechanism

- A (partial) grammar in the generative tradition formally captures the observable *output* in its relation to (an assumed) *input*.
- The assumption is that not all observable forms (surface forms) are a direct reflection of the input (underlying forms)
- In German, all coda obstruents a voiceless even if the word is related to a morpheme that otherwise has a voiced obstruent:
  Input: (German /baːd/) = /baːt/
- In English (or Russian, or Bulgarian) vowels change their quality (are reduced) if the syllable they bear is unstressed:
  Input: (English /pɒlɪtɪkæl/) = /pəˈlɪtɪkəl/
  Input: (Belorussian /kola/) = /kaˈla/

OT – SPE

- The wish to capture the Input - Output relations is part of *all* generative grammars.
- The differences lie in the assumptions about how the Output is determined.
- In classical (linear) Generative Phonology the Output is *derived* from the Input by applying an *ordered set of rules*.
- Optimality theory expresses the Output as the result of an *ordered set of constraints* which only allow certain forms to exist on the surface.
- This way of looking at it stresses the parallels between the two approaches. Accounts of OT tend to stress the differences.

What's special about OT?

- The goal of Optimality Theory is to present *Universal Constraints* (i.e. they operate in *all* languages; there are *no* language-specific constraints).
- All constraints are essentially "*violable*" (= they can be "ignored")
- These should explain both *language-specific* observations *and differences* between (a) speaking styles, (b) dialects, (c) different languages.
- A *different set* of constraints may apply in different languages (but they are all selected from the same pool of universal constraints).
- The same constraints may apply *in a different order* (thus changing the Output that appears on the surface).
- The Input is (of course?) different from one language to another (because the *underlying forms of the lexicon* comprise the Input)

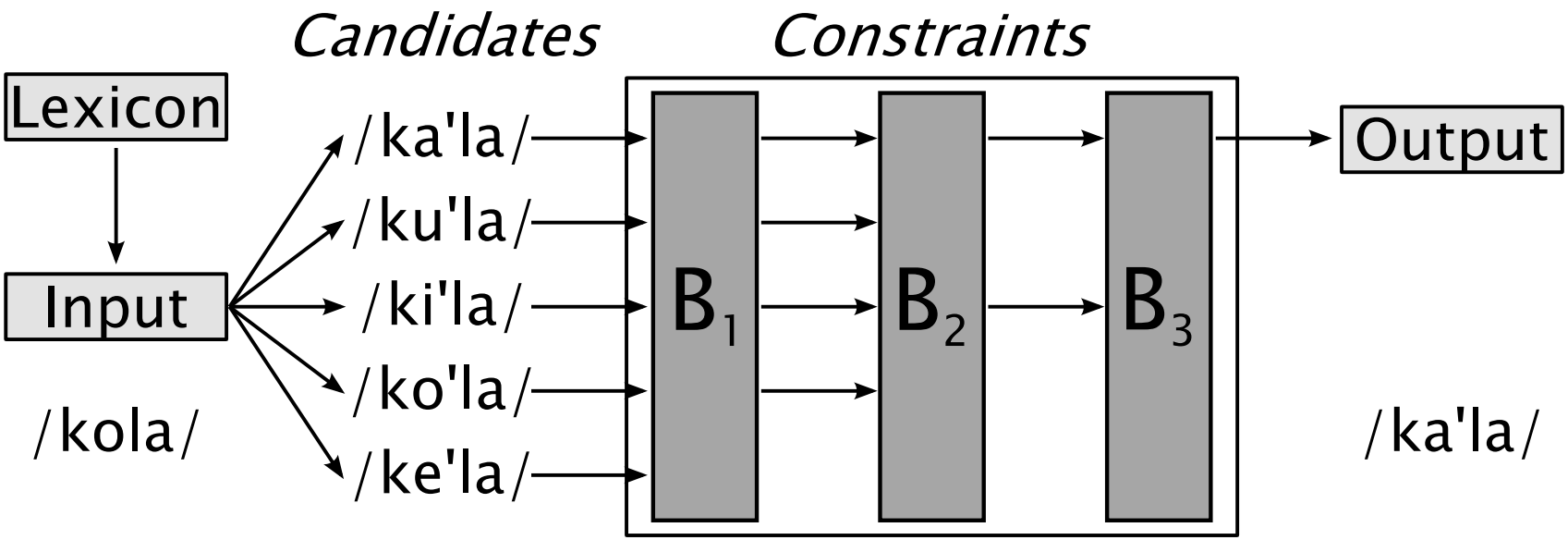
Components of an OT grammar (1)

