Update of Agent-Based Systems Descriptor (10pt and 20pt versions)
M Rovatsos, submitted to Board of Studies Meeting, 9th March 2016

As it is currently unclear what proportion of UG3 courses will decide to move to 20 points in the future, how many course options will be available to AI students as a result of this, and how this will affect duties allocation, I am submitting two proposals for approval, one for a 10-credit version (Appendix B), and one for a 20-credit version (Appendix C) to give the School full flexibility to offer either of these.

The following changes to the current course format (Appendix A) are proposed for the **10-credit version**:

- Removal of learning outcomes related to agent programming and experimentation
- Removal of prerequisites and addition of a lecture to capture relevant background
- Reduction of summative assessment to one assignment
- Replacement of programming assignments by paper-and-pencil exercise
- Introduction of a formative piece of assessment in preparation for the summative assessment
- Removal of topic on logics for multiagent system and lecture on agent programming

These changes are expected to result in a **reduction from 11/112 to 7/85 hours of work** in a single peak week/the entire course for students. They would reduce the (currently excessive) breadth of topics covered in the course. A bespoke assignment topic for every student could be used over the entire course duration and embedded in tutorials, which should support linking different course topics to each other.

No major **resource implications** would result from this change, except a one-off slight re-design of some tutorial questions. The annual design of a bespoke assignment topic for every student requires some effort, but the lecture can vary either the target application scenarios *or* the tasks every student has to perform over any consecutive instances of the course to avoid plagiarism (e.g. change domains in year *i*, change tasks in year *i+1*, and so on).

We have experimented before with removal of all summatively assessed coursework, which caused a significant drop in average student performance on the course, hence it seems preferable to retain one piece of summative assessment to ensure students engage with the course in parallel to other semester-time commitments.

The following changes to the current course format are proposed for the **20-credit version**:

- Removal of prerequisites and addition of two lectures to capture relevant background
- Three lectures per week over eight weeks, more time to introduce the material at a slower pace
- Addition of two lectures on single-agent and multi-agent learning
- Introduction of a formative piece of assessment in preparation for the first summative assessment
- More drop-in lab support to help students with programming assignments

These changes are expected to result in an **increase from 11/112 to 12/135 hours of work** in a single peak week/the entire course for students. They would only increase the breadth of material covered by about 10% compared to the current course structure, and include more support for programming assignments that are currently quite challenging given that students are required to learn a new programming paradigm.

The new material on learning was included in the early years of the course, but had been removed as it led to excessive breadth of different topics covered. As in the 10-credit version, specific lectures are allocated to make up for lack of prerequisite knowledge, also in terms of programming, thus enabling students with different backgrounds to take it (in the past VUG students and MSc students have found parts of the course challenging due to their backgrounds).

In terms of **resource** implications, this would obviously result in 10 more credits of ABS being taught. A shift to 20 credits would require an update of lecture slides, though this will not be too onerous given that most of the work consists of enriching current material with more examples and explanations. Tutorial topics will have to be rearranged across different weeks to accommodate the new lecture schedule. Teaching support time will have to be increased slightly to accommodate a couple of additional drop-in labs.

If the 20-credit version is adopted, it would be most sensible to move it to Semester 1 as many other UG3 AI courses are offered in Semester 2. This is unless many other UG3 AI courses propose a semester change.

I would prefer for the course to be examined at the end of the semester it is taught in and the proposal for the 20-credit version is submitted subject to this assumption (lectures are only for 8 weeks, leaving enough time for revision, and tutorials could be moved to start in week 2 and finish in week 10).

Appendix A. Current course structure – Agent–Based Systems
Level 10, normal Year taken: 3, 10 points

The course is open to UG3, UG4, and MSc students. It has Inf2D (or equivalent knowledge) as a prerequisite, and Logic Programming is a strongly recommended prerequisite (some background in Prolog is useful for the programming assignments in Jason, a Prolog-based agent programming language).

