| | Universitas Negeri Surabaya<br>Faculty of Mathematics and Natural Sciences<br>Data Science Undergraduate Study Program | Document Code |
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# SEMESTER LEARNING PLAN

| Courses | CODE | Course Family | Credit Weight | | | SEMESTER | Compilation Date |
|---|---|---|---|---|---|---|---|
| Artificial Intelligence | 4920203014 | | T=2 | P=1 | ECTS=4.77 | 3 | March 27, 2022 |

| AUTHORIZATION | SP Developer | Course Cluster Coordinator | Study Program Coordinator |
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| | Dr. Elly Matul Imah, M.Kom | ..... | Yuliani Puji Astuti, S.Si., M.Si. |

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| **Learning model** | **Project Based Learning** | |
| **Program Learning Outcomes (PLO)** | **PLO study program that is charged to the course** | |
| | **PLO-11** | Able to implement data science technology in real problems |
| | **PLO-18** | Mastering information technology concepts both in terms of computing and data management to solve data science problems |
| | **Program Objectives (PO)** | |
| | **PO - 1** | Students are able to explain the basic concepts of intelligent and autonomous agents |
| | **PO - 2** | Students are able to apply the state-space-search thinking framework, both uninformed and informed search, to model a problem, and design and implement it to solve the problem |
| | **PO - 3** | Students are able to apply local-search to overcome complexity problems in state-space-search |
| | **PO - 4** | Students are able to apply adversarial-search to determine optimization strategies |
| | **PO - 5** | Students are able to apply techniques for solving constraint satisfaction problems |
| | **PO - 6** | Students are able to use logic as a knowledge representation language to model aspects of the real world, as well as carry out reasoning on these representations |
| | **PO - 7** | Students are able to apply the principles of decision making based on modeling and probabilistic reasoning as well as learning from data |
| | **PO - 8** | Students are able to explain approaches to designing multi-agent systems |
| | **PO - 9** | Students are able to design problem solutions using artificial intelligence techniques |
| | **PLO-PO Matrix** | |

| P.O | PLO-11 | PLO-18 |
|---|---|---|
| PO-1 | | |
| PO-2 | | |
| PO-3 | | |
| PO-4 | | |
| PO-5 | | |
| PO-6 | | |
| PO-7 | | |
| PO-8 | | |
| PO-9 | | |

**PO Matrix at the end of each learning stage (Sub-PO)**

| P.O | Week | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| PO-1 | | | | | | | | | | | | | | | | |
| PO-2 | | | | | | | | | | | | | | | | |
| PO-3 | | | | | | | | | | | | | | | | |
| PO-4 | | | | | | | | | | | | | | | | |
| PO-5 | | | | | | | | | | | | | | | | |
| PO-6 | | | | | | | | | | | | | | | | |
| PO-7 | | | | | | | | | | | | | | | | |
| PO-8 | | | | | | | | | | | | | | | | |
| PO-9 | | | | | | | | | | | | | | | | |

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| **Short Course Description** | This course introduces the basic concepts of artificial intelligence as well as various approaches and techniques for solving problems in the field of artificial intelligence. Lecture participants will be equipped with theoretical understanding and practical skills related to the basics of developing intelligent and autonomous agents. Topics discussed include the concepts of artificial intelligence and rational agents; modeling techniques and finding solutions to a variety of problems in intelligent systems, including: uninformed search, informed/heuristic search, local search, adversarial search, constraint satisfaction problems, logical approach to knowledge representation and reasoning, probabilistic approach to decision making, machine learning, multi-agent systems; as well as philosophical and ethical issues of artificial intelligence. |
| **References** | **Main :** |
| | 1. 1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.<br>2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017. |
| | **Supporters:** |
| | 1. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017. |
| **Supporting lecturer** | Dr. Elly Matul Imah, M.Kom.<br>Riskyana Dewi Intan Puspitasari, M.Kom. |

| Week- | Final abilities of each learning stage (Sub-PO) | Evaluation | | Help Learning, Learning methods, Student Assignments, [ Estimated time] | | Learning materials [ References ] | Assessment Weight (%) |
|---|---|---|---|---|---|---|---|
| | | Indicator | Criteria & Form | Offline ( *offline* ) | Online ( *online* ) | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1 | Students are able to explain the basic concepts of intelligent and autonomous agents | 1. Able to explain the history and basic concepts of artificial intelligence<br>2. Able to explain the concepts of agent and environment<br>3. Able to explain the structure and behavior of intelligent agents and their environment | **Criteria:** Non-Test Assignments<br><br>**Form of Assessment** : Participatory Activities | - Presentation<br>- Questions and answers<br><br>TM: 150”<br>PT : 150”<br>BM: 150”<br>3x50 | Discussion via LMS | **Material:** History of artificial intelligence, Concept of artificial intelligence, Agents and environment, Structure and behavior of intelligent agents<br>**References:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |

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| **2** | Students are able to apply the state-space-search thinking framework, both uninformed and informed search, to model a problem, and design and implement it to solve the problem | 1. Able to understand the state-space-search framework for modeling a problem<br>2. Able to explain the concept of uninformed search such as: Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, and Bidirectional search<br>3. Able to implement the concept of uninformed search to model and solve a problem. | **Form of Assessment** : Participatory Activities | - Presentation - Questions and answers<br><br>TM: 150"<br>PT : 150"<br>BM: 150"<br>3x50 | Discussion via LMS | **Material:** Concept of state-space-search framework, Concept of uninformed search, Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search - Bidirectional search<br>References :<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |
| **3** | Students are able to apply the state-space-search thinking framework, both uninformed and informed search, to model a problem, and design and implement it to solve the problem | 1. Able to explain informed search concepts such as: Greedy best-first search, A* search, and Memory-bounded heuristic search<br>2. Able to implement the concept of informed search to model and solve a problem | **Criteria:** Non-Test Assignments<br><br>**Form of Assessment** : Participatory Activities | - Presentation - Questions and answers<br><br>TM: 150"<br>PT : 150"<br>BM: 150"<br>3x50 | Discussion via LMS | **Material:** Concept of informed search, Greedy best-first search, A* search, Memory-bounded heuristic search<br>**References:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 5% |

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| **4** | Students are able to apply local-search to overcome complexity problems in state-space-search | 1. Able to explain the basic concepts of local search algorithms<br>2. Able to explain the types of local search algorithms such as: Hill-climbing search, Simulated annealing, Local beam search, and Genetic algorithms<br>3. Able to explain the concept of local search in a continuous environment | **Form of Assessment** : Participatory Activities | - Presentation - Questions and answers<br><br>TM: 150"<br>PT : 150"<br>BM: 150"<br>3x50 | Discussion via LMS | **Material:** Concept of local search, Hill-climbing search, Simulated annealing, Local beam search, Genetic algorithms, Local Search in a continuous environment, and Online Search<br>**Library:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |
| **5** | Students are able to apply adversarial search to determine optimization strategies | 1. Able to define the game into a search problem<br>2. Able to explain the concept of algorithms to determine optimal strategies for games such as: minimax algorithm, and alpha-beta search<br>3. Able to explain techniques for overcoming problems in adversarial search<br>4. Able to implement adversarial search to determine optimization strategies | **Criteria:**<br>Non-Test Assignments<br><br>**Form of Assessment** : Participatory Activities | - Presentation - Questions and answers<br><br>TM: 150"<br>PT : 150"<br>BM: 150"<br>3x50 | Discussion via LMS | **Material:** Search problems in games, Minimax algorithm, Alpha-beta search, Cutting off search, Forward pruning<br>**Library:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |

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| **6** | Students are able to apply techniques for solving constraint satisfaction problems | 1. Able to define constraint satisfaction problems<br>2. Able to explain the concept of inference techniques in CSP<br>3. Able to explain CSP solving techniques such as: Backtracking search, minimum-remaining-values and degree heuristics, least-constraining-value heuristic, Local search using the min-conflicts heuristic, Cutset conditioning, and Tree decomposition. | **Form of Assessment** : Participatory Activities | - Presentation<br>- Questions and answers<br><br>TM: 150"<br>PT : 150"<br>BM: 150"<br>3x50 | Discussion via LMS | **Material:** Concept of constraint satisfaction problems, Inference techniques in CSP, Backtracking search, Minimum-remaining-values and degree heuristics, Least-constraining-value heuristic, Local search using the min-conflicts heuristic, Cutset conditioning, Tree decomposition<br>**Literature:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |
| **7** | Students are able to use logic as a knowledge representation language to model aspects of the real world, as well as carry out reasoning on these representations | 1. Able to explain the concept of knowledge-base<br>2. Able to explain the concept of representation language<br>3. Able to explain the concept of Logic<br>4. Able to use logic as a language of representation<br>5. Able to explain the concept of propositional logic and inference formulas and proof<br>6. Able to build agents using propositional logic | **Form of Assessment** : Participatory Activities | - Presentation<br>- Questions and answers<br><br>TM: 150"<br>PT : 150"<br>BM: 150"<br>3x50 | Discussion via LMS | **Material:** Knowledge-base, Representation language, Logic, Propositional logic, Inference, Building agents using propositional logic<br>**Literature:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |

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| **8** | | Able to answer the questions tested | **Criteria:**<br>Writing test<br><br>**Form of Assessment** :<br>Test | Written Exam<br>2x50 | | **Material:** All taught chapters<br>**References:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 20% |
| **9** | Students are able to use logic as a knowledge representation language to model aspects of the real world, as well as carry out reasoning on these representations | 1. Able to explain appropriate representation language<br>2. Able to explain the concept of models from first-order logic<br>3. Able to explain symbols and interpretation of first-order logic<br>4. Able to build agents using a first-order logic approach<br>5. Able to explain inference in first-order logic | **Form of Assessment** :<br>Practice / Performance | - Presentation<br>- Questions and answers<br><br>TM: 150”<br>PT : 150”<br>BM: 150”<br>3x50 | Discussion via LMS | **Material:** First-order logic, Symbols and interpretation of first-order logic, Building agents using a first-order logic approach, Inference in first-order logic<br>**Literature:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |

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| **10** | Students are able to apply the principles of decision making based on modeling and probabilistic reasoning as well as learning from data | 1. Able to explain the concept of Bayesian Networks<br>2. Able to explain the concept of conditional distribution representation<br>3. Able to explain the concept of inference in Bayesian networks<br>4. Able to explain stochastic approximation techniques<br>5. Able to implement decision making principles based on modeling | **Form of Assessment** : Participatory Activities | - Presentation<br>- Questions and answers<br><br>TM: 150”<br>PT : 150”<br>BM: 150”<br>3x50 | Discussion via LMS | **Material:** Bayesian Networks, Representation of conditional distributions, Inference in Bayesian networks, Stochastic approximation techniques, Implementation of decision making principles based on modeling.<br>**Literature:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 5% |
| **11** | Students are able to apply the principles of decision making based on modeling and probabilistic reasoning as well as learning from data | 1. Able to explain the concept of supervised learning including classification and regression problems<br>2. Able to explain the concept of the Decision Tree algorithm<br>3. Able to explain the concept of learning algorithm performance evaluation including the learning curve<br>4. Able to explain the division of train data and test data using cross-validation)<br>5. Able to explain machine learning algorithm concepts such as: linear regression, logistic regression, neural networks, support vector machines, and ensemble learning | **Form of Assessment** : Participatory Activities | - Presentation<br>- Questions and answers<br><br>TM: 150”<br>PT : 150”<br>BM: 150”<br>3x50 | Discussion via LMS | **Material:** Supervised learning, Decision Tree, Learning curve, Cross-validation, Linear regression, Logistic regression, Neural networks, Support vector machine (SVM), Ensemble learning<br>**Library:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 5% |

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| **12** | Students are able to explain approaches to designing multi-agent systems | Students are able to explain Multi agents | **Form of Assessment** : Participatory Activities | - Presentation - Questions and answers<br><br>TM: 150”<br>PT : 150”<br>BM: 150”<br>3x50 | Discussion via LMS | **Material:** Multi Agents<br>**Library:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 5% |
| **13** | Students are able to explain approaches to designing multi-agent systems | 1. Students are able to explain the weaknesses and strengths of artificial intelligence<br>2. Students are able to identify threats to society posed by artificial intelligence and related technologies | **Form of Assessment** : Participatory Activities | - Presentation - Questions and answers<br><br>TM: 150”<br>PT : 150”<br>BM: 150”<br>3x50 | Discussion via LMS | **Material:** Weaknesses and advantages of artificial intelligence, Identifying threats of artificial intelligence to society<br>**References:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 2% |

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| **14** | Students are able to design problem solutions using artificial intelligence techniques | 1. Able to formulate research questions from real world problems that will be solved using deep learning models<br>2. Able to conduct literature studies related to research questions<br>3. Able to design problem solving methods using deep learning models | **Form of Assessment** : Project Results Assessment / Product Assessment | - Presentation - Questions and answers<br><br>TM: 150”<br>PT: 150”<br>TM: 150”<br>3x50 | Discussion via LMS | **Material:** Developing research questions, literature study, **library method design:** *1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 10% |
| **15** | Students are able to design problem solutions using artificial intelligence techniques | 1. Able to implement problem solving methods using techniques from artificial intelligence<br>2. Able to carry out analysis of the results of experiments carried out<br>3. Able to draw conclusions from experiments carried out and compare them with constraints from similar applications | **Form of Assessment** : Project Results Assessment / Product Assessment | - Presentation - Questions and answers<br><br>TM: 150”<br>PT: 150”<br>TM: 150”<br>3x50 | Discussion via LMS | **Material:** Method Implementation, Results Analysis, Conclusion **Literature:** *1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 10% |

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| **16** | | 1. Able to present projects carried out<br>2. Able to convey the implementation of the project being worked on<br>3. Able to answer the questions given | **Criteria:**<br>Oral test<br><br>**Form of Assessment** :<br>Project Results Assessment / Product Assessment | - Final Project Presentation<br>- Question and answer<br>- 3x50 project assessment | Upload assignments via LMS | **Material:**<br>Presentation, question and answer, discussion<br>**References:**<br>*1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall 2010.*<br>*2. David Poole & Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press 2017.* | 30% |

**Evaluation Percentage Recap: Project Based Learning**

| No | Evaluation | Percentage |
|---|---|---|
| 1. | Participatory Activities | 34% |
| 2. | Project Results Assessment / Product Assessment | 50% |
| 3. | Practice / Performance | 2% |
| 4. | Test | 20% |
| | | 100% |

**Notes**

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.