HOW TO BUILD A SOFTWARE AGENT?

Ph.D. Esteban Guerrero esteban@cs.umu.se



CONTENT



QUESTIONS?



BEFORE START...

- Any question about the lecture?
- Any suggestion or petition?

Go to www.menti.com and use the code 63 46 25 7



ABOUT OUR LEARNING ENVIRONMENT



ESTEBAN GUERRERO

- Current position: Researcher
- Topic: Formal and applied methods of Artificial Intelligence for autonomous multi-agents systems
- Education:
 - Ph.D. in Computing Science, Umeå University. Sweden.
 - Ph. Lic. in Computing Science, Umeå University.
 - M.Sc. Master's degree in Computer Science, Malmö University. Sweden.
 - M.Sc. Master's studies in Telematics Engineering, University of Cauca. Colombia.
 - B.Eng. Bachelor degree in Electronic and Telecommunications Engineering, University of Cauca. Colombia.
- Industrial experience:
 - 4 years R&D engineer in a telecommunications company.





STAR-C: Sustainable behaviour change for health supported by person-Tailored, Adaptive, Riskaware digital Coaching in a social context Partners: Department of Computing Science, Department of Epidemiology and Global Health, Department of Culture and Media Studies and Department of Social Work Umeá University

Project period. 2018-12-01 - 2024-11-3

Funding agency: FORTE

Budget 14'940.000 SEK (Swedish krona)

Research subject: Public health and community medicine



Jonglera - an agent-based coaching system for stress management Partners: Computing Science dept. and dept. of Psychology, Umeå University Key words: multi-agent system; argumentation theory; coalitions; stress; psychology 2017-2019



Autonomous adaptation of software agents in the support of human activities Partners: Computing Science dept. Umeå University Sweden and Human Performance and Technology Lab., National Taiwan University, Taiwan



Intelligent skiing coach Partners: Computing Science dept. and Umeå School of Sport Sciences, Umeå University Key words: 3D camera, machine learning; multiagent system; biomechanics 2017-



Mobile sports science platform Partners: Computing Science dept. and Umeå School of Sport Sciences, Umeå University Key words: mobile application, multi-agent system; sensors; 2016-2017

https://people.cs.umu.se/esteban/



INTERACTIVITY IN SMART ENVIRONMENTS 2020



Towards a *trusted* intelligent coach

Partners: Computing Science dept. and Umeå School of Sport Sciences, Umeå University Key words: 3D camera; machine learning; multiagent system; biomechanics

2018-

OUR COMMUNICATIONS

• Top 5 4:

- 1. Email <u>esteban@cs.umu.se</u>
- 2. Canvas tools, chat, discussions, etc.
- 3. UmU Play video comments (<u>https://play.umu.se</u>)
- 4. YouTube video comments
- 5. Scheduled office visits



WHAT ABOUT YOU?

What experience in software tools do you have?

Open <u>https://www.menti.com/</u> Code 3093764



Artwork: Ketrina Yim, UC Berkeley CS188 ANTIFICIAL HITERING ENVIRONMENTS 2020

OUR AGREEMENTS

Social

- Respect
- Dialogue
- Inclusiveness



COVID related

- In physical laboratories sessions (if any) take measures <u>https://support.cs.umu.se/covid-information/info</u>
- If person is infected, contact ISE2020 course teachers



OUR AGREEMENTS

Technical

- Design/development attribution
- Design/development agreement
- Design/development acknowledgement
- Plagiarism has strong consequences <u>https://www.umu.se/en/student/we-can-assist-you/your-rights-and-responsibilities/cheating-and-plagiarism/</u>
- No Wizard-of-Oz in final projects (Adobe XD, Figma, Sketch, Balsamiq, etc.), only in the presentation of the initial design





ENGINEERING AGENTS



ENGINEERING AGENTS

Recap:

- The Belief-Desire-Intention (original) is a theory to explain and predict the behavior and mental state of people.
- BDI model in (computer science) is used to design software to explain predict behaviour of agents with mental states.

Think like people

Act like people



Think ration ly

Act rationally

Computational rationality, e.g. maximizing an expected utility

Artwork: <u>Ketrina Yim</u>, UC Berkeley <u>CS188 Artificial Intelligence</u>.

ENGINEERING AGENTS



TOOLS FOR BUILDING AGENT'S MODULES





KNOWLEDGE GRAPH CREATION



THE AGENT'S KNOWLEDGE



What an agent should have in its mind?



It depends on the environment!







TOOLS FOR KNOWLEDGE BUILDING



TOOLS FOR KNOWLEDGE BUILDING



Other alternatives:

ALTOVA SchemaAgent (pro: connected with UML and other tools; con: non free). URL: https://www.altova.com/

 AminePlatform (pro: open source; con: current version -2017- not working). URL: http://amineplatform.sourceforge.net/

Sigma (pro: open source; con: installation bugs mostly Linux support). URL: https://github.com/ontologypo rtal/sigmakee

TopQuadrant (pro: Eclipse-like; cons: bugs, non free)

PROGRAMMING LANGUAGES USED IN ARTIFICIAL INTELLIGENCE TOOLS









Question: What programming language(s) do you use/prefer? Answer keywords in https://www.menti.com/ code: 3093764





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Try some DL (Description Logics) queries with the people ontology and check the explanations:

- adult and has_pet some cat or has_pet some dog
- adult and has_pet value Rex
- woman and has_pet min 1 cat
- animal and is_pet_of some adult

Э	Existential, someValuesFrom	"some", "at least one"
A	Universal, allValuesFrom	"only"
Э	hasValue	"equals x"
=	Cardinality	"exactly n"
≤	Max Cardinality	"at most n"
2	Min Cardinality	"at least n"

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UMEÅ UNIVERSITY

Try Protégé with the core ontology!





