**CSCI 599: Natural Language Dialogue Systems**
**Spring 2013**

*Place and time:* GFS 213, Wed 3:30 pm-6:20pm

**Course Webpage:** http://projects.ict.usc.edu/nld/cs599s13/

**Instructors:**
David Traum Research Assistant Professor (traum@ict.usc.edu)
David DeVault Research Assistant Professor (devault@ict.usc.edu)
Office Hours: Office: SAL 234 Wednesdays 2:00-3:15
or after class, or by appointment (at ICT in Playa Vista)

**Prerequisites:**
Students should have some experience with natural language processing or artificial intelligence, and should be comfortable with medium-sized programming projects. Recommended background would be at least one of the following courses: CSCI 544 (Natural Language Processing) or CSCI 561 (Foundations of Artificial Intelligence) or CSCI 562 (Empirical Methods in Natural Language Processing) or EE619 (Advanced Topics in Speech Recognition). Students who have not taken one of these courses should request permission from the instructors.

**Course Description:**
This course will introduce students to existing computational techniques and active research areas in the design of natural language dialogue systems. Natural language dialogue involves extended communication between two or more participants using a natural language such as English. Dialogue systems are designed to participate in extended natural language interactions with human users, and have been developed for a variety of interactive settings where a conversational interface offers advantages. Dialogue systems leverage a range of natural language processing and modeling techniques to help them serve as fluent and efficient conversational partners. This course will introduce students to these techniques, with topics to include spoken language understanding, modeling dialogue genres, dialogue management and representing context, dialogue response policies, natural language generation, embodied conversational agents, incremental speech processing, and dialogue system evaluation.

Dialogue systems are both an old topic in AI and Computer Science (with famous early examples such as Eliza, Lunar, and SHRDLU) and a topic of much current interest and research. Indeed, dialogue systems have recently become a commercial reality, with companies such as Nuance, Microsoft, AT&T, Google, Apple, and others providing ubiquitous speech recognition services and voice-driven information access systems. These services are increasingly accessible (on the web, mobile devices, and anywhere

Internet connectivity can be established), and they provide exciting new possibilities for dialogue systems to be made available to large user populations. Throughout the course, students will acquire an appreciation for some of the capabilities and potential of these new technologies, as well as their current limitations.

**Learning Objectives:**

Students should come away from the course with a basic understanding of dialogue system design and evaluation, and be able to:

- implement simple dialogue systems
- read and assess research papers in the area
- embark on new research in the area

**Course Format:**

The course lecture periods will consist of approximately 1/2 lectures by the instructors, and 1/2 group discussion of research papers, mostly led by students. For all class periods, students will be responsible for sending in discussion questions on the readings, as well as participating in class discussions. Each student will have to lead the discussion of one advanced research topic, including a short review presentation on the topic. Students will also complete several small assignments, and carry out a main project on a topic agreed by the instructors.

**Grading:**

There will be no exams in this class. Grades will be determined based on

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| 1. reading and reviewing assigned papers (sending in questions) | 10% |
| 2. participation in class discussions | 10% |
| 3. leading one discussion topic based on assigned readings | 20% |
| 4. 2-3 small assignments | 20% |
| 5. main project (including one page description, project specification final writeup & class presentation) | 40% |

**Course Materials:**

*Required readings:* The primary readings for this course will be a set of technical papers to accompany each lecture session and student-led topic. These papers will be made available on the course webpage or as class handouts.

