Statistical & Cognitive Modeling for Formal Semantics

Instructor: Adrian Brasoveanu, abrsvn@ucsc.edu

Winter 2012

1 Organizational matters

- Class: TuTh 4:00PM–5:45PM, Steven Lib 102
- Office hours: Th 12:30PM–1:30PM and by email appointment (abrsvn@ucsc.edu), Stevenson 259

Web access

- There is an eCommons site for this course: https://ecommons.ucsc.edu/xsl-portal; check fairly regularly for announcements and / or new materials.
- The syllabus, readings, handouts etc. are / will be posted under Resources.

Important note

If you qualify for classroom accommodations because of a disability, please get an Accommodation Authorization from the Disability Resource Center (DRC) and submit it to me in person outside of class (e.g., office hours) as soon as possible. Contact DRC at 459-2089 (voice), 459-4806 (TTY), or http://drc.ucsc.edu for more information on the requirements and / or process.

2 Outline of the broader research program

Capturing the particular ways in which natural language interpretation proceeds is usually taken to involve rich abstract representations and fairly complex operations over such representations. Under this view, two general goals of formal semantics are to

(i) identify patterns of interpretation that seem to involve such abstract (non-overt / latent) representations and operations and

(ii) design logical systems in which the 'right' range of representations and operators can be defined and in which these representations and operators interact in the 'right' way.

At the same time, providing solid empirical foundations for increasingly sophisticated formal semantic theories requires increasingly sophisticated methods of empirical investigation and statistical analysis of the resulting data.

In addition, semantic theories should be complemented and further constrained by cognitive theories of

(i) how such structured, abstract and compositionally assembled representations and operations can be learned / induced from 'raw' observed data and

(ii) the kinds of mechanisms that underlie the processing of such representations and operations in actual natural language usage.

The seminar will focus on establishing and solidifying multiple connections between detailed, formally sophisticated semantic theories (of quantifier scope, interpretation of indefinites etc.) and modern Bayesian methods of data analysis, as well as cognitive models (based on Bayesian ideas) of learning abstract, highly structured representations of the kind deployed in formal semantics.

3 Schedule (subject to change)

3.1 Intro to Statistical & Cognitive Modeling (Week 1)

1. Lewandowsky & Farrell (2011), Chapter 1
2. Lee (2011)
3. [fyi only] Lewandowsky & Farrell (2011), Chapter 7

3.2 Intro to Bayesian Data Analysis (Weeks 1-4)

We will work our way through a series of R scripts. The scripts are / will be posted on the eCommons page for the course. It is highly recommended that you also work through those scripts on your own (R and WinBUGS / JAGS required).
Required background readings:

1. Kruschke (2011), Chapters 2-9
2. [optional] Lee & Wagenmakers (in prep.), Chapters 3-9

3.3 Quantifier Scope, Indefinites and Sentence-internal Readings (Weeks 4-8)

1. Brasoveanu (2012)
2. Tunstall (1998), Chapters 3 and 5
3. Anderson (2004), Chapter 2
4. Brasoveanu & Farkas (2011), Sections 2-4
5. Brasoveanu (2011), Sections 2-5
6. Dotlačil (2010), Chapters 2 and 5

3.4 Bayesian Cognitive Modeling for Formal Semantics: Learning the Meaning of Number Words and Quantifiers (Weeks 8-10)

1. [optional] Carey (2004)
2. Lee & Wagenmakers (in prep.), Chapter 15
3. Piantadosi (2011), Chapters 2 and 3

4 Student Evaluation

- reading all the assigned readings (no skipping, no skimming etc.); for any reading presented by the instructor, every registered student will have to provide a **different** contentful question addressing core issues pertaining to that reading at the beginning of the class, i.e., before the in-class presentation of that reading; note that providing distinct contentful questions will require the registered students to have at least a brief joint discussion outside of class (this can very well be over email or the instructor can set up a forum on the eCommons page for the course)
- 10-minute summaries of the material covered in the previous class for subsections 3.1 and 3.2 of the above schedule (as many times as needed; rotates through all registered students)
- at least one in-class presentation (maybe two) of a chapter from the dissertations listed in subsections 3.3 and 3.4 of the above schedule
- a final paper describing an original research project, the preparation and content of which must satisfy the following requirements:

  1. the paper / project will involve:
     (a) the description of an open issue in formal semantics
     (b) the description of an experiment and / or corpus study that could make progress with respect to that issue
     (c) the description of a statistical model (and / or cognitive model, if you want to go to that level) adequate for modeling the experimental / corpus data and extracting the generalizations / results relevant to the semantic issue under consideration
     (d) simulating at least 2 datasets based on the model (with 2 theoretically relevant sets of parameters for the model), providing graphical summaries of the datasets, running the statistical analyses of the datasets, extracting the generalizations and formulating conclusions that directly bear on the theoretical issue under consideration
  2. a 2-page abstract (*Sinn und Bedeutung* style) by the end of week 8
  3. a fairly detailed handout (6-8 pages) to be presented in week 10
  4. final paper, 10-15 pages (*Sinn und Bedeutung* style), to be submitted one week after the last class

There will be no incompletes for this class or extensions of any deadlines unless justified by serious unforeseeable events. Please note that lack of adequate planning & preparation for minor perturbations like having a cold does not count as a suitable justification. You will be evaluated based on what you (fail to) accomplish by the specified deadlines.

Anonymous feedback

For anonymous feedback throughout the course, please click on the link below (or copy and paste it in your browser window): `http://people.ucsc.edu/~abrsvn/brasoveanu_feedback.htm`. Please mention the course you are providing feedback for.

5 Additional resources (recommended, but fyi only)

1. *Cognitive Modeling*, Busemeyer, J.R. & A. Diederich, Sage Publications, 2009
2. *The Mind's Arrows: Bayes Nets and Graphical Causal Models in Psychology*, C. Glymour, MIT Press, 2001
3. *Computational and Mathematical Modeling in the Social Sciences*, S. de Marchi, Cambridge University Press, 2005
4. *Data Analysis Using Regression and Multilevel/Hierarchical Models*, Gelman, A. & J. Hill, Cambridge University Press, 2007
5. *In All Likelihood: Statistical Modelling and Inference Using Likelihood*, Y. Pawitan, Oxford University Press, 2001
6. *Modeling with Data*, B. Klemens, Princeton University Press, 2009
7. *Bayesian Reasoning and Machine Learning*, D. Barber, Cambridge University Press, 2012

References

Anderson, C. (2010). *The Structure and Real-Time Comprehension of Quantifier Scope Ambiguity*. PhD dissertation, Northwestern University.

Brasoveanu, A. (2011). Sentence-internal *Different* as Quantifier-internal Anaphora. *Linguistics and Philosophy* 34, 93-168.

Brasoveanu, A. (2012). The Grammar of Quantification and the Fine Structure of Interpretation Contexts. *Synthese*, accepted with minor revisions.

Brasoveanu, A. & D.F. Farkas (2011). How Indefinites Choose Their Scope. *Linguistics and Philosophy* 34, 1-55.

Carey, S. (2004). Bootstrapping & the Origin of Concepts. *Daedalus* 133, 59-68.

Dotlačil, J. (2010). *Anaphora and Distributivity*. PhD dissertation, Utrecht University.

Kruschke, J. (2011). *Doing Bayesian Data Analysis*. Academic Press (Elsevier).

Lee, M. D. (2011). How Cognitive Modeling Can Benefit from Hierarchical Bayesian Models. *Journal of Mathematical Psychology* 55, 1-7.

Lee, M. D. & E.J. Wagenmakers (in preparation). *Bayesian Modeling for Cognitive Science: A Practical Course*. Cambridge University Press.

Lewandowsky, S. & S. Farrell (2011). *Computational Modeling in Cognition: Principles and Practice*. Sage Publications.

Piantadosi, S.T. (2011). *Learning and the Language of Thought*. PhD dissertation, MIT.

Tunstall, S.L. (2010). *The Interpretation of Quantifiers: Semantics & Processing*. PhD dissertation, UMass Amherst.