- *Input* (Lexicon):
  The lexicon contains the lexical representations (underlying forms) of the morphemes and supplies the Input for the *Generator*. (the phonological form of the morphemes is language-specific)
- *Generator*:
  The Generator produces a potentially infinite number of Output candidates: Gen(Input) $\Rightarrow \{K_1, K_2, K_3, \ldots, K_n\}$ and passes them to the *Evaluator*.
- *Evaluator*:
  The Evaluator consists of a set of ordered *Constraints*: $\{B_1 \gg B_2 \gg \ldots B_n\}$ and evaluates the Output candidates with regard to their "harmony values" (the degree to which they comply with the constraints). It selects the optimal candidate. The selection ist unique:, there is one optimal candidate as Output: Eval($\{K_1, K_2, K_3, \ldots, K_n\}$) $\Rightarrow$ Output.

Components of an OT grammar (2)

- *Output*:
  If two candidates *both* comply with several constraints, there must be further (lower-order) constraints which differentiate between the two and select *one* candidate.
- If *two* candidates cannot be differentiated, they are identical.

The Architecture of Optimality Theory



OT-Representations (Tableaux)

/Y/	A	B	C
x	*		*
y		*	
☞ z			*

- Top left corner Underlying Representation;
- Candidates generated by Gen (x, y, z) – one per line;
- Columns indicate the order of dominance (relative strength) of the constraints (A, B, C);
- Solid lines indicate a hierarchy; dashed lines idicate equal rank;
- Constraint satisfaction is signalled by an empty cell;
- Asterisk indicates constrain violation;
- Exclamation mark ! (or *) signifies a fatal violation (non-optimality);
- Grey shading = irrelevant; ☞ shows the optimal candidate.

Basic OT concepts

- Constraints
- Conflict
- Dominance
- Optimality

Constraints

- A Constraint is a structural condition, which can either be *satisfied* by an Output-Form or it can be *violated*.
- There are three types of constraints:
  - *Faithfulness* constraints
  - *Markedness* constraints
  - *Alignment* constraints

Markedness Constraints

- *Markedness constraints* require the Output Form to fulfill certain well-formedness criteria. These may be *positively* or *negatively* formulated, so we distinguish between:
- *Negative constraints*
  - Vowels are not nasalized (*VNASAL)
  - Syllables have no coda (NOCODA or *CODA)
  - Coda obstruents are not voiced (*VOICECODA)
- *Positive constraints*
  - Sonorant must be voiced (SONVOICE)
  - Syllables must have an onset (ONSET)
  - Syllables must have a peak (PEAK)

Faithfulness Constraints

- In contrast to Markedness-Constraints, which only refer to the Output Form, Faithfulness Constraints require the OutputForms to retain the properties of the Input (the underlying lexical form). In the ideal case, the Output is identical to the Input.
  - In the Output all segments of the Input must be preserved (no elision)
  - The Output must preserve the linear sequence of all Input segments (no metathesis)
  - Output segments must have a corresondence in the Input (no epenthesis)
  - Output segments und Input segments must have identical feature values (IDENT-IO$_{feature}$ or PRESERVE-IO$_{feature}$).

