



Ucayali State University (UNU)  
School of Computer Science  
Syllabus 2023-I

## 1. COURSE

CS261. Intelligent Systems (Mandatory)

## 2. GENERAL INFORMATION

2.1 Credits	:	4
2.2 Theory Hours	:	2 (Weekly)
2.3 Practice Hours	:	2 (Weekly)
2.4 Duration of the period	:	16 weeks
2.5 Type of course	:	Mandatory
2.6 Modality	:	Blended
2.7 Prerequisites	:	MA203. Statistics and Probabilities. (4 <sup>th</sup> Sem)

## 3. PROFESSORS

Meetings after coordination with the professor

## 4. INTRODUCTION TO THE COURSE

Research in Artificial Intelligence has led to the development of numerous relevant tonic, aimed at the automation of human intelligence, giving a panoramic view of different algorithms that simulate the different aspects of the behavior and the intelligence of the human being.

## 5. GOALS

- Evaluate the possibilities of simulation of intelligence, for which the techniques of knowledge modeling will be studied.
- Build a notion of intelligence that later supports the tasks of your simulation.

## 6. COMPETENCES

- a) An ability to apply knowledge of mathematics, science. (**Usage**)
- h) A recognition of the need for, and an ability to engage in life-long learning. (**Familiarity**)
- i) An ability to use the techniques, skills, and modern computing tools necessary for computing practice. (**Familiarity**)
- j) Apply the mathematical basis, principles of algorithms and the theory of Computer Science in the modeling and design of computational systems in such a way as to demonstrate understanding of the equilibrium points involved in the chosen option. (**Familiarity**)

## 7. TOPICS

Unit 1: Fundamental Issues (2)	
Competences Expected: a	
Topics	Learning Outcomes
<ul style="list-style-type: none"> <li>• Overview of AI problems, examples of successful recent AI applications</li> <li>• What is intelligent behavior? <ul style="list-style-type: none"> <li>– The Turing test</li> <li>– Rational versus non-rational reasoning</li> </ul> </li> <li>• Problem characteristics <ul style="list-style-type: none"> <li>– Fully versus partially observable</li> <li>– Single versus multi-agent</li> <li>– Deterministic versus stochastic</li> <li>– Static versus dynamic</li> <li>– Discrete versus continuous</li> </ul> </li> <li>• Nature of agents <ul style="list-style-type: none"> <li>– Autonomous versus semi-autonomous</li> <li>– Reflexive, goal-based, and utility-based</li> <li>– The importance of perception and environmental interactions</li> </ul> </li> <li>• Philosophical and ethical issues.</li> </ul>	<ul style="list-style-type: none"> <li>• Describe Turing test and the “Chinese Room” thought experiment [Usage]</li> <li>• Determining the characteristics of a given problem that an intelligent systems must solve [Usage]</li> </ul>
<b>Readings :</b> [De 06], [Pon+14]	

<b>Unit 2: Agents (2)</b>	
<b>Competences Expected: a</b>	
<b>Topics</b>	<b>Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Definitions of agents</li> <li>• Agent architectures (e.g., reactive, layered, cognitive)</li> <li>• Agent theory</li> <li>• Rationality, game theory <ul style="list-style-type: none"> <li>– Decision-theoretic agents</li> <li>– Markov decision processes (MDP)</li> </ul> </li> <li>• Software agents, personal assistants, and information access <ul style="list-style-type: none"> <li>– Collaborative agents</li> <li>– Information-gathering agents</li> <li>– Believable agents (synthetic characters, modeling emotions in agents)</li> </ul> </li> <li>• Learning agents</li> <li>• Multi-agent systems <ul style="list-style-type: none"> <li>– Collaborating agents</li> <li>– Agent teams</li> <li>– Competitive agents (e.g., auctions, voting)</li> <li>– Swarm systems and biologically inspired models</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• List the defining characteristics of an intelligent agent [Usage]</li> <li>• Characterize and contrast the standard agent architectures [Usage]</li> <li>• Describe the applications of agent theory to domains such as software agents, personal assistants, and believable agents [Usage]</li> <li>• Describe the primary paradigms used by learning agents [Usage]</li> <li>• Demonstrate using appropriate examples how multi-agent systems support agent interaction [Usage]</li> </ul>
<b>Readings :</b> [Nil01], [RN03], [Pon+14]	

