ACE
Autonomic Software Engineering for online Cultural Experiences

Carles Sierra

IIIA-CSIC
### Partners

<table>
<thead>
<tr>
<th>Partner</th>
<th>City</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIIA-CSIC</td>
<td>Barcelona</td>
<td>Carles Sierra</td>
</tr>
<tr>
<td>Goldsmiths, U. London</td>
<td>London</td>
<td>Mard d’Inverno</td>
</tr>
<tr>
<td>IRIT, CNRS</td>
<td>Toulouse</td>
<td>Leila Amgoud</td>
</tr>
</tbody>
</table>

Other Researchers: Nardine Osman, Henri Prade, Matthew Yee-King, Dave de Jonge, Roberto Confalonieri, Katina Hazelden, Bruno Rosell.
Project Objectives

- To develop autonomic BDI architectures for personal assistants of human agents engaging in online activities.
- To develop a peer to peer autonomic electronic institution infrastructure to support the autonomous interaction or human and autonomic agents.
- To embed the P2P infrastructure into mobile appliances to allow for a mobile social distributed consumption of cultural artefacts.
- To develop a series of case studies with cultural institutions and build a full specification of a selected case study that we will develop into a working prototype.
### WP 1: P2P eInstitutions

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>WP</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2P Institution node architecture</td>
<td>D1.1</td>
<td>M6</td>
</tr>
<tr>
<td>Running P2P node</td>
<td>D1.2</td>
<td>M6, M12, M24</td>
</tr>
<tr>
<td>P2P Electronic Institution prototype</td>
<td>D1.3</td>
<td>M12, M24</td>
</tr>
</tbody>
</table>

### WP 2: Autonomic Agents

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>WP</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>An autonomic Agent Architecture</td>
<td>D2.1</td>
<td>M6</td>
</tr>
<tr>
<td>An argumentation-based Negotiation Framework</td>
<td>D2.2</td>
<td>M6</td>
</tr>
<tr>
<td>Personal autonomic agent</td>
<td>D2.3</td>
<td>M12, M24</td>
</tr>
</tbody>
</table>

### WP 3: Negotiated social online cultural experiences

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>WP</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set of case studies of how autonomic agents could be applied to enrichable social online experiences</td>
<td>D3.1</td>
<td>M3</td>
</tr>
<tr>
<td>A full specification jointly written with a London cultural institution of the functionality of a system to enable online social experiences</td>
<td>D3.2</td>
<td>M6 I, M6 II</td>
</tr>
<tr>
<td>First implementation of the cultural experience prototype</td>
<td>D3.3</td>
<td>M12 I, M12 II</td>
</tr>
<tr>
<td>A complete validation and evaluation of prototype</td>
<td>D3.4</td>
<td>M21</td>
</tr>
<tr>
<td>Self-evaluation document in working in a multi-disciplinary cultural context especially with respect to potential role of autonomic agents</td>
<td>D3.5</td>
<td>M24</td>
</tr>
</tbody>
</table>
Last Year’s work

- P2P Electronic Institutions
- Autonomic agents
- Cultural experiences
- Results
Last Year’s work

- P2P Electronic Institutions
- Autonomic agents
- Cultural experiences
- Results
WP1 objectives

- Develop a P2P Electronic Institution infrastructure
- Embed the P2P autonomic electronic institution infrastructure in mobile devices
- Make the software available as open source
T1.1: P2P Electronic Institution Concept

- Completed; see deliverable D1.1.
- New component introduced in the EI concept: Device Manager
- Network architecture based on Freepastry
T1.2: P2P Node Implementation

- Completed; see deliverable D1.2. Two software versions.
- Distributed search for content.
- Specific for the WeCurate application.
T1.3: Electronic Institution Prototype

- Completed; see deliverable D1.3.
- The Horniman Museum was chosen for the WeCurate case study and an electronic institution specified for it.
T1.3: Electronic Institution Prototype
Last Year’s work

- P2P Electronic Institutions
- Autonomic agents
- Cultural experiences
- Results
WP2 Objectives