*Textbook:* Spoken Dialogue Systems, Kristiina Jokinen and Michael McTear, Synthesis Lectures on Human Language Technologies, 2010. This book is freely available to USC students at: http://www.morganclaypool.com/doi/pdf/10.2200/S00204ED1V01Y200910HLT005

## Course Schedule:

| | Topics/Daily Activities | Readings | Homework Due Dates |
|---|---|---|---|
| **Week 1** | **Lectures:** Overview of course: what is dialogue, dialogue genres, demos of dialogue systems, dialogue system components, techniques for dialogue modeling and dialogue management, research topics | **Jokinen & McTear Ch. 1**<br>**(optional) Jurafsky&Martin Ch 24**<br>**Traum 2008** | |
| **Week 2** Dates | **Lectures:** Simple models of dialogue structure: trees and finite state approaches, dialogue acts, key phrase reactive approaches, information retrieval-based approaches, Voice XML | **Jokinen & McTear Ch. 2.1-2.1.1, 2.3,**<br>**Weizenbaum 1966**<br>**Sutton et al 1996**<br>**Traum 1999**<br>**Leuski & Traum 2011** | Assignment 1 |
| **Week 3** Dates | **Lectures:** Speech recognition, use of speech recognizers in dialogue systems, natural language understanding | **Bhagat et al 2005**<br>**Goldwater et al 2000** | |
| **Week 4** Dates | **Lectures:** Advanced models of dialogue structure: frame-based approaches, information-state approaches, plan- and agent-based approaches | **Jokinen & McTear Ch. 2.1.2, 2.2, 4, 5.1**<br>**Goddeau et al 1996**<br>**Traum & Larsson 2003**<br>**Smith et al 1995**<br>**Allen et al 1995**<br>**Rich et al 2001** | Assignment 2 |
| **Week 5** Dates | **Lectures:** Natural language generation for dialogue systems, text-to-speech synthesis, use of speech synthesizers in dialogue systems | **Walker & Rambow 2002**<br>**Stent 2002**<br>**Oh & Rudnicky 2002**<br>**Devault et al 2008** | |
| **Week 6** Dates | **Lectures:** Dialogue system evaluation, overview of specialized research topics | **Jokinen & McTear Ch. 6**<br>**Carletta 1996**<br>**Gandhe & Traum 2008**<br>**Moeller 2010** | Project proposal (1 page) |
| **Week 7** Dates | **Lectures:** Stochastic approaches to dialogue: dialogue policy design and training, MDP and POMDP reinforcement learning, simulated users | **Jokinen & McTear Ch. 2.4**<br>**Levin & Pieraccini 1997**<br>**Roy et al 2000** | Assignment 3<br>Discussion topic choice |

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| **Week 8** Dates | **Discussion topics** | | |
| **Week 9** Dates | **Discussion topics** | | |
| **Week 10** Dates | **Discussion topics** | | |
| **Week 11** Dates | **Discussion topics** | | Project specification (4 pages) |
| **Week 12** Dates | **Discussion topics** | | |
| **Week 13** Dates | **Discussion topics** | | |
| **Week 14** Dates | **Project Presentations** | | |
| **Week 15** Dates | **Project Presentations** | | Final project |

Weeks 8-13 will be concerned with mostly student-led discussions of papers on selected research topics. Detailed bibliographies for each topic will be posted on the course webpage. Actual topics will be decided based on interest of students, but will be selected from among themes including:

- turn-taking
- mixed-initiative
- referring in dialogue
- grounding and repair
- dialogue act modeling
- dialogue act recognition
- incremental speech processing
- multi-party dialogue (3 or more participants)
- multi-modal dialogue
- prosody and information structure
- dialogue genres: task-oriented, tutoring, casual conversation, information-seeking
- embodied conversational agents
- human-robot dialogue interaction
- dialogue tracking in other language-processing systems (machine translation, summarization/extraction)
- non-cooperative dialogue systems (negotiation, deception)
- affective dialogue systems
- dialogue with different user populations (children, elderly, differently abled)

