



# Learning to Optimise Human-Computer Interaction

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# Outline

- 1: Who we are.....
- 2: Problems/ history of the field:
  - **Robust MultiModal natural language interfaces**
  - **“What to say and How to say it?”**
- 3: Our techniques and results:
  - Context-sensitive recognition
    - Supervised Learning
  - Interaction management as statistical planning
    - **(PO)MDPs and Reinforcement Learning**
- 4: Open research areas/ what we can learn from this group/ how can we collaborate?

# Who we are



*Jingying Chen*

**Paul Crook**

**Srini Janarthanam**

*Mary Ellen Foster*

(Matthew Frampton)

(Kalliroi Georgila)

**Helen Hastie**

(Jamie Henderson)

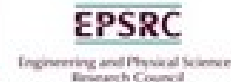
**Xingkun Liu**

**Ivan Meza Ruiz**

**Johanna Moore**

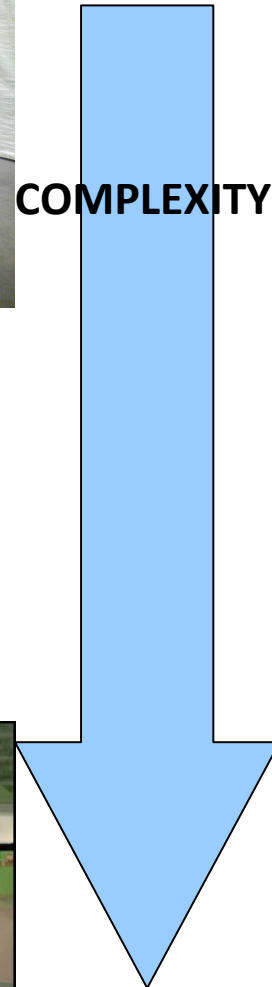
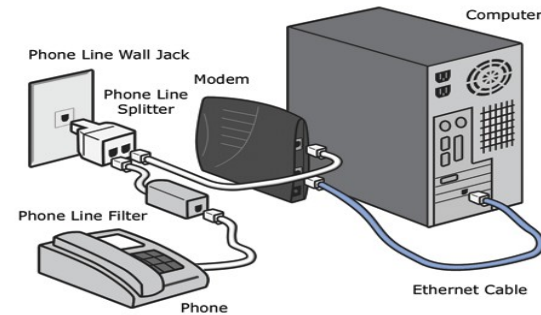
**Verena Rieser**

- EC FP6 “TALK”
- EC FP7 “CLASSiC”
- EPSRC
- Scottish Enterprise
- British Council
- Technology Enhanced Learning



# Example problem domains

- Multimodal search (TALK “TownInfo”)
- TroubleShooting (CLASSIC)
- Robot control (WITAS)
- Virtual characters (ECHOES)