Alignment Constraints

- Alignment constraints create connections between different forms:
  - Example:
    A-$R_{stem\text{-}\sigma}$ = All stems end at the right-hand edge of a syllable.
    Cf. Liaison in French (as a violation):
    “on est au salon” [õ.nɛ.to.salõ]

Optimality: Dominance and Conflict

- *Optimality*:
  An Output is optimal when it best fulfils the hierarchically ordered set of constraints, i.e. when it has the least serious violations.
- *Conflict*:
  Constraints compete with one another. In particular, there is a fundamental conflict between Markedness constraints and Faithfulness constraints.
- *Dominance*:
  The higher-ranking of two conflicting constraints "dominates" the lower-ranking one.

Constraint Interaction: an example from Belorussian

- Goal: *No mid vowels in unstressed syllables!*
- *Markedness* constraint:
  LIC-MID/STRESS:
  Mid vowels are only allowed when they are stressed.
- The following *Faithfulness* constraint conflicts with it:
  IDENT-IO[low] *or* PRESERVE[low]:
  The specification of the feature [low] for an Input segment must be preserved in the corresponding Output segment.
  IDENT-IO[high] *or* PRESERVE[high]:
  The specification of the feature [high] for an Input segment must be preserved in the corresponding Output segment.
- These two constraint (types) are in conflict with each other.

Constraint Interaction

- The underlying lexical form (Input) is /kola/
- The Generator produces the candidates [kola], [kala], [kila], [kula], [kela].
- *Constraint ranking*:
  In Belorussian the feature [low] replaces [mid], so as to avoid mid vowels. Therefore Belorussian will tolerate the violation of PRESERVE[low]. However, LIC-MID/STRESS and PRESERVE[high] will never be violated. Therefore the ranking is:

$$\text{LIC-MID/STRESS} \gg \text{PRESERVE[high]} \gg \text{PRESERVE[low]}$$

Vowel Reduction - Belorussian

The Constraint Tableau:

/kola/	LIC–MID/STRESS	PRESERVE[high]	PRESERVE[low]
☞ [kaˈla]			*
[kuˈla]		*!	
[kiˈla]		*!	
[koˈla]	*!		
[keˈla]	*!		

Factorial Typology: a non-linguistic Example

Let us assume the following Universal Constraints:

CAT = “Keep the cat in.”
WINDOW = “Keep the window open.”
DOOR = “Keep the door open.”

	Possible constraint ordering:	*Results of each order:*
1.	CAT ≫ WINDOW ≫ DOOR	Cat inside; window and door closed.
2.	CAT ≫ DOOR ≫ WINDOW	Cat inside; window and door closed.
3.	WINDOW ≫ CAT ≫ DOOR	Cat outside; window open, door closed.
4.	WINDOW ≫ DOOR ≫ CAT	Cat outside; window and door open.
5.	DOOR ≫ CAT ≫ WINDOW	Cat outside; door open, window closed.
6.	DOOR ≫ WINDOW ≫ CAT	Cat outside; door and window open.

Factorial Typology: a commentary

- (factorial 3) $3! = 6$ i.e., there are 6 possible Grammars.
- *But Grammars 1 and 2 generate the same Output; Grammars 4 and 6 also.*
- How many Output conditions are there?
- Is the ordering of DOOR and WINDOW important?

Factorial Typology: an exercise (1)

- *Create a factorial typology.*
- A 5-Vowel System with vowel reduction is assumed.
- 3 constraints:
  - LIC-MID/STRESS
  - PRESERVE[low]
  - PRESERVE[high]

  = 6 possible orderings.

Factorial Typology: an exercise (2)

LIC-MID/STRESS ≫ PRESERVE[Low] ≫ PRESERVE[High]
LIC-MID/STRESS ≫ PRESERVE[High] ≫ PRESERVE[Low] = *Belorussian*
PRESERVE[Low] ≫ PRESERVE[High] ≫ LIC-MID/STRESS
PRESERVE[High] ≫ PRESERVE[Low] ≫ LIC-MID/STRESS
PRESERVE[Low] ≫ LIC-MID/STRESS ≫ PRESERVE[High]
PRESERVE[High] ≫ LIC-MID/STRESS ≫ PRESERVE[Low] = *Belorussian*

The Constraint Tableau:

/kola/	LIC–MID/STRESS	PRESERVE[high]	PRESERVE[low]
☞ [kaˈla]			*
[kuˈla]		*!	
[kiˈla]		*!	
[koˈla]	*!		
[keˈla]	*!		