<b>Unit 3: Basic Search Strategies (2)</b>	
<b>Competences Expected: a,j</b>	
<b>Topics</b>	<b>Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Problem spaces (states, goals and operators), problem solving by search</li> <li>• Factored representation (factoring state into variables)</li> <li>• Uninformed search (breadth-first, depth-first, depth-first with iterative deepening)</li> <li>• Heuristics and informed search (hill-climbing, generic best-first, A*)</li> <li>• Space and time efficiency of search</li> <li>• Two-player games (introduction to minimax search)</li> <li>• Constraint satisfaction (backtracking and local search methods)</li> </ul>	<ul style="list-style-type: none"> <li>• Formulate an efficient problem space for a problem expressed in natural language (eg, English) in terms of initial and goal states, and operators [Usage]</li> <li>• Describe the role of heuristics and describe the trade-offs among completeness, optimality, time complexity, and space complexity [Usage]</li> <li>• Describe the problem of combinatorial explosion of search space and its consequences [Usage]</li> <li>• Compare and contrast basic search issues with game playing issues [Usage]</li> </ul>
<b>Readings :</b> [Nil01], [Pon+14]	

Unit 4: Advanced Search (18)	
Competences Expected: a,j	
Topics	Learning Outcomes
<ul style="list-style-type: none"> <li>• Stochastic search <ul style="list-style-type: none"> <li>– Simulated annealing</li> <li>– Genetic algorithms</li> <li>– Monte-Carlo tree search</li> </ul> </li> <li>• Constructing search trees, dynamic search space, combinatorial explosion of search space</li> <li>• Implementation of A* search, beam search</li> <li>• Minimax search, alpha-beta pruning</li> <li>• Expectimax search (MDP-solving) and chance nodes</li> </ul>	<ul style="list-style-type: none"> <li>• Design and implement a genetic algorithm solution to a problem [Usage]</li> <li>• Design and implement a simulated annealing schedule to avoid local minima in a problem [Usage]</li> <li>• Design and implement A*,beam search to solve a problem [Usage]</li> <li>• Apply minimax search with alpha-beta pruning to prune search space in a two-player game [Usage]</li> <li>• Compare and contrast genetic algorithms with classic search techniques [Usage]</li> <li>• Compare and contrast various heuristic searches vis-a-vis applicability to a given problem [Usage]</li> </ul>
<b>Readings :</b> [Gol89], [Nil01], [RN03], [Pon+14]	

Unit 5: Reasoning Under Uncertainty (18)	
Competences Expected: a,j	
Topics	Learning Outcomes
<ul style="list-style-type: none"> <li>• Review of basic probability</li> <li>• Random variables and probability distributions <ul style="list-style-type: none"> <li>– Axioms of probability</li> <li>– Probabilistic inference</li> <li>– Bayes' Rule</li> </ul> </li> <li>• Conditional Independence</li> <li>• Knowledge representations <ul style="list-style-type: none"> <li>– Bayesian Networks <ul style="list-style-type: none"> <li>* Exact inference and its complexity</li> <li>* Randomized sampling (Monte Carlo) methods (e.g. Gibbs sampling)</li> </ul> </li> <li>– Markov Networks</li> <li>– Relational probability models</li> <li>– Hidden Markov Models</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Apply Bayes' rule to determine the probability of a hypothesis given evidence [Usage]</li> <li>• Explain how conditional independence assertions allow for greater efficiency of probabilistic systems [Usage]</li> <li>• Identify examples of knowledge representations for reasoning under uncertainty [Usage]</li> <li>• State the complexity of exact inference Identify methods for approximate inference [Usage]</li> </ul>
<b>Readings :</b> [KF09], [RN03]	

<b>Unit 6: Basic Machine Learning (4)</b>	
<b>Competences Expected: a,j</b>	
<b>Topics</b>	<b>Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Definition and examples of broad variety of machine learning tasks, including classification</li> <li>• Inductive learning</li> <li>• Simple statistical-based learning, such as Naive Bayesian Classifier, decision trees</li> <li>• The over-fitting problem</li> <li>• Measuring classifier accuracy</li> </ul>	<ul style="list-style-type: none"> <li>• List the differences among the three main styles of learning: supervised, reinforcement, and unsupervised [Usage]</li> <li>• Identify examples of classification tasks, including the available input features and output to be predicted [Usage]</li> <li>• Explain the difference between inductive and deductive learning [Usage]</li> <li>• Describe over-fitting in the context of a problem [Usage]</li> <li>• Apply the simple statistical learning algorithm such as Naive Bayesian Classifier to a classification task and measure the classifier's accuracy [Usage]</li> </ul>
<b>Readings :</b> [Mit98], [RN03], [Pon+14]	