TASK BUILDING A KNOWLEDGE BASE COLLABORATIVELY



Procedure:

•Split the group in Zoom rooms to form teams -randomly-

•Select a <u>specific</u> running example of a smart environment

- 1.Examples: an older adult living at home with some specific needs (smart home environment), a tourist looking for specific city places with particular needs (smart city), a mixed reality pet that work as a companion of a person with specific needs (smart virtual environment), etc. **–please imagine other scenarios**
- 1. Re-use the previous example maybe

•Knowledge graph collaboratively building based on the example

- 2.In the Zoom room one person opens the Zoom Whiteboard (Share Screen->Whiteboard-> Share)
- 3.Create the taxonomy of entities (nodes) with relationships (*is-a*) using a color
- 4.Create semantic relationships (e.g. **has_pet, is_pet_of**) with other color
- 5.Add some *individuals* in other words, examples or instances of those entities with other color
- 6.Add names of the group member in the top-left of the drawing
- 7.Add a title to the graph, example: older adult smart environment graph, tourist smart city graph, etc.

•Save the drawing graph locally

- 8.In Zoom click in Save on top of the Whiteboard
- •Answer questions (next slide), take notes about those answers. Then present those answers.

•Time 10 minutes

Alternatively, for sharing if Annotations and Whiteboard in Zoom is limited:

- 1. All the team members go to <u>0365.umu.se/</u>
- 2. Login with UmU credentials
- 3. One person creates and opens a new Whiteboard
- 4. Share the link of the new whiteboard with the other members via Zoom
- 5. Make the knowledge graph collaboratively
- 6. Save the graph



Procedure:

- Open Web protégé: <u>https://webprotege.stanford.edu/</u>
- Create an account
- Create the taxonomy (the families of knowledge entities)

•Time 10 minutes

Questions

•What information of the graph is *necessary*?

- •What parts of the graph *change on time* (dynamic smart environment variables)?
- •What information may be *uncertain* or *incomplete*?



PRESENTATION OF THE RUNNING EXAMPLE AND KNOWLEDGE GRAPH



PRESENTATION OF EXAMPLE AND KNOWLEDGE GRAPH

Procedure:

- Join the main Zoom session
- Different members of the group present the running example.
- Others present the graph.
- Other the reflections

Time for every presentation 5-10 minutes





MORE EXAMPLES AND RESOURCES



RESOURCES

Videos

- 1. Knowledge graph introduction using Protégé and Web Protégé
 - o <u>https://play.umu.se/media/t/o 3x6wbk3a</u>
- 2. Knowledge graph inference using Web Protégé

 <u>https://play.umu.se/media/t/o_w26f2068</u>
- 3. Knowledge graphs relationships
 - \circ <u>https://play.umu.se/media/t/o_kvb62yvt</u>





EXAMPLES



BDI Agents and Artifacts in Unity

14 commits	ទ្រៃ 2 branches	♥ 0 releases	😃 1 contributor
Branch: master New pull request			Find file Clone or download -
👷 conner985 Update README.md			Latest commit 4114c1e on Oct 24, 2018
Examples/RecyclingRobots	the example now have some balloo	ns to visualize what the bot is doing	2 years ago
UnityLogic	the example now have some balloo	ns to visualize what the bot is doing	2 years ago
README.md	Update README.md		last year

UnityLogic

world

BDI Agents and Artifacts in Unity

For any question you can contact me at: conner985@gmail.com

Development framework based on Prolog with interoperability with Unity to write complex behaviours in a declarative way - i.e. do_this, than_this, finally_this

You can read more about this project in my master thesis at: http://amslaurea.unibo.it/15657/1/poli_nicola_tesi.pdf

A video of the example developed using this architecture is available at: https://www.youtube.com/watch?v=BMHiZImVC3A

In the example, agents learn from one another and build their own behaviour at runtime sharing their knowledge of the

Game Engines and MAS: BDI & Artifacts in Unity

Author: Nicola POLI Supervisor: Prof. Andrea OMICINI

Cosupervisor: Dr. Stefano MARIANI

> Examiner: Dr. Silvia MIRRI

Thesis in Autonomous Systems

https://amslaurea.unibo.it/15657/1/poli_nicola_tesi.pdf

https://github.com/conner985/UnityLogic

EXAMPLES



E README.md

JS-son - a Lean, Extensible JavaScript Agent Programming Library

O PASSED docs passing

JS-son is a lean and extensible JavaScript library for programming agents. It has a focus on reasoning loops (agentinternals), and supports the belief-desire-intention approach, among others. Install it with:

npm install js-son-agent

Belief-Desire-Intention (BDI) Agents

JS-son follows the belief-desire-intention(-plan) (BDI) approach; a popular model for developing intelligent agents. However, it is also possible to implement agents that follow simpler reasoning-loop approaches. For example, in its simplest form, JSson agents can follow a *belief-plan* approach, that means based on their perception of their environment and their own internal state, the execution of plans--which act on the environment and update the agent's own beliefs--is determined.

In this section, we explain how JS-son agents make use of the BDI (and plan) concepts and how the Environment object type processes agent actions. For detailed documentation of the corresponding JS-son object types and functions, generate the JSDoc (see below).

Game of Life

- At each step in time, the following transitions occur:
- Any live cell with fewer than two live neighbours dies, as if by underpopulation.
- Any live cell with two or three live neighbours lives on to the next generation.
- Any live cell with more than three live neighbours dies, as if by overpopulation.
- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

https://people.cs.umu.se/~tkampik/demos/js-son/

THANK YOU

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Cost 1 - Human