Optimality Theory as a general cognitive architecture

Tamás Biró (t.s.biro@uva.nl)
Amsterdam Center for Language and Cognition,
Universiteit van Amsterdam
Spuistraat 210, 1012 VT, Amsterdam, Netherlands

Judit Gervain (judit.gervain@parisdescartes.fr)
Laboratoire Psychologie de la Perception
UMR 8158 CNRS-Paris Descartes
45 rue des Saints-Pères, Paris, 75006, France

Keywords: Optimality Theory; Harmony Grammar; cognitive
architectures; connectionism; symbolic approaches.

Optimality Theory and cognitive science

It was exactly 25 years ago that Paul Smolensky introduced
Harmony Theory (Smolensky, 1986), a framework that would
pursue an exciting, but certainly not straight path through lin-
guistics (namely, *Optimality Theory*) and other cognitive do-
mains. The goal of this workshop is not so much to look back
to this path, but rather to discuss its potential continuation(s).

Soon after its publication, *Optimality Theory* (OT) (Prince
& Smolensky, 1993/2004) became one of the most suc-
cessful frameworks for linguistic research. The number of
publications submitted to the *Rutgers Optimality Archive*
(at http://roa.rutgers.edu) exceeded one thousand in
November 2008, with a large number of OT-related publica-
tions never added to ROA. The older sister of OT, *Harmony
Grammar* (HG) (Smolensky, 1986) has also been the object
of a recent raise in interest, especially since the publication of
The Harmonic Mind (Smolensky & Legendre, 2006). Their
key idea is that the linguistic mapping between form and
meaning, or between underlying form and surface form, is
realized by optimizing an abstract function: a real-valued one
in HG, and a vector-valued one in OT.

By developing the *Integrated Connectionist/Symbolic
(ICS) Cognitive Architecture*, Smolensky and his colleagues
worked out the connection between linguistics and a gen-
eral theory of the mind/brain in a hardly precedented manner.
Their approach is probably significantly closer to mainstream
computational cognitive science than much of contemporary
theoretical linguistics. General-purpose cognitive architec-
tures (ACT-R) have also been combined with OT (Misker &
Anderson, 2003; Rij, Rijn, & Hendriks, 2010). Learnability
is addressed by, among others, Tesar, Boersma and Magri.

The authors of the *The Harmonic Mind* alluded to the pos-
sibility that ICS—that is, Optimality Theory and Harmony
Grammar—may prove a useful and adequate model of much
of (higher) cognition, including domains beyond language.
Simultaneously, and probably independently of their remark,
simply as a consequence of OT's success in linguistics, a
number of scholars have advanced Optimality Theoretic mod-
els for non-linguistic phenomena. The authors of these iso-
lated attempts usually even did not know of each other.

Constraints applied to traffic rules (Boersma, 1998, 2003)
and to a Talmudic dilemma (Dresher, 1996) aim only at illus-
trating the OT formalism. Parker and Parker (2004) present
an analysis of ethical *decision making* in a religious context,
which is clearly a first step toward an OT-style account of a
non-linguistic cognitive function, despite potential criticism
related to the cognitive grounding of their constraints. Al-
though not elaborating on the connection with Optimality
Theory, the "take the best" heuristics of the *ABC Research
Group* can also be seen as an OT/HG-style approach to higher
cognition (Gigerenzer, Todd, & the ABC Research Group,
1999). (Compare the *lexicographic decision rule* of Coenen
and Marewski (2009) to strict domination in OT; see the dis-
cussions about the relation between OT and the ABC Re-
search Group's heuristics by Smolensky and Legendre (2006,
vol. 1, p. 41-42) and Bíró (2006, p. 225f).)

Even more explicit is the wish to view OT as a general
cognitive framework for (higher) cognition in the work of
Douglas Jones on kinship terminology, as well as of Tamás
Biró on religious rituals. Jones (2003, 2010) developed an
Optimality Theoretic model for one of the classic topics in
cultural anthropology, the cross-cultural typology of kinship
systems. Beside the connection to cognition in general, he
also embedded his analysis in an evolutionary psychological
account. His most recent article in BBS generated a vivid dis-
cussion on the applicability of OT beyond linguistics among
the authors of the numerous peer-reviews. Biró (in press) has
employed Optimality Theory to account for food taboos and
the dynamics of different types of rituals. By the latter, he
attempted computationally to underpin current theories in the
cognitive science of religion.

Goals of the workshop

Our goals are twofold: first, to offer a meeting point to those
applying OT (or HG) to non-linguistic domains, to increase
the visibility of such attempts and to promote future efforts in
this direction; and second, together with linguistic OT'ers, to
discuss the place of OT, HG and ICS within the cognitive sci-
ences. Collocating the workshop with CogSci offers the pos-
sibility to non-OT'ers to join the discussion, and for OT'ers
to get feedback and constructive criticism from external eyes.

By developing OT/HG-style analyses for a growing num-
ber of phenomena from various domains of (higher) cogni-

tion, we obtain descriptions of many functions of the human mind within a uniform paradigm, employing a shared language and shared standards. We also may get closer to understanding how these domains are processed in the human brain, by translating symbols to connections using either Smolensky's ICS, or future alternatives to it.

