MAP-I

Joint doctoral programme in Computer Science of Universidade do Minho, Universidade de Aveiro and Universidade do Porto

2013/14 Course Edition

Interactive Computing Systems

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Abstract

This document describes a course on "Interactive Computing Systems" to be offered as part of the 2013/14 edition of the Joint doctoral programme in Computer Science of Universidade do Minho, Universidade de Aveiro and Universidade do Porto (MAP-I).

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Course Description

1 The topic, its rationale and context

This document describes a course on "Interactive Computing Systems" to be offered as part of the 2013/14 edition of the Joint doctoral programme in Computer Science of Universidade do Minho, Universidade de Aveiro and Universidade do Porto (MAP-I). The course covers topics in the area of Human-Computer Interaction, with a particular emphasis on the Engineering of Interactive Computing Systems. At the end of this course, students should be able to understand the opportunities and challenges raised by the continued evolution of interaction technology.

The course is organised by researchers from the Universities of Minho and Aveiro with a vast and complementary research and teaching experience in the field of Human Computer Interaction, and is being proposed as one of the options in the curricular unit on Programming Paradigms.

Human-Computer Interaction (HCI) is "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" [Hewett et al., 1996]. The term 'Computing systems' is used here in a broad sense to denote from systems consisting of a single user interacting with a single computer to spaces enhanced with ubiquitous technology to support the activities or needs of multiple users. Technological development, in particular in the areas of embedded and mobile systems, means that "the interface between humans and computers is harder than ever to define" while at the same time we become more and more dependent on technology [Sellen et al., 2009]. Making the discipline an active area of research.

HCI is addressed at the post-graduate programme level in top tier institutions (e.g. CMU, Stanford, Virginia Tech, UCL, Uppsala, etc.). Offerings range from HCI courses in Information Systems, Informatics, or Computer Science programmes to HCI specific PhD programmes. Being an highly interdisciplinary field, HCI can be approached from a variety of angles. The current proposal takes an approach which is akin to that of courses such as 'Advanced Topics in Human-Computer Interaction' (Virginia Tech) or 'Research Topics in Human Computer Interaction' (Stanford). Hence, the course focusses in presenting an in-depth view of a number of advanced topics in relevant areas of the engineering of interactive computing systems (Evaluation, Interaction techniques, Interaction paradigms, and Design and development methods).

2 Objectives and Learning Outcomes

This course approaches HCI from an Engineering perspective, drawing on the background of the team. As explained above, the objective is to present students with in-depth treatment of a number of selected topics. Upon successful completion of this curricular unit, students should be able to:

- formulate UI hypothesis and devise validation experiments, discussing and applying different evaluation techniques;

- explain the advantages and limitations of describing interactive computing systems with models, as a way to abstract from the systems' complexity and to reason about their properties;

- discuss the main 3D interfaces available as well as their main applications and limitations, the guidelines for their development, and present the main challenges in 3D and Natural User Interfaces applications;

- identify which types of context information, context-sensitive procedures, and interaction techniques might be realistically supported given the limitations of the technology and the specificities of a particular interaction scenario;

- discuss the advantages, limitations and challenges of interaction through public displays, the role of the shared nature of public displays in user engagement, and the key interaction techniques with them;

- explain the concepts of Lean UX and Model-based User Interface development and contrast their roles in developing interactive computing systems.

3 Syllabus

1. **Introduction to HCI**

   A general introduction to HCI to provide students with enough background for the topics addressed in the course.

2. **Evaluation**

   The evaluation of interactive computing systems is addressed from a number of different perspectives. Traditional approaches based on user testing or expert review are covered first. Then, the role of models in the analyses of interactive systems [Harrison et al., 2008, Barbosa et al., 2011] is discussed, and the opportunities that a clear expression of the problem and systematic analysis techniques may afford presented.

   (a) User studies – usability testing and controlled experiments
   (b) Usability inspection – expert reviews
   (c) Automated analysis through model-based testing
   (d) Automated analysis through formal verification

3. **Interaction techniques**

   A number of promising and useful interaction methods are covered. The topic addresses 3D interfaces and the tracking and displaying technology required to deliver

information according to the user point of view, as well as more recent results using multi-sensory information. The new perspectives of use open by Natural user interfaces, and their ability to bind physical and real world and benefit from the capabilities that users already have to interface with the real world are also addressed [Bowman et al., 2012, Kulik, 2009].

(a) 3D interaction

(b) Multi-sensory interfaces

(c) Natural user interfaces

(d) Development technologies and guidelines

4. **Interaction paradigms**

A number of advanced topics on Interaction Paradigms are addressed here, with a particular emphasis on Ubiquitous Computing. Topics range from the capability of systems to adapt to their usage situations (both during design and once deployed) through implicit interactions and context-awareness [Schmidt, 2013], to the development of public displays having the ability to create a shared experience between nearby people and the challenges this creates, such as shared ownership and social negotiation around their use. Virtual reality systems are also addressed, in particular the use of 3D application server as a means of prototyping Ubiquitous Computing environments.