Current learning outcomes are

- Describe and discuss different architectures for intelligent agents and interaction mechanisms for cooperative and competitive settings.
- Use abstract formal models of agents and agent interactions to analyse the properties of concrete designs.
- Explain the algorithmic and theoretical foundations of agents and multiagent systems, with an emphasis on knowledge-based and game-theoretic techniques.
- Be able to model, analyse and critically evaluate distributed systems using agent-based abstractions and related concepts.
- Design and implement agent-based systems using modern implementation platforms and agent programming languages.
- Design and conduct empirical experiments and evaluate the performance of implemented agent-based systems.

The course is currently delivered through 17 lectures:

1. Introduction
2. Abstract Agent Architectures
3. Deductive Reasoning Agents
4. Practical Reasoning Agents
5. Reactive and Hybrid Agent Architectures
6. Introduction to AgentSpeak/Jason
7. Agent Communication
8. Methods for Coordination
9. Multiagent Interactions
10. Social Choice
11. Coalition Formation
12. Resource Allocation
13. Bargaining
14. Argumentation in Multiagent Systems
15. Logics for Multiagent Systems
16. Summary and Concluding Remarks
17. Mock exam (feedback/feedforward event)

These are accompanied by 8 small-group **tutorials** from week 3 to week 11. A couple of **drop-in** labs are offered (though nor compulsory) to provide support with programming assignments.
The course follows the **standard assessment pattern** with a timetabled two-hour **exam** accounting for 75% of the course mark, and two **programming assignments** worth 12.5% each.

The estimated weekly workload for the course for a typical “core” week would include 3 hours for attending lectures and tutorial, 5 hours for work on programming assignments, and 3 hours of self-study. This totals to about **11 hours**, which is above the expected average at peak times.

In terms of total workload for the course, we have 25 = 17 + 8 for lectures and tutorials, 30 = 5 x 6 for work on assignments during six weeks, 33 hours for self-study during term time, and an estimated 24 hours for exam revision, which totals to **112 hours**, again over the target of 100 hours.

Appendix B. Proposed course structure – Agent–Based Systems (10 points)
Level 10, normal Year taken: 3
The course is open to UG3, UG4, and MSc students. No prerequisites.

Learning outcomes:[1]

- Describe and evaluate different architectures for intelligent agents and interaction mechanisms for cooperative and competitive settings.
- Use abstract formal models of agents and agent interactions to specify concrete designs and analyse their properties.
- Demonstrate an understanding of the algorithmic and theoretical foundations of agents and multiagent systems, with an emphasis on knowledge-based and game-theoretic techniques.
- Be able to model, analyse and critically evaluate distributed systems using agent-based abstractions and related concepts.

The course is delivered through 15 lectures[2]:

1. Introduction
2. Formal notation and logic-based modelling
3. Abstract Agent Architectures
4. Deductive Reasoning Agents
5. Practical Reasoning Agents
6. Reactive and Hybrid Agent Architectures
7. Agent Communication
8. Methods for Coordination
9. Multiagent Interactions
10. Social Choice
11. Coalition Formation
12. Resource Allocation
13. Bargaining
14. Argumentation in Multiagent Systems
15. Summary and Concluding Remarks

These are accompanied by 8 small-group **tutorials** from week 3 to week 11.

The course follows the **standard assessment pattern** with a timetabled two-hour **exam** accounting for 75% of the course mark, and one summative **paper-and-pencil assignment** worth 25%.

The **assessed coursework** involves producing a semi-formal specification and narrative description of a system that uses agent-based techniques in a target application domain. Each student has to work on a different target scenario provided by the lecturer. The **formative assessment** is a preliminary submission of the summative assessment, which is discussed in small-group scheduled feedback labs in the week after its submission, in good time before the final submission of the assessed coursework.

The estimated weekly workload for the course for a typical "core" week would include 3 hours for attending lectures and tutorial, 2 hours for working on the assignment or attending a feedback lab, and 2 hours of self-study. This totals to about **7 hours** in peak weeks.