**Bibliography for lecture topics:**


1. Jokinen and McTear Spoken Dialogue Systems, Morgan & Claypool, Synthesis Lectures on Human Language Technologies, 2010
2. Chapter 24 Dialogue and Conversational Agents, Jurafsky, Daniel, and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics. 2nd edition. Prentice-Hall, 2009.
3. David Traum, Talking to Virtual Humans: Dialogue Models and Methodologies for Embodied Conversational Agents" In I Wachsmuth and G Knoblich (Ed.), Modeling Communication with Robots and Virtual Humans, pp. 296-309, 2008. pre-release version
4. ELIZA--A Computer Program For the Study of Natural Language Communication Between Man and Machine Communications of the ACM Volume 9, Number 1 (January 1966): 36-45.
5. David R Traum, Speech Acts for Dialogue Agentsin Michael Wooldridge and Anand Rao, editors, "Foundations And Theories Of Rational Agents", Kluwer Academic Publishers, pages 169--201, 1999.
6. Sutton, S., Novick, D.G., Cole, R., Vermeulen, P., de Villiers, J., Schalkwyk, J. and Fanty, M., "Building 10,000 Spoken-Dialogue Systems," Proceedings of the 1996 International Conference on Spoken Language Processing, Philadelphia, PA, 709-712, October, 1996.
7. How May I Help You? A.L. Gorin, G. Riccardi and J.H. Wright Speech Communication, vol. 23, pp. 113-127, 1997.
8. Vector-Based Natural Language Call Routing Jennifer Chu-Carroll, Bob Carpenter. Journal of Computational Linguistics, 25(30), pp. 361-388, 1999.
9. Anton Leuski and David Traum. NPCEditor: Creating virtual human dialogue using information retrieval techniques. AI Magazine, 32(2):42–56, 2011.
10. Automatic handling of Frequently Asked Questions using Latent Semantic Analysis, Patrik Larsson and Arne Jönsson, 6th IJCAI Workshop on Knowledge and Reasoning in Practical Dialogue Systems, Pasadena, CA, USA, 2009.
11. Donghui Feng Cooperative Model Based Language Understanding in Dialogue HLT 2003
12. R. Bhagat, A Leuski, and E Hovy Shallow Statistical Parsing despite Little Training Data International Workshop on Parsing technologies, 2005.
13. Building a Robust Dialogue System with Limited Data, 2000, by Sharon J. Goldwater, Elizabeth Owen Bratt, Jean Mark Gawron, and John Dowding, presented at the Workshop on Conversational Systems at the 1st Meeting of the North American Chapter of the Association for Computational Linguistics, Seattle, WA.
14. Thompson, H. S., Anderson, A., Bard, E. G., Doherty-Sneddon, G., Newlands, A., and Sotillo, C. 1993. The HCRC Map Task corpus: natural dialogue for speech recognition. In Proceedings of the Workshop on Human Language Technology