- Argumentation-based agent architecture
- BDI mental model
- Argumentation-based negotiation
T2.1: Autonomic Agent architecture

- Interfacing users to the system
- Storing the likes and dislikes as preferences
- Merging users’ tags (Group preference defined)
- Selecting subsequent images
- Architecture completed; see deliverable D2.1
- Model was implemented and presented at AT’12
T2.2: Negotiation Framework

- Arguments are supports for an overall image opinion as pairs \( \langle \text{tag}, \text{value} \rangle \)
- Arguments change dynamically, sometimes via private negotiations
- Work completed; see deliverable D2.2
- Work presented at MDAI’12
T2.2: Negotiation Framework

Figure 2: WeCurate interface.
T2.3: Personal autonomic agents for cultural experiences

- Largest development effort
- P2P EI connected with autonomic agents
- Work completed; see deliverable D2.3
- The model was implemented
T2.3: Personal autonomic agents for cultural experiences

- incarnate WeCurate users by storing their actions and arguments
- enact the curation workflow and the scenes
- support social interactions by means of agent-to-agent protocols
- take collective decisions to drive the curation workflow
- support argument-based multiple criteria decision making
T2.3: Personal autonomic agents for cultural experiences
Last Year’s work

- P2P Electronic Institutions
- Autonomic agents
- Cultural experiences
- Results
WP3 objectives

- Case study selection and specification
- Cultural experience prototype
- Validation of the prototype
T3.1: Case scenarios pilot study and Selection

- Completed; see deliverable D3.1.
- The Horniman Museum was chosen for the WeCurate case study.
T3.2: Case Study Specification

- Completed; see deliverable D3.2.
- Work was presented at AT 2012 Croatia.
- The case study was based around a public installation at the Horniman museum which took place in November 2012.
- A follow up case study was also developed for an exhibition that ran concurrently at 4 sites, 2 on campus at Goldsmiths and 2 off campus in Lewisham.
T3.3: Implementation of the Cultural Experience Prototype

- Completed; see deliverable D3.3a and D3.3b.
- Work presented at AAMAS 2013.
T3.4: Validation and evaluation of the prototype

- Public validation and evaluation carried out on site at Horniman Museum November 2012.
- Completed; see deliverable D3.4.
T3.4: Validation and evaluation of the prototype

WeCurate was installed as a multiuser museum interactive, and was used by visitors in groups of up to four people. Multiple sources of qualitative and quantitative data were collected:

- An automatic log of all participants actions (92 sessions)
- Observations based on field notes (37 sessions)
- Questionnaires (48 collected)

The analysis of the data concentrated on the distinct interactive behaviours of different social groups.
T3.4: Validation and evaluation of the prototype

High variation of engagement:

- Time: mean 5mins 38secs (+/- 4mins 25secs)
- Images viewed: mean 4.4 (+/- 4.1)

Social groups: 83% familiar with the group (46% family) reflecting the public’s everyday habits in cultural institutions. Key findings showed evidence of collective decision making and negotiation:

- Parent and child: scaffolded experience
- Adult groups: playful engagement and interdependent behaviours
T3.4: Validation and evaluation of the prototype

Strong evidence for the social group’s influence over individual’s decision making, made available via the WeCurate system:

- Participants felt they were able to communicate their preferences and had an awareness of the group’s intentions and opinions - 87% of participant were aware of others’ action via the synchronised view.

- The social group had an influence on individual’s decision making, as 42% reported changing their decision as a consequence of seeing (a representation of) other’s actions.

- Effectiveness of the agents - 75% of participants voted on the images they prefered.
T3.5: Self-evaluation

- Completed; see deliverable D3.5.
- The self evaluation addresses the primary research questions: does the agent technology enable users to share an experience, and are they good predictors of the behaviours of groups when making collective decisions? The successes, areas for improvement, and potential for future work are discussed.
Last Year’s work

- P2P Electronic Institutions
- Autonomic agents
- Cultural experiences
- Results
Results: Scalability

- 48 agents

- Message delivery time:
  - Number of nodes: 1, 2, 3, 4

- Graph shows the relationship between the number of nodes and message delivery time.
Results: Scalability

![Graph showing scalability results](image)

- **x-axis**: Number of agents
- **y-axis**: Message delivery time

### Key Points
- The graph illustrates the scalability of the system as the number of agents increases.
- At 4 nodes, the message delivery time is observed to be at its highest, indicating a potential bottleneck.
- The trend suggests that as the number of agents increases, the message delivery time also increases, which is crucial for understanding system performance under load.
Results: Publications I

Angela Fabregues and Carles Sierra.
HANA: a Human-Aware Negotiation Architecture.
In Decision Support Systems, In press.

