On the Importance of Errors:
Competence and Performance in Optimality Theory

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Overview

- *Competence* vs. *performance*
- Adequacy of a performance model
- Performance models for Optimality Theory
- The *dis*-harmonic mind?
- Performance errors, irregularities and learning

Competence vs. *performance*

Noam Chomsky:

"Linguistic theory is concerned primarily with an ideal speaker-listener, in a completely homogeneous speech-community, who knows its language perfectly and is unaffected by such grammatically irrelevant conditions as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language in actual performance. ... We thus make a fundamental distinction between *competence* (the speaker-hearer's knowledge of his language) and *performance* (the actual use of language in concrete situations)."
(Chomsky: *Aspects*, 1965, pp. 3-4)

Competence vs. *performance*

So, language production varies due to (among others)

- memory limitations,
- distractions, shifts of attention and interest,
- and errors (random or characteristic)

This observation is not about linguistic *competence*, but
who would deal with it, if not a linguist???

NB: phenomena often influenced by linguistic factors.

Competence vs. *performance*

Paul Smolensky:

"... *competence* can be understood as an idealization of actual behavior—*performance*—in which we have removed the effects of limitations on computational resources: generally speaking, space, time, and precision." (Smolensky et al.: *The Harmonic Mind*, 2006, vol. 1, p. 228.)

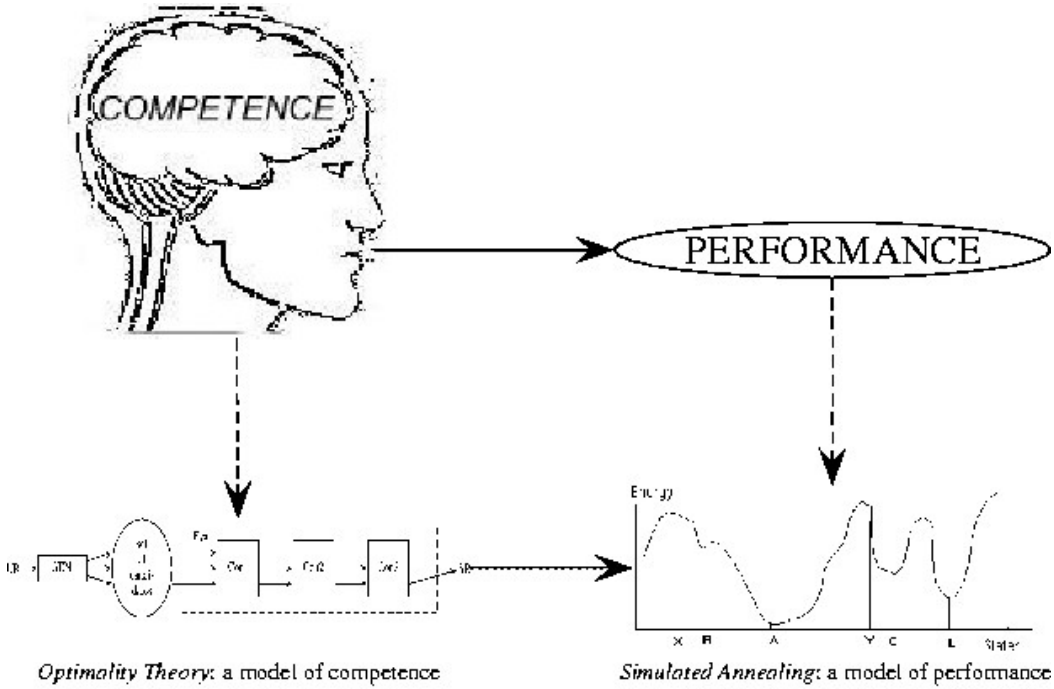
Competence = grammar: is a *function*

$$input \mapsto correct\ output/parse/struct.\ description$$

Performance: *algorithm* that finds it. Or doesn't.

Competence: performance run infinitely slowly.

Competence vs. *performance*



Optimality Theory: a model of competence

Simulated Annealing: a model of performance

Bíró (2006): Finding the Right Words, p. 44.

Competence vs. *performance*

Level	its product	its model	the product in the model
Competence in narrow sense: static knowledge of the language	grammatical form	standard OT grammar	globally optimal candidate
Dynamic language production process	acceptable or attested forms	SA-OT algorithm	local optima
Performance in its outmost sense + outside world	acoustic signal, information, message, etc.	phonetics, pragmatics, socioling., biology psychology	??

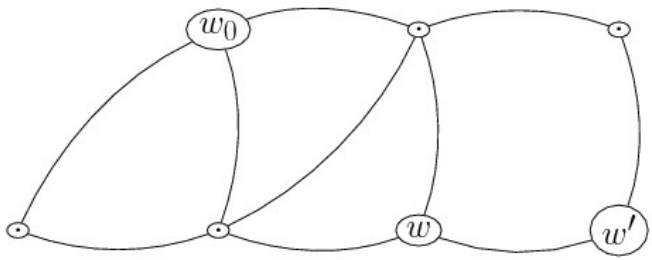
Adequacy of a performance model

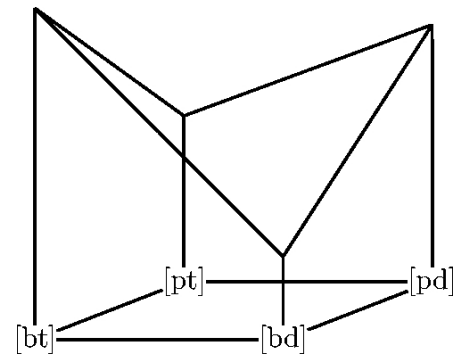
Performance model: an algorithm that realizes (implements) the grammar ($i.e.$, the model of competence), which

- usually finds the form grammatical w.r.t. grammar,
- but also makes the same errors as humans do,
- with a similar frequency
- under various conditions (speech rate, style, etc.).