In terms of total workload for the course, we have 23 = 15 + 8 for lectures and tutorials, 16 = 2 x 10 for work on assignments during ten weeks, 22 hours for self-study during term time, and an estimated 20 hours for exam revision, which totals to **85 hours**.

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[1] Programming- and experimentation-related learning outcomes have been removed, and others emphasise design and critical analysis skills more.

[2] Advanced logics and agent programming have been removed, and a new lecture introduced to refresh formal notation and logic-based modelling skills, especially to support students who don't have an Inf2D background.

Appendix C. Proposed course structure – Agent–Based Systems (20 points)

Level 10, normal Year taken: 3

The course is open to UG3, UG4, and MSc students. No prerequisites.

Learning outcomes:[3]

- Describe and evaluate different architectures for intelligent agents and interaction mechanisms for cooperative and competitive settings.
- Use abstract formal models of agents and agent interactions to specify concrete designs and analyse their properties.
- Demonstrate an understanding of the algorithmic and theoretical foundations of agents and multiagent systems, with an emphasis on knowledge-based and game-theoretic techniques.
- Be able to model, analyse and critically evaluate distributed systems using agent-based abstractions and related concepts.
- Design and implement agent-based systems using modern implementation platforms and agent programming languages.
- Design and conduct empirical experiments and evaluate the performance of implemented agent-based systems.

The course is delivered through 24 lectures:

1. Introduction
2. Formal notation basics (refresher on set-theoretic notation etc)
3. Abstract Agent Architectures
4. First-Order Logic (refresher of material from Inf2D)
5. Modal Logic (possible worlds, axiom systems etc)
6. Deductive Reasoning Agents
7. Practical Reasoning Agents
8. Agent Programming I (introduction of paradigm and basic concepts)
9. Agent Programming II (examples and case studies)
10. Reasoning about Rational Agents (applying epistemic logic to describing agents)
11. Reactive and Hybrid Agent Architectures
12. Agent Communication (updated to include more material on semantics)
13. Methods for Coordination
14. Multiagent logics (logic-based modelling for multiple agents)
15. Argumentation in Multiagent Systems
16. Decision Theory and Game Theory (broader introduction to basic concepts)
17. Multiagent Interactions
18. Social Choice
19. Coalition Formation
20. Resource Allocation
21. Bargaining
22. Single-agent learning (basic reinforcement learning)
23. Multiagent Learning (multiagent reinforcement learning algorithms)
24. Summary and Concluding Remarks

With the exception of two lectures on learning (introducing methods not covered in IVR, IAR, and IAML), no new material is added. Instead, the current material is stretched across more lectures, and the ordering changed to introduce the formal foundations for each method before/after it is introduced. About 45% of the lectures focus on symbolic and game-theoretic/numerical methods respectively, the remaining 10% on agent programming.

The lectures are accompanied by 8 small-group **tutorials** from week 3 to week 11. Four **drop-in** labs are offered (though nor compulsory) to provide support with programming assignments.

The course follows the **standard assessment pattern** with a timetabled two-hour **exam** accounting for 75% of the course mark, and two **programming assignments** worth 12.5% each. The **formative assessment** is a preliminary submission of the first summative assessment, which is discussed in small-group scheduled feedback labs in the week after its submission, in good time before the submission of the assessed coursework.

The estimated weekly workload for the course for a typical "core" week would include 4 hours for attending lectures and tutorial, 5 hours for working on the assignment, and 3 hours of self-study. This totals to about **12 hours** in peak weeks. In terms of total workload for the course, we have 32 = 24 + 8 for lectures and tutorials, 30 = 6 x 5 for work on assignments during six weeks, 33 hours for self-study during term time, and an estimated 40 hours for exam revision, which totals to **135 hours**.

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[3] As per current descriptor, slight rewording of some outcomes.