We see a distinction between OT/HG-style models, on the one hand, and *utility function*-based models, on the other. A huge body of literature describe phenomena by optimizing a utility-like function external to the brain (for instance, energy needed to move one's arm during action planning), or even external to the human (for instance, monetary gain/loss). Unlike these approaches, an OT/HG-style model optimizes an abstract target function, a theoretical construct (which may or may not correspond to energy level of the network in the brain). A workshop at CogSci is a unique opportunity for those involved in the two research lines running in parallel to engage in a cross-fertilizing discourse.

We seek papers describing new results and addressing, primarily, though not exclusively, the following issues:

- Optimality Theory and Harmony Grammar as general frameworks of (higher) cognition.

- OT/HG-style analyses of phenomena belonging to (primarily, non-linguistic) domains that have not yet employed OT.

- The connection of linguistic OT/HG to the study of other (higher) cognitive functions.

- OT *vs.* HG, from theoretical-mathematical and cognitive-neuroscientific perspectives.

- OT/HG-style formalisms *vs.* utility function-based approaches from a mathematical-computational perspective; their place in explaining the brain/mind.

- Relating connectionist and symbolic approaches: the ICS Architecture and its eventual alternatives.

- Ontogenetic aspects of OT/HG approaches (learnability).

- Phylogenetic aspects of OT/HG approaches (including historical change, evolutionary models, etc.).

Format of the full-day workshop

The full-day workshop will consist of talks (and eventually of a poster session), with ample time for discussion. Abstracts will have been solicited from researchers known to be interested in OT, and readers of emailing lists in linguistics and the cognitive sciences. We aim at publishing (a selection of) the papers as a volume or special issue following the conference.

Paul Smolensky has accepted our invitation to feature as keynote speaker. The following people have expressed their interest in participation: Petra Hendriks (Groningen U.), Lotte Hogeweg (RU Nijmegen), Giorgio Magri (Institut Jean Nicod, Paris), and Paul Miers (Towson U.).

The likely audience include those working on linguistics and higher cognition, and on mathematical-computational models thereof. Estimated number of participants: 20-30.

Organizers of the Workshop

Tamás Bíró is currently a postdoc at the *Amsterdam Center for Language and Communication*, working on the *Simulated Annealing for Optimality Theory Algorithm* (Bíró, 2006). Judit Gervain is a CNRS researcher at the *Laboratoire Psychologie de la Perception* in Paris, working on neurlinguistic aspects of syntax and its early acquisition. The two organizers have previous experience in organizing workshops together.

References

Bíró, T. (2006). *Finding the right words*. Unpublished doctoral dissertation, University of Groningen. (ROA-896)

Biró, T. (in press). Optimal religion: OT accounts for ritual dynamics. In I. Czachesz & T. Bíró (Eds.), *Changing minds: Religion and cognition through the ages.* Peeters.

Boersma, P. (1998). *Functional phonology* (Vol. 11). The Hague: Holland Academic Graphics.

Boersma, P. (2003). Review of *B. Tesar* & *P. Smolensky* (2000): Learnability in OT. *Phonology*, *20*, 436–446.

Coenen, A., & Marewski, J. N. (2009). Predicting moral judgments of corporate responsibility with formal decision heuristics. In N. Taatgen & H. van Rijn (Eds.), *Proc. 31st annual conference of CSS* (pp. 1524–1528). Austin, TX.

Dresher, E. (1996). The rise of optimality theory in first century Palestine. *GLOT Intern.*, *2*. Available from `http://homes.chass.utoronto.ca/~dresher/col6.html`

Gigerenzer, G., Todd, P. M., & the ABC Research Group. (1999). *Simple heuristics that make us smart*. Oxford: Oxford University Press.

Jones, D. (2003). The generative psychology of kinship. Part 2. Generating variation from universal building blocks with OT. *Evolution and Human Behavior*, *24*, 320-350.

Jones, D. (2010). Human kinship, from conceptual structure to grammar. *Behavioral and Brain Sciences*, *33*, 367–416.

Misker, J. M., & Anderson, J. R. (2003). Combining Optimality Theory and a cognitive architecture. In F. Detje et al. (Ed.), *Proc. 5th International Conf. on Cognitive Modeling* (Vol. 5, p. 171-176). Universitäts-Verlag Bamberg.

Parker, S., & Parker, M. (2004). Optimality Theory and ethical decision making. *Work Papers SIL*. Available from `http://www.und.edu/dept/linguistics/wp/2004ParkerParker.PDF`.

Prince, A., & Smolensky, P. (1993/2004). *Optimality Theory: Constraint interaction in Generative Grammar*. Malden: Blackwell. Originally RuCCS-TR-2.

Rij, J. van, Rijn, H. van, & Hendriks, P. (2010). Cognitive architectures and language comprehension. *Journal of Child Language*, *37*(3), 731–766.

Smolensky, P. (1986). Information processing in dynamical systems: Foundations of Harmony Theory. In *Rumelhart et al.: Parallel distributed processing* (Vol. 1, p. 194-281). Cambridge, MA, London, England: Bradford, MIT Press.

Smolensky, P., & Legendre, G. (2006). *The Harmonic Mind: From neural computation to Optimality-Theoretic grammar*. Cambridge, MA – London, UK: MIT Press.