DISCOVERING SOCIAL INTERACTION STRATEGIES FOR ROBOTS FROM RESTRICTED-PERCEPTION WIZARD-OF-OZ STUDIES

Pedro Sequeira, Patrícia Alves-Oliveira, Tiago Ribeiro, Eugenio Di Tullio, Sofia Petisca, Francisco S. Melo, Ginevra Castellano and Ana Paiva

pedro.sequeira@gaips.inesc-id.pt

11TH ACM/IEEE INTERNATIONAL CONFERENCE ON HUMAN-ROBOT INTERACTION (HRI 2016) MARCH 7-10, 2016 NEW ZEALAND

This work was supported by national funds through the FCT with reference UID/CEC/50021/2013
INTRODUCTION
DISCOVERING SOCIAL INTERACTION STRATEGIES FOR ROBOTS FROM RESTRICTED-PERCEPTION WIZARD-OF-OZ STUDIES
Discovering **Social Interaction Strategies for Robots** from Restricted-Perception Wizard-of-Oz Studies
Discovering Social Interaction Strategies for Robots from Restricted-Perception Wizard-of-Oz Studies
Discovering Social Interaction Strategies for Robots from Restricted-Perception Wizard-of-Oz Studies

Correspondence Problem!!
Discovering Social Interaction Strategies for Robots from Restricted-Perception Wizard-of-Oz Studies
Discovering Social Interaction Strategies for Robots from Restricted-Perception Wizard-of-Oz Studies
Methodology
Methodology

Overview

- Data Collection
- Strategy Extraction
- Strategy Refinement
Methodology

Collaborative Learning Scenario

Students

Multiplayer Collaborative EnerCities

Robotic tutor (Aldebaran NAO)

Touch table
Methodology

Overview

Data Collection -> Strategy Extraction -> Strategy Refinement

pedro.sequeira@gaips.inesc-id.pt
Objectives:

- **Mock-up studies** with end-users
- **Gain insight** on human interaction strategies
- Build **Task AI**
- Perform restricted-perception **WoZ studies**
Methodology

Data Collection (2/4)

- Mock-up studies
  - Interviews with teachers
  - 30 students (aged 13-15) and 1 teacher
- Task AI:
  - Defines a set of state features and high-level behavioral repertoire
Methodology

Data Collection (3/4)

• Restricted-perception WoZ studies:
  • **Limit** what the wizard can observe from the task
  • Let wizard **dynamically** choose **appropriate interaction strategy**
  • **56 students** aged 14–16
Methodology
Overview

Data Collection → Strategy Extraction → Strategy Refinement
Methodology

Strategy Extraction (1/3)

Objectives:
- Build a **hybrid** interaction strategy controller
- **Rule-based:** hand-coded rules denoting common practices
- **ML-based:** complex situations in expert’s decision process
**Methodology**

**Strategy Extraction (2/3)**

- **Rule-based module**
  - **Collect data** offline from mock-up and WoZ studies
  - Encode **well-known** interaction strategy rules
  - At run-time, **trigger specific rules** to activate interaction behaviors
Methodology

**Strategy Extraction (3/3)**

Data Preparation

- WoZ Log File
  - perceptual features
  - wizard behaviors

Data Set

- attributes
  - 0 0 0 0 1 0 0 1 behavior a
  - 1 1 0 1 0 1 1 0 do_nothing
  - 1 0 1 0 1 0 0 1 behavior c
  - 0 1 0 1 1 1 0 1 behavior b
  - 1 1 0 0 1 0 0 1 behavior a

Training

- Perceptual State
  - perceptual features
- Interactive behavior

Run-time Classification

- Mapping Function

- Machine learning-based module
  - Prepare **data-set** from the WoZ data
  - Discover a **mapping function** through ML
  - At run-time, **select an appropriate** robot interaction behavior
Methodology Overview

Data Collection → Strategy Extraction → Strategy Refinement

pedro.sequeira@gaips.inesc-id.pt
Objectives:

- Refine robot behavior through iterative process
- Use **active learning** by querying experts for improvement
- Let experts provide **corrective feedback**
Methodology

**Strategy Refinement (2/2)**

- Evaluation & refinements:
  - **Fully-autonomous** robot with **hybrid controller**
  - 54 high-school **students** (**long-term**: 4 different times over a **month**)
  - Group’s **emotional climate**
  - **Fine-tuning** of machine-learning algorithms
Methodology

Evaluation Study

- Study conditions
  - Fully-autonomous vs. Restricted-perception WoZ vs. Unrestricted WoZ
  - Several HRI metrics
- Evaluation results:
  - Students evaluated the robotic tutor as being empathic
  - No significant differences in most metrics
  - High engagement with the robot
Conclusions

- **Restricted-perception** WoZ
  - Wizard *observes* everything **accessible to robot**
  - Wizard chooses **appropriate interaction strategy**

- **Design methodology**
  - Data collection
  - Strategy extraction
  - Strategy refinement

- **Implementation of fully-autonomous robot**
  - **Hybrid** interaction controller
  - Tutor is perceived as **empathic**
Acknowledgements

- EMbOdied-perceptive Tutors for Empathy-based learning
  - EU-FP7 project
  - [http://www.emote-project.eu/](http://www.emote-project.eu/)

- Main objective
  - **Empathic** artificial embodied **tutors**
  - **Perceive** learning progress
  - **Intervene** in learning process
The End