Nardine Osman and Carles Sierra and Fiona McNeill and Juan Pane and John Debenham.
Trust and Matching Algorithms for Selecting Suitable Agents.
In ACM Transactions on Intelligent Systems and Technology, Volume 5, Issue 1, 2014.

Nardine Osman and Mark d’Inverno and Carles Sierra and Leila Amgoud and Henri Prade and Matthew Yee-King and Roberto Confalonieri and Dave de Jonge and Katina Hazelden.
An Experience-Based BDI Logic: Motivating Shared Experiences and Intentionality.
In the 39th Annual Conference of the IEEE Industrial Electronics Society (IECON 2013), Vienna, Austria, 2013.

Mark d’Inverno; Michael Luck; Pablo Noriega; Juan A. RodrÃguez-Aguilar and Carles Sierra.
Communicating Open Systems: Extended Abstract.
In IJCAI 2013, AAAI Press, Beijing, China, 2013.

Dave de Jonge, Bruno Rosell and Carles Sierra.
Human Interactions in Electronic Institutions.
Nardine Osman; Mark d’Inverno; Carles Sierra; Leila Amgoud; Henri Prade; Matthew Yee-King; Roberto Confalonieri; Dave de Jonge and Katina Hazelden.
An Experience-Based BDI Logic: Motivating Shared Experiences and Intentionality.
In the 39th Annual Conference of the IEEE Industrial Electronics Society (IECON 2013), Vienna, Austria, 2013.

Matthew Yee-King; Roberto Confalonieri; Dave de Jonge; Katina Hazelden; Carles Sierra; Mark d’Inverno; Leila Amgoud and Nardine Osman.
WeCurate: Enriching the sociocultural practices of the museum experience.
In AAMAS 2013, Saint Paul, Minnesota, USA, p.917-924 , 2013.

Katina Hazelden, Matthew Yee-King, Roberto Confalonieri, Dave de Jonge, Carles Sierra, and Mark d’Inverno.
Multiuser Museum Interactives for Shared Cultural Experiences: an Agent Based Approach.

Andrew Koster, Jordi Madrenas, Nardine Osman, Marco Schorlemmer, Jordi Sabater-Mir, Carles Sierra, Angela Fabregues, Dave de Jonge, Josep Puyol-Gruart, and Pere García.
u-Help: supporting helpful communities with information technology.

Katina Hazelden, Matthew Yee-King, Leila Amgoud, Mark d’Inverno, Carles Sierra, Nardine Osman, Roberto Confalonieri, and Dave de Jonge.
WeCurate: Multiuser museum interactives for shared cultural experiences.
Results: Publications III

Dave de Jonge and Carles Sierra.
Branch and bound for negotiations in large agreement spaces.

Leila Amgoud, Roberto Confalonieri, Dave de Jonge, Mark d’Inverno, Katina Hazelden, Nardine Osman, Henri Prade, Carles Sierra, and Matthew Yee-King.
Sharing online cultural experiences: An argument-based approach.

Andrew Koster, Jordi Madrenas-Ciurana, Nardine Osman, W. Marco Schorlemmer, Jordi Sabater-Mir, Carles Sierra, Dave De Jonge, Angela Fabregues, Josep Puyol-Gruart, and Pere Garcia-Calves.
u-Help: Supporting Helpful Communities with Information Technology.

Katina Hazelden, Matthew Yee-King, Leila Amgoud, Mark d’Inverno, Carles Sierra, Nardine Osman, Roberto Confalonieri, and Dave de Jonge.
WeCurate: Designing for synchronised browsing and social negotiation.