Moreover, *runtime* and *complexity* of algorithm is plausible.

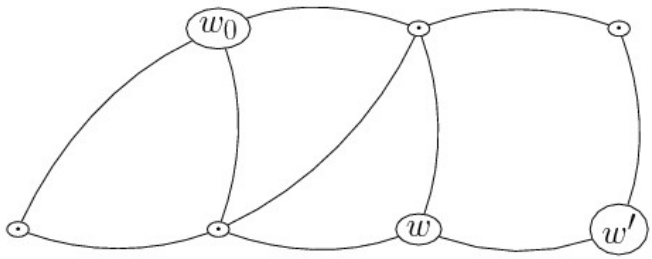
Performance models (simulated annealing) for OT

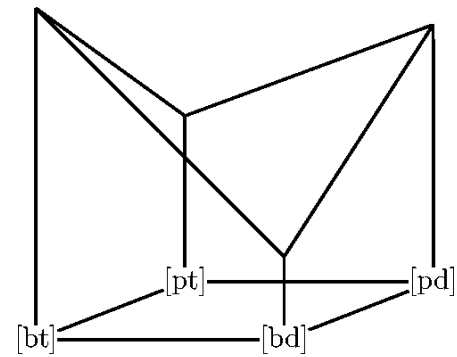




- Goal: to find the (globally) optimal candidate.
- Add a *neighbourhood structure* on the candidate set.
- Landscape's vertical dimension = harmony.
- Neighbourhood structure → local optima.

Performance models (simulated annealing) for OT





- Random walk. If neighbour more optimal: move. If less optimal: move early in the algorithm, don't move later.
- System can get stuck in local optima: errors produced.
- Precision of the algorithm depends on its speed (!!).

Example: Fast speech: Dutch metrical stress

fo.to.toe.stel 'camera'	*uit.ge.ve.rij* 'publisher'	*stu.die.toe.la.ge* 'study grant'	*per.fec.tio.nist* 'perfectionist'
susu	ssus	susuu	usus
fó.to.tòe.stel fast: *0.82* slow: *1.00*	*ùit.gè.ve.ríj* fast: *0.65* / **0.67** slow: *0.97* / **0.96**	*stú.die.tòe.la.ge* fast: *0.55* / **0.38** slow: *0.96* / **0.81**	*per.fèc.tio.níst* fast: *0.49* / **0.13** slow: *0.91* / **0.20**
fó.to.toe.stèl fast: *0.18* slow: *0.00*	*ùit.ge.ve.ríj* fast: *0.35* / **0.33** slow: *0.03* / **0.04**	*stú.die.toe.là.ge* fast: *0.45* / **0.62** slow: *0.04* / **0.19**	*pèr.fec.tio.níst* fast: *0.39* / **0.87** slow: *0.07* / **0.80**

Simulated / **observed** (Schreuder) frequencies.

In the simulations, $T_{step} = 3$ used for fast speech and $T_{step} = 0.1$ for slow speech.

The *dis*-harmonic mind?

ICS (Integrated Connectionist/Symbolic Cognitive Architecture):

> "[T]here is no symbolic algorithm whose internal structure can predict the time and the accuracy of processing; this can only be done with connectionist algorithms" (Smolensky and Legendre (2006): *The Harmonic Mind*, vol. 1, p. 91).

Simulated Annealing for Optimality Theory (Bíró 2006):

- symbolic computation only
- predicts time and accuracy of processing

Errors and irregularities

ICS (Smolensky & Legendre 2006), SA-OT (Bíró 2006): both implement Optimality Theory with *simulated annealing*.

Consequences:

- *Performance errors*: frequency diminishes at slow (careful) production (as in traditional simulated annealing).
- *Irregularities*: frequency does not diminish at slow (careful) production (due to *strict domination*).

Not all forms in a language need be analyzed as grammatical!

Consequences for language acquisition

Child is exposed to teacher's *performance distribution* (derived from teacher's competence + production mechanism):

- Grammatical forms, performance errors and irregular forms
- produced with different frequencies
- under various circumstances (time pressure, stylistic and sociolinguistic variations, etc.—parameters of SA-OT)

Can she reproduce the teacher's underlying *competence*?

Conclusions

- Performance (language production) as the implementation of the grammar.
- E.g.: competence = OT, performance = SA-OT or ICS.
- Errors and irregularities
  - asses the descriptive adequacy of the combined competence + performance model
  - consequences to language learning/acquisition, and evolution

Thank you for your attention!

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