Factorial Typology: an exercise (3)

/kola/	LIC–MID/STRESS	PRESERVE[low]	PRESERVE[high]	PRESERVE[rnd]
[kaˈla]		*!		*
☞ [kuˈla]			*	
[kiˈla]			*	*!
[koˈla]	*!			
[keˈla]	*!			*

- This grammar provides for the raising of unstressed mid vowels.
- An unstressed /e/ is reduced to [i] ([kila]): PRESERVE[Front].
- This reduction pattern occurs in Luiseño: /e/ > [i], /o/ > [u].
- The same pattern can be arrived at with the hierarchy:

PRESERVE[Low] ≫ LIC-MID/STRESS ≫ PRESERVE[High]

Factorial Typology: an exercise (4)

/kola/	PRESERVE[low]	PRESERVE[high]	LIC–MID/STRESS
[kaˈla]	*!		
[kuˈla]		*!	
[kiˈla]		*!	
☞ [koˈla]			*
☞ [keˈla]			*

- This grammar doesn't allow reduction of unstressed mid vowels
- This reduction pattern can be observed in many languages: e.g. Spanish, Polish
- The same pattern results from the hierarchy:

PRESERVE[High] ≫ PRESERVE[Low] ≫ LIC-MID/STRESS

Constraint Interaction (1)

- E.g.: *Final devoicing in German*
- Obstruents in the coda are voiceless: /hant/ ‘Hand’ vs. /hɛndə/ ‘Hände’
- The underlying lexical Form is /hand/
- The following constraint is assumed:
  *VOICED-CODA = Obstruents in the coda cannot be voiced.
- The following Faithfulness constraint conflicts with it:
  IDENT-IO[vce] = The Specification of the feature [voice] in the Input segment must be retained in the corresponding Output segment

Constraint Interaction (2)

- The Generator generates the candidates [hand] and [hant] (as well as many others such as: [han], [hɛnd], etc.)
  We restrict ourselves to the first two:
  [hand] conforms to IDENT-IO[vce], but violates *VOICED-CODA
  [hant] violates IDENT-IO[vce], but conforms to *VOICED-CODA
- We get the optimal form [hant] if we assume the following hierarchy of constraints:

$$\text{*VOICED-CODA} \gg \text{IDENT-IO[vce]}$$

- In English the hierarchy has to be reversed:

$$\text{IDENT-IO[vce]} \gg \text{*VOICED-CODA}$$

“Auslautverhärtung” German

/hand/	*VOICED–CODA	IDENT–IO[vce]
[hand]	*!	
☞ [hant]		*

Alternative: English

/hand/	IDENT–IO[vce]	*VOICED–CODA
☞ [hand]		*
[hant]	*!	

What about the following?

German
Direktor
Doktor
Reaktor

Italian
Direttore
Dottore
Reattore

What constraints in what order can explain these two different Outputs in the two languages?

And another comparison?

English

/fɪˈlɒsəfə/ – /fɪləˈsɒfɪkəl/
/ˈskɒlə/ – /skəˈlæstɪk/
/ˈmærɪnə/ – /məˈriːnə/
/ˈærɪd/ – /əˈrɪdɪti/
/ˈsiːkwəns/ – /sɪˈkwɛnʃəl/
/ˈiːkwəl/ – /ɪˈkwɒlɪti/
/ˈfəʊtəˌgrɑːf/ – /fəˈtɒgrəfə/

German

/filoˈsoːf/ – /filosoˈfiː/
/mediˈtsiːn/ – /meditsiˈnaːl/
/fotoˈgraːf/ – /fotograˈfiː/
/ˈmaːgiər/ – /maˈgiː/
/ˈhabitʊs/ – /habiˈtaːt/
/ˈloːgɪʃ/ – /loˈgɪsmʊs/

What constraints in what order can explain these two different Outputs in the two languages? Think of the effect of stress on vowel quality in Belorussian.