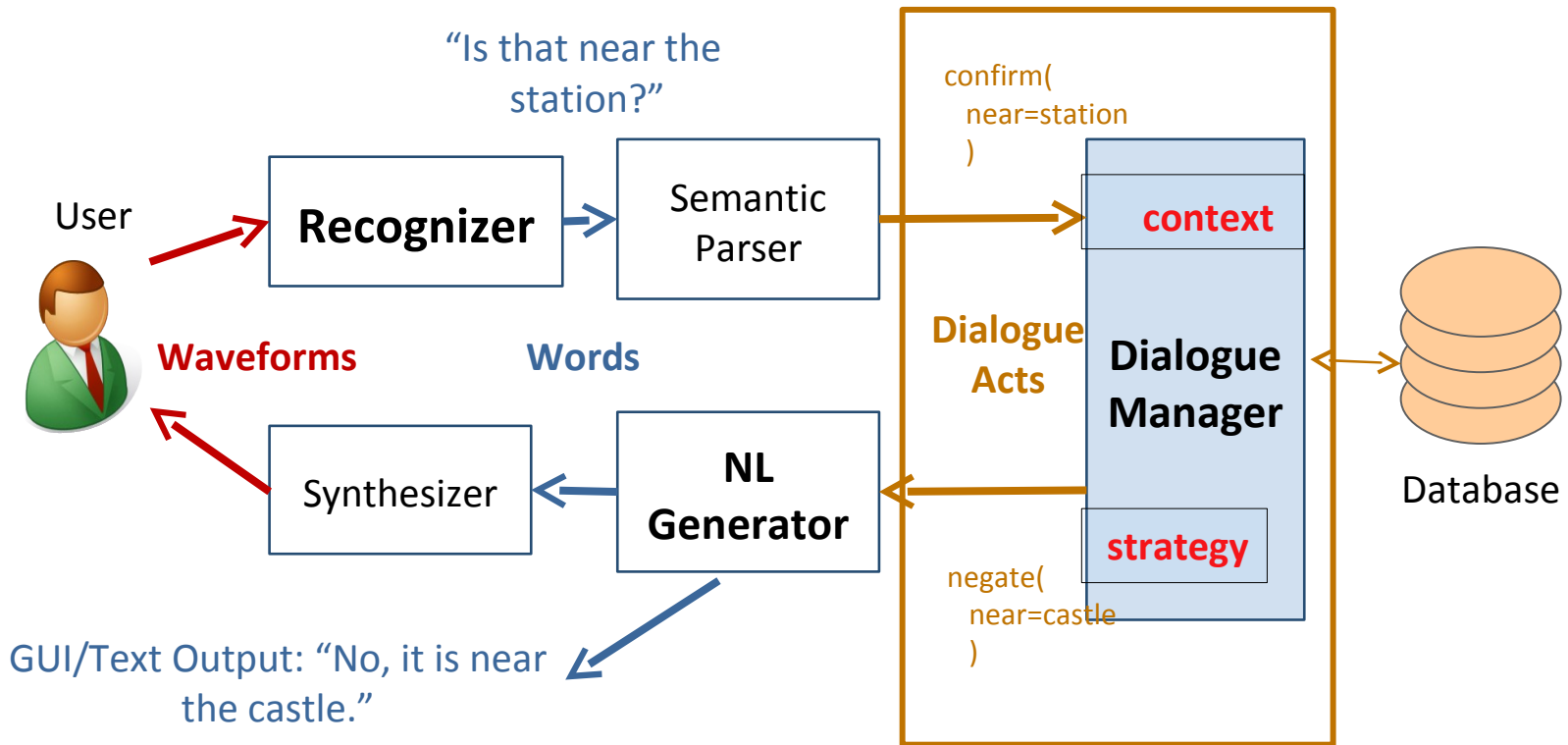
# Example: flight information systems



# MM & NL Interface problems

- How to handle *noisy* and *ambiguous* Input: *uncertainty*
- How to select a “good” next system action: *planning*
- **Adapting** to (uncertain) interaction **context**:
  - How to interpret user input actions?
  - How to select good output actions? (“**trade-offs**”)
- The problem space is very large:
  - Large number of possible contexts
  - **Hand-coded solutions** are difficult to design and are not guaranteed to be good
  - Systems are fragile, and Users are often frustrated :(

# Multimodal Dialogue Systems



Commercial **Dialogue Managers** are deterministic, rule-based, and hand-crafted (Voice XML)

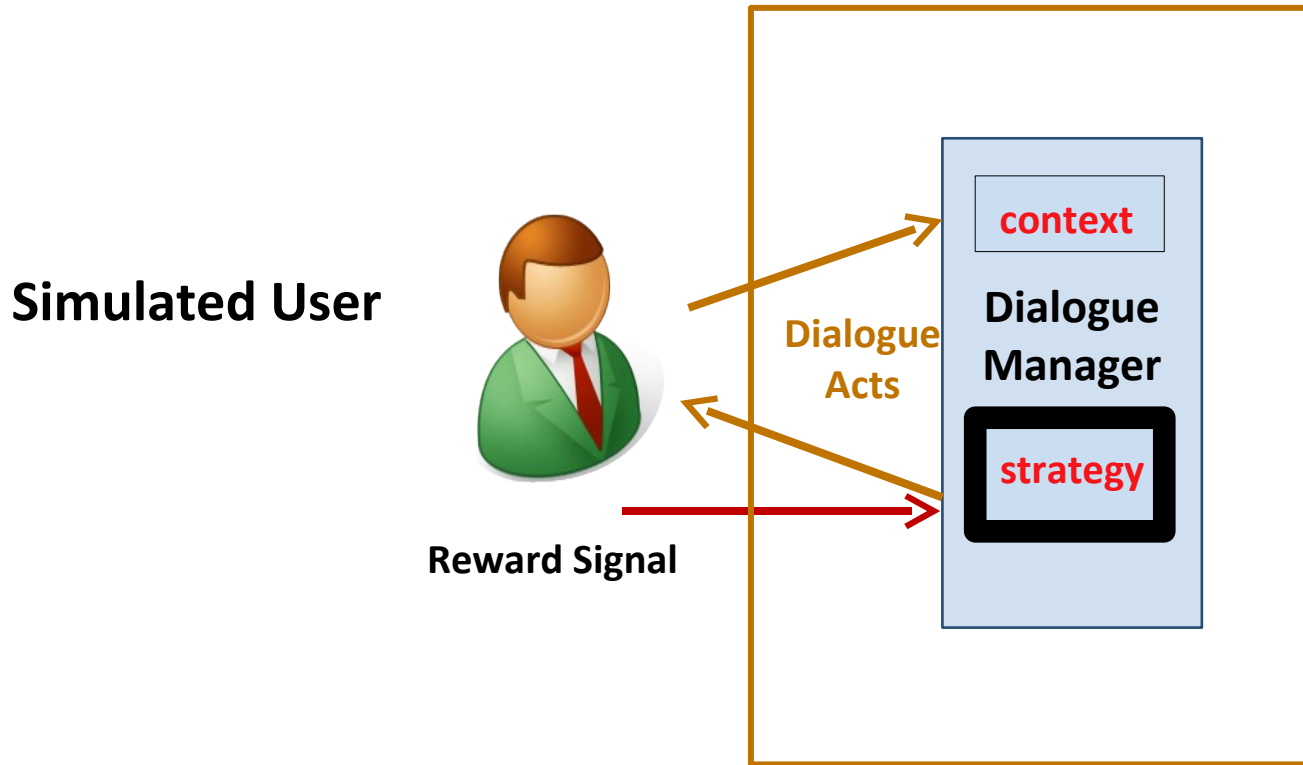
Machine Learning systems can be **automatically optimised**