(a) Context-aware sensing systems

(b) Interactive Public Displays

(c) Virtual reality systems and the prototyping of Ubiquitous Computing environments

5. **Design and development approaches**

This module introduces students to two different, and to an extent antagonistic, approaches: Lean UX [Gothelf and Seiden, 2013], which is strongly anchored on fast iterations over multiple designs and on measuring the results of those designs to support the evolution of the project; and Model-Based User Interface Development [Meixner et al., 2011], which is based on the idea of a structured development progressing from more conceptual models to the final user interface through a process of model refinement. The students will have the opportunity to contrasts the two approaches and explore the roles that each might play in the development of an Interactive Computing System.

(a) Lean UX

(b) Model-based development

4 Teaching and Assessment

This course corresponds to 5 ECTS involving a broad range of learning activities with a particular focus on active learning techniques. These will be favoured, not only for their ability in stimulating student engagement, but mainly because the learning outcomes proposed for this course include high-level objectives that can only be achieved through the execution, by the students, of analysis, development and discussion tasks. Furthermore, the high quality of the students involved, will contribute to maximise participation and therefore the benefits of the approach.

Lectures will be used to provide an initial background and quickly prepare everyone to the topic. The use of videos and the study of reference case studies will be used to complement the presentation of the topics and guide the study of the most commonly used approaches and issues. Student presentations and exercises will be used to promote engagement and exercise the analysis of existing work.

- 50% based on written or practical assignments proposed at the end of each course unit.

- 50% based on an individual survey monograph.

5 Main Bibliography

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Lecturing Team

José Creissac Campos is a an Assistant Professor within the Departamento de Informática/Universidade do Minho, where he has taught and been responsible for a number of HCI courses at postgraduate level, and a researcher at HASLab/INESC TEC. His research interests lie in the intersection of Software Engineering and Human-Computer Interaction (HCI). He is particularly interested in the application of formal software engineering techniques and tools to the modelling and analysis of interactive systems. Current and recent funded research includes the model-based testing, reverse engineering and formal analysis of user interfaces, and the prototyping of ambience intelligence systems using virtual reality simulations. He is a member of IFIP WG 2.7/13.4 on User Interface Engineering, and a founding member of the Engineering Interactive Computer Systems community of ACM. Among other roles, he is currently co-chairing the Doctoral Consortium for EICS 2013, was general co-chair for EICS 2012 and tutorials co-chair for INTERACT 2011. He serves in the steering committee of the EICS series of conferences, and regularly serves in the programme committees of several conferences, including IFIP TC13 INTERACT, ACM CHI (WiP) and ACM EICS. He was awarded an International Excellence Award by the BCS HCI Group in 2009, and a Recognition of Service Award by ACM in 2012.

Paulo Dias is an Assistant Professor within the Department of Electronics Telecommunications and Informatics/University of Aveiro where he has tough several HCI and Visualization courses at graduate and postgraduate level as well as several courses on programing. His main research interests are within, Virtual Reality, Computer Vision, Visualization Combination and fusion of data from multiple sensors and 3D Reconstruction. He has supervised several MSc dissertations in these areas, co-supervises a PhD thesis in Interactive Data Visualization. He is currently involved in the AcoustiCAVE project (PTDC/EEA-ELC/112137/2009) that aims Auralisation Models and Applications in Virtual Reality Environments and the Produtech PTI project (QREN 13851) where he is involved in developing VR training tools to allow interaction with software simulations of real industrial facilities. He was involved in the past years in the reviewing process of several HCI conference such as ACM CHI and IFIP INTERACT.

Rui José is an Assistant Professor at the University of Minho, where he leads the Ubicomp research group. Rui José received his PhD in Computer Science from Lancaster University in 2001. His research interests are in ubiquitous systems in general and particularly on the design and development of ubiquitous information services that are situated within particular physical and social settings. In recent years, he has been focusing on public digital displays and how they can be transformed into a new open communication medium for public and semi-public spaces. He has been PI or co-PI in multiple international research projects (FP7, FET-OPEN, Portugal/CMU partnership) and also national projects (QREN, FCT). Rui José is a member of ACM and its SIGCHI. Rui José has been part of several program committees, such as the International Conference on Indoor Positioning and Navigation (IPIN); the Interna-

tional Conference on Advances in Computer Entertainment Technology (ACE), the International Symposium in Ambient Intelligence (ISAmI), the International Workshop on Ambient Assisted Living (IWAAL-2011), the International Conference on Intelligent Environments (IE), the International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI), the Workshop on Pervasive Advertising, the International Symposium on Ubiquitous Computing and Ambient Intelligence (UCAmI'11), and the International Symposium on Pervasive Displays (PerDis). Rui José was the main promoter of the course on Ambient Intelligence and Ubiquitous Computing that took place in previous editions of MAP-i.

Beatriz Sousa Santos is an Associate Professor with the Department of Electronics Telecommunications and Informatics/University of Aveiro where she has tough several HCI and Visualization courses at graduate and postgraduate level. She obtained "Agregação" in Human-Computer Interfaces. Her main research interests are within Interactive Data and Information Visualization, Virtual Reality and Medical Imaging. She has supervised or co-supervised five PhD theses and about twenty MSc theses. She has integrated the Program Committees of about 30 international conferences