## Results: Meetings

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Place</th>
<th>Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/09/11</td>
<td>Kick-off Meeting</td>
<td>Barcelona</td>
<td>IIIA, GC and IRIT</td>
</tr>
<tr>
<td>20-21/10/11</td>
<td>Technical and MGT Meeting</td>
<td>Barcelona</td>
<td>IIIA, GC and IRIT</td>
</tr>
<tr>
<td>8-10/12/11</td>
<td>Technical and MGT Meeting</td>
<td>Toulouse</td>
<td>IIIA, GC and IRIT</td>
</tr>
<tr>
<td>06/01/12</td>
<td>Technical and MGT Meeting</td>
<td>London</td>
<td>IIIA, GC and IRIT</td>
</tr>
<tr>
<td>08/02/12</td>
<td>Technical and MGT Meeting</td>
<td>Barcelona</td>
<td>IIIA, GC and IRIT</td>
</tr>
<tr>
<td>13-17/02/12</td>
<td>Technical integration</td>
<td>London</td>
<td>IIIA and GC</td>
</tr>
<tr>
<td>28-30/03/12</td>
<td>Shared experiences and collective intentionality</td>
<td>Paris</td>
<td>IIIA and GC</td>
</tr>
<tr>
<td>3-4/05/12</td>
<td>Technical and MGT Meeting</td>
<td>Barcelona</td>
<td>IIIA, GC and IRIT</td>
</tr>
<tr>
<td>28/05/12</td>
<td>Technical integration</td>
<td>London</td>
<td>IIIA and GC</td>
</tr>
<tr>
<td>10-12/09/12</td>
<td>Technical integration</td>
<td>London</td>
<td>IIIA, IRIT and GC</td>
</tr>
<tr>
<td>14/10/12</td>
<td>Technical and MGT meeting</td>
<td>Dubrovnik</td>
<td>IIIA, IRIT and GC</td>
</tr>
<tr>
<td>22/02/13</td>
<td>MGT meeting</td>
<td>Skype meeting</td>
<td>IIIA, IRIT and GC</td>
</tr>
<tr>
<td>06-07/06/13</td>
<td>Technical and MGT meeting</td>
<td>Barcelona</td>
<td>IIIA, IRIT and GC</td>
</tr>
</tbody>
</table>
Results: Spin-off company

- We are working on the incubation of a spin-off company, **SocialBrowsing**, based on the acquired *know-how* and results of ACE.
- The incubation process is lead by one of the project’s members and it is supported by a valorisation manager and a scientific advisor both from IIIA-CSIC.
- Since agost 2013 we have taken several actions in order to create the spin-off.
Results: Spin-off Actions

1. Identification of competitive advantages:
   - A novel model of online and real-time collaboration
   - Group decision making algorithms such as selection, multiple-criteria, polls, etc.
   - Group interactions to create user and group profiles

2. Development of a business idea:
   - A SaaS for the agile development of social and collaborative business applications
   - We have participated in the VALORTEC 2013 Contest organised by ACC1O

3. Development of a business plan:
   - Many verticals possible (marketing, entertainment, education, tourism, etc.)
   - As part of the VALORTEC Contest we have developed our first business plan focusing on marketing research

---

1 The Agency for the Enterprise competitiveness of the Government of Catalonia
Results: Spin-off Actions

4 Building the founder team:
   - The current project team is:
     - Roberto Confalonieri as CEO and CTO
     - Lissette Lemus to support the commercialisation and marketing
     - Carles Sierra as Scientific Advisor
   - Looking to complete the team with a Software Engineer and a Sales Manager

5 Initial fund-raising:
   - We have estimated a first seed round of 83.000 €
   - We have presented the business plan to several local business angels
Results summary

- Consortium Agreement was signed
- Several general meetings
- 4 architects week-long meetings
- Two prototypes running
- User test completed
- All deliverables completed and publicly available
- 17 papers published
- 1 spin-off company planned
- 1 STREP project funded on call 8 based on ideas generated in ACE: PRAISE
Thanks!