# Uses of Machine Learning

- **Supervised learning** to classify user input in context:
  - Context sensitive speech and gesture recognition
  - To reduce uncertainty and ambiguity
- **Reinforcement Learning** for output:
  - Planning what to say/do next
  - Optimise the system *strategy* to reach overall long term goals of the interaction
  - In the presence of noise, ambiguity, uncertainty



# RL for MultiModal Interaction

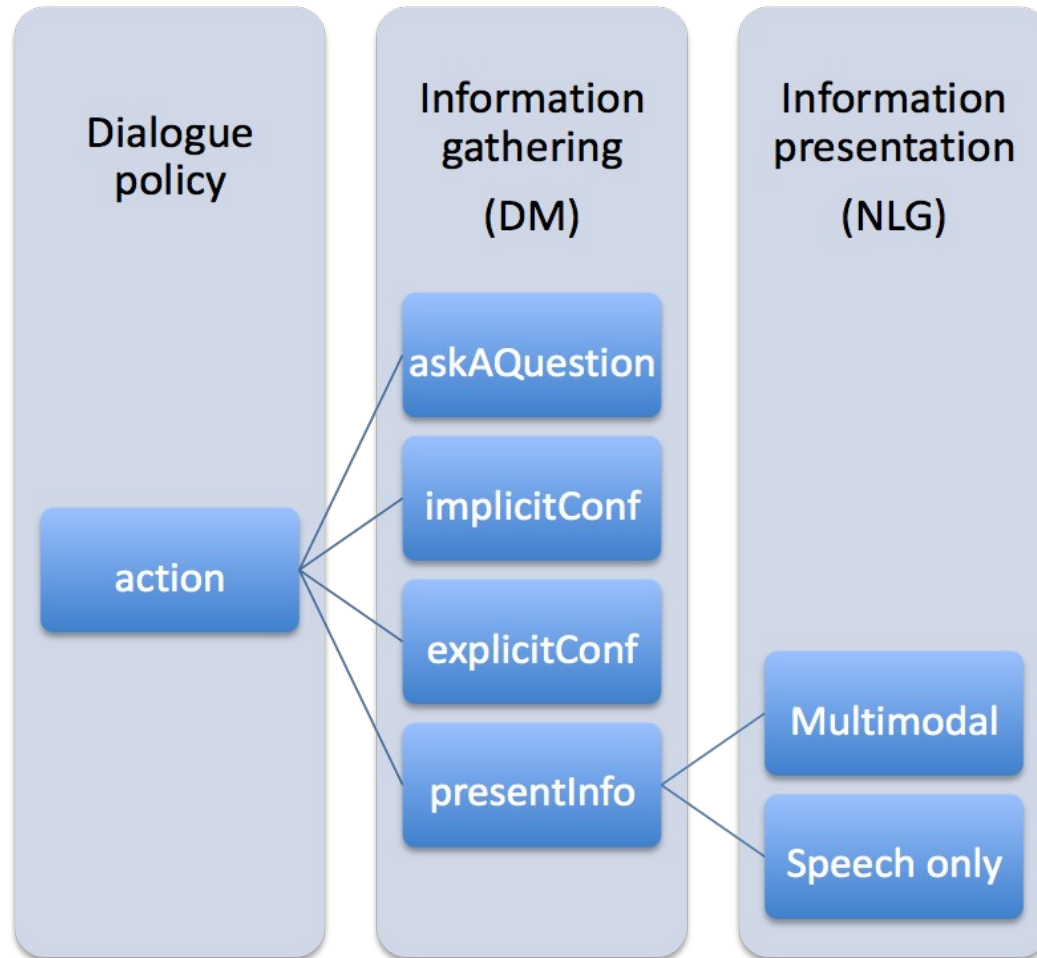
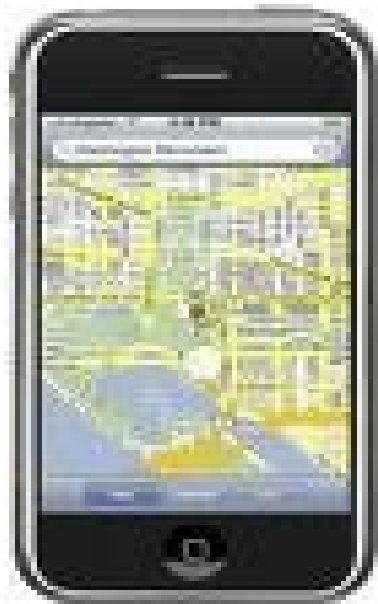