(Princeton, New Jersey, March 21 - 24, 1993). Human Language Technology Conference. Association for Computational Linguistics, Morristown, NJ, 25-30.
15. D. Goddeau, H. Meng, J. Polifroni, S. Seneff, and S. Busayapongchai. 1996. A form-based dialogue manager for spoken language applications. In Proc. ICSLP, 1996 pp. 701--704.
16. V. Zue, et al., JUPITER: A Telephone-Based Conversational Interface for Weather Information, IEEE Transactions on Speech and Audio Processing, Vol. 8 , No. 1, January 2000.
17. Xu, W. and Rudnicky, A. Task-based dialog management using an agenda. ANLP/NAACL 2000 Workshop on Conversational Systems, May 2000, pp. 42-47.
18. David Traum and Staffan Larsson, The Information State Approach to Dialogue Management in Current and New Directions in Discourse and Dialogue, Ed. Jan van Kuppevelt and Ronnie Smith, Kluwer, 2003, pp 325-354.
19. Colin Matheson, Massimo Poesio, and David Traum, Modelling Grounding and Discourse Obligations Using Update Rules, in Proceedings of the 1st Annual Meeting of the North American Association for Computational Linguistics (NAACL2000), May 2000.
20. Smith, D.R. Hipp, and A.W. Biermann. An Architecture for Voice Dialog Systems Based on Prolog-Style Theorem Proving. Computational Linguistics 21:3, 1995.
21. Perrault and Allen A plan-based analysis of indirect speech acts. Computational Linguistics, 6:167-183, 1980
22. Defining a Conversational Agent. James Allen. Chapter 17 of Natural Language Understanding Benjamin/Cummings Publishing Company, 1995.
23. The TRAINS Project James F. Allen et al. Journal of Experimental and Theoretical AI, 1995.
24. Effective Human-Computer Cooperative Spoken Dialogue: The Ags Demonstrator M.D. Sadek, A. Ferrieux, A. Cozannet, P. Bretier, F. Panaget, J. Simonin Proceedings of the Fourth International Conference on Spoken Language Processing (ICSLP'96)
25. Design Considerations on Dialgue Systems: From Theory to Technology - The Case of Artimis David Sadek. ESCA Workshop ``Interactive Dialogue in Multi-modal Systems,'' pp. 173-187, 1999.
26. Rich, C.; Sidner, C.L.; Lesh, N.B., "COLLAGEN: Applying Collaborative Discourse Theory to Human-Computer Interaction", Artificial Intelligence Magazine, Winter 2001 (Vol 22, Issue 4, pps 15-25)
27. Rich, C.; Sidner, C.L., "COLLAGEN: A Collaboration Manager for Software Interface Agents", An International Journal: User Modeling and User-Adapted Interaction, Vol. 8, Issue 3/4, pps 315-350, 1998
28. Computer Speech & Language Special issue on Spoken Language Generation, 2002.
29. David DeVault, David Traum, and Ron Artstein, Making Grammar-Based Generation Easier to Deploy in Dialogue Systems In proceedings of The 9th SIGdial Workshop on Discourse and Dialogue (SIGdial 2008), June, 2008.
30. Sikorski, T., and Allen, J. F. A task-based evaluation of the TRAINS-95 dialogue

system. In Proceedings of the Workshop on Dialog Processing in Spoken Language Systems, ECAI-96 (Budapest, 1996).
31. Assessing Agreement on Classification Tasks: The Kappa Statistic. Jean Carletta. Computational Linguistics, 22(2):249-254, 1996.
32. Towards Developing General Models of Usability with PARADISE. Marilyn A. Walker, Diane J. Litman, Candace. A. Kamm and Alicia Abella. Natural Language Engineering 2000.
33. Wieland Eckert, Esther Levin, and Roberto Pieraccini. Automatic evaluation of spoken dialogue systems. In TWLT13: Formal semantics and pragmatics of dialogue, pages 99--110, 1998.
34. David R. Traum, Susan Robinson, Jens Stephan Evaluation of multi-party virtual reality dialogue interaction, In Proceedings of Fourth International Conference on Language Resources and Evaluation (LREC 2004), pp. 1699-1702.
35. Sudeep Gandhe and David Traum Evaluation Understudy for Dialogue Coherence Models In proceedings of The 9th SIGdial Workshop on Discourse and Dialogue (SIGdial 2008), June, 2008.
36. Sebastian Moller Assessment and Evaluation of Speech-Based Interactive Systems: From Manual Annotation to Automatic Usability Evaluation Chapter 15 of Speech Technology, Fang Chen, ed., Springer, 2010.
37. Levin, E., and Pieraccini, R. (1997). A stochastic model of computer-human interaction for learning dialogue strategies. In Proc. 5th European Conf. on Speech Communication and Technology.
38. Spoken Dialog Management Using Probabilistic Reasoning. N. Roy, J. Pineau & S. Thrun. Proceedings of the Association for Computational Linguistics (ACL), 2000.
39. Optimizing Dialogue Management with Reinforcement Learning: Experiments with the NJFun System. Satinder Singh, Diane Litman, Michael Kearns and Marilyn Walker. Journal of Artificial Intelligence Research (JAIR), Vol. 16, 2002.

**Statement for Students with Disabilities:**
Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

**Statement on Academic Integrity:**
USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are

located in Appendix A: http://www.usc.edu/dept/publications/SCAMPUS/gov/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

**Emergency Preparedness/Course Continuity in a Crisis**

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.