- **Users trained from real data**
- **noise is simulated**
- **optimise User Satisfaction**

Reward is defined based on analysis of real data: by regression

Dialogue Manager decisions are optimised over 10000s of simulated dialogues

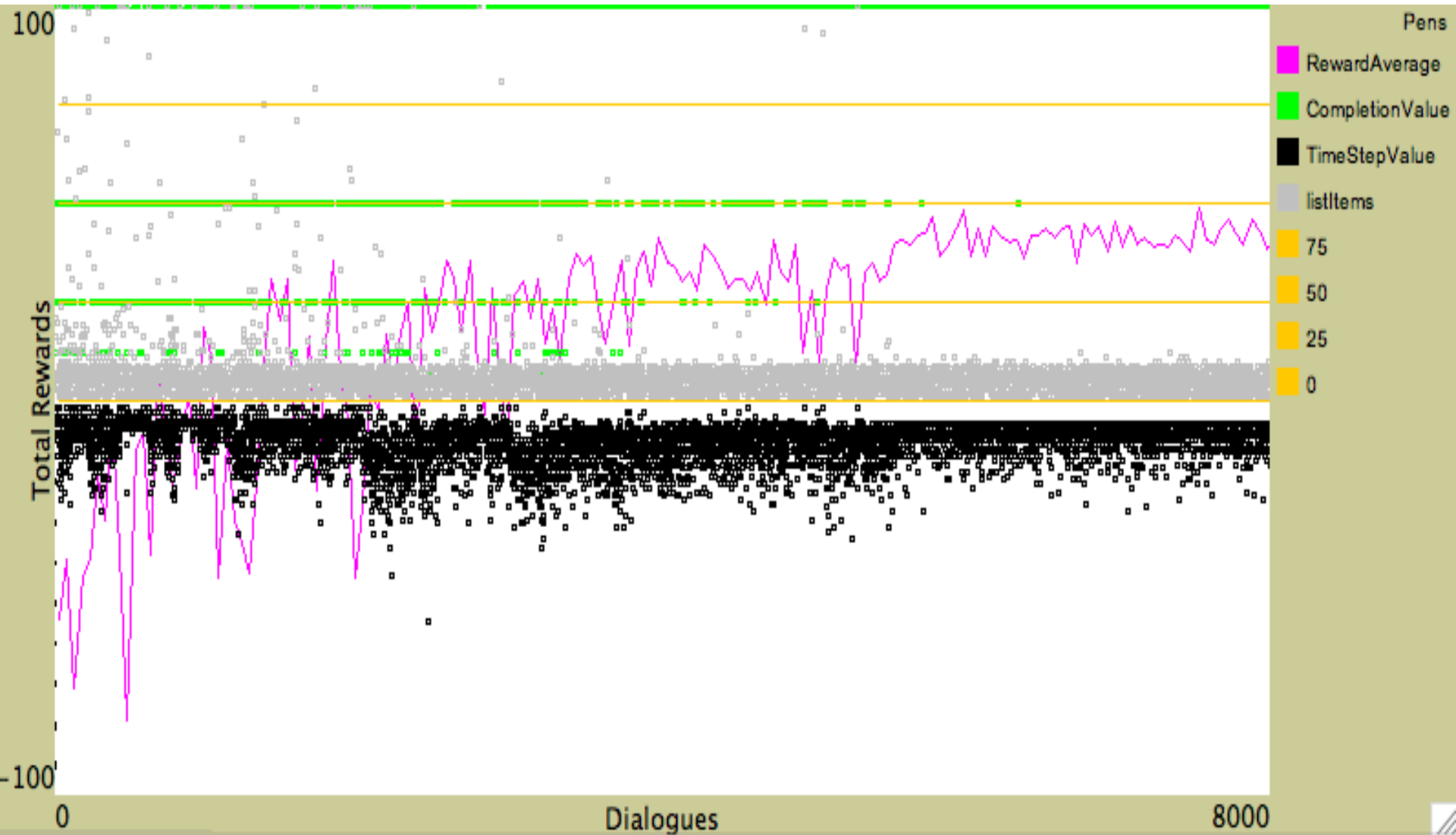
# A strategy learning problem



# What have we achieved?

- Significant reductions in Word Error Rate using **context-sensitive speech recognition**
- A **fully data-driven methodology for optimising dialogue systems** (Rieser & Lemon, *ACL* 2005-8)
  - Significantly outperforming hand-coded rule-based systems (e.g. COMMUNICATOR) in real user trials
  - (Henderson, Lemon, Georgila *Computational Linguistics* 2008)
- New methods for **User Simulation**
- Use of **very large state spaces** via function approximation
- Feature engineering: importance of **Dialogue Acts**
  - (Frampton & Lemon *ACL*, 2006/8)

# Interactive multimodal search




# Some Hot topics

- Lack of dialogue data: (*Rieser & Lemon, ACL 2005-8*)
  - Bootstrapping from *small datasets*
  - Simulated Users & evaluation
  - Data driven Reward modelling
- *Partial Observability* & very large state spaces:
  - Linguistically motivated features (e.g. DAs)
  - Feature Engineering
  - State Generalisation methods
- Extending and scaling up the techniques:
  - More complex Multimodal interaction
  - Complex tasks (troubleshooting, tutorials, robots..)

# Our current projects & challenges

- **EPSRC**: fully statistical dialogue systems, using POMDP dialogue managers
  - State generalization techniques, POMDP feature engineering for tractability & scalability
  - User simulations to re-rank ASR hypotheses
- **CLASSiC** (EC FP7): Reinforcement Learning for Natural Language Generation (NLG)
  - Hierarchical MDPs to model levels/stages of NLG
  - Data collection, bootstrapping from small datasets
  - User simulations responsive to NLG decisions

# Our current projects & challenges

- **DUDE**: commercialisation of the technology
  - Bringing ML techniques into mainstream commercial development
  - “Real world” demo systems: 
- **ECHOES** (ESRC/EPSCRC Technology Enhanced Learning): interacting with virtual characters in multimodal interfaces
  - Classifying user gestures, gaze, etc ... from live video
  - Learning Adaptive behaviours for virtual characters
  - Optimizing for educational value/learning gain

# How can we collaborate???

- Bootstrapping from *small datasets*:
  - Simulated Users & evaluation...
  - Reward modelling
- *Partial Observability* & very large state spaces:
  - Linguistically motivated features
  - Generalisation methods
  - Feature Engineering
- Extending to:
  - Rich Multimodal interfaces (gesture, video,...)
  - Complex tasks (troubleshooting, tutorials, robots..)



# Recent References

- <http://www.classic-project.org/publications>
- Verena Rieser and Oliver Lemon, "Learning Effective Multimodal Dialogue Strategies from Wizard-of-Oz data: Bootstrapping and Evaluation", Proc. **ACL 2008**
- James Henderson, Oliver Lemon, and Kallirroi Georgila, "Hybrid Reinforcement / Supervised Learning of Dialogue Policies from Fixed Datasets", **Computational Linguistics 34:4** (in press)
- Verena Rieser and Oliver Lemon, "Does this list contain what you were searching for? Learning adaptive dialogue strategies for Interactive Question Answering", **Natural Language Engineering** (to appear)
- Oliver Lemon, "Adaptive Natural Language Generation in Dialogue using Reinforcement Learning", **SEMdial (LONDial) 2008**
- Matthew Frampton and Oliver Lemon, "Using Dialogue Acts to learn better repair strategies for Spoken Dialogue Systems", **ICASSP 2008**