<b>Unit 7: Advanced Machine Learning (20)</b>	
<b>Competences Expected: a,j</b>	
<b>Topics</b>	<b>Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Definition and examples of broad variety of machine learning tasks</li> <li>• General statistical-based learning, parameter estimation (maximum likelihood)</li> <li>• Inductive logic programming (ILP)</li> <li>• Supervised learning <ul style="list-style-type: none"> <li>– Learning decision trees</li> <li>– Learning neural networks</li> <li>– Support vector machines (SVMs)</li> </ul> </li> <li>• Unsupervised Learning and clustering <ul style="list-style-type: none"> <li>– EM</li> <li>– K-means</li> <li>– Self-organizing maps</li> </ul> </li> <li>• Semi-supervised learning</li> <li>• Learning graphical models</li> <li>• Performance evaluation (such as cross-validation, area under ROC curve)</li> <li>• Application of Machine Learning algorithms to Data Mining (cross-reference IM/Data Mining)</li> </ul>	<ul style="list-style-type: none"> <li>• Explain the differences among the three main styles of learning: supervised, reinforcement, and unsupervised [Usage]</li> <li>• Implement simple algorithms for supervised learning, reinforcement learning, and unsupervised learning [Usage]</li> <li>• Determine which of the three learning styles is appropriate to a particular problem domain [Usage]</li> <li>• Compare and contrast each of the following techniques, providing examples of when each strategy is superior: decision trees, neural networks, and belief networks [Usage]</li> <li>• Evaluate the performance of a simple learning system on a real-world dataset [Usage]</li> <li>• Characterize the state of the art in learning theory, including its achievements and its shortcomings [Usage]</li> <li>• Explain the problem of overfitting, along with techniques for detecting and managing the problem [Usage]</li> </ul>
<b>Readings :</b> [RN03], [KF09], [Mur12]	

Unit 8: Natural Language Processing (12)	
Competences Expected: a,j	
Topics	Learning Outcomes
<ul style="list-style-type: none"> <li>• Deterministic and stochastic grammars</li> <li>• Parsing algorithms <ul style="list-style-type: none"> <li>– CFGs and chart parsers (e.g. CYK)</li> <li>– Probabilistic CFGs and weighted CYK</li> </ul> </li> <li>• Representing meaning / Semantics <ul style="list-style-type: none"> <li>– Logic-based knowledge representations</li> <li>– Semantic roles</li> <li>– Temporal representations</li> <li>– Beliefs, desires, and intentions</li> </ul> </li> <li>• Corpus-based methods</li> <li>• N-grams and HMMs</li> <li>• Smoothing and backoff</li> <li>• Examples of use: POS tagging and morphology</li> <li>• Information retrieval <ul style="list-style-type: none"> <li>– Vector space model <ul style="list-style-type: none"> <li>* TF &amp; IDF</li> </ul> </li> <li>– Precision and recall</li> </ul> </li> <li>• Information extraction</li> <li>• Language translation</li> <li>• Text classification, categorization <ul style="list-style-type: none"> <li>– Bag of words model</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Define and contrast deterministic and stochastic grammars, providing examples to show the adequacy of each [Usage]</li> <li>• Simulate, apply, or implement classic and stochastic algorithms for parsing natural language [Usage]</li> <li>• Identify the challenges of representing meaning [Usage]</li> <li>• List the advantages of using standard corpora Identify examples of current corpora for a variety of NLP tasks [Usage]</li> <li>• Identify techniques for information retrieval, language translation, and text classification [Usage]</li> </ul>
<b>Readings :</b> [Nil01], [RN03], [Pon+14]	

Unit 9: Perception and Computer Vision (12)	
Competences Expected: a,j	
Topics	Learning Outcomes
<ul style="list-style-type: none"> <li>• Computer vision <ul style="list-style-type: none"> <li>– Image acquisition, representation, processing and properties</li> <li>– Shape representation, object recognition and segmentation</li> <li>– Motion analysis</li> </ul> </li> <li>• Modularity in recognition</li> <li>• Approaches to pattern recognition <ul style="list-style-type: none"> <li>– Classification algorithms and measures of classification quality</li> <li>– Statistical techniques</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Summarize the importance of image and object recognition in AI and indicate several significant applications of this technology [Usage]</li> <li>• List at least three image-segmentation approaches, such as thresholding, edge-based and region-based algorithms, along with their defining characteristics, strengths, and weaknesses [Usage]</li> <li>• Implement 2d object recognition based on contour-and/or region-based shape representations [Usage]</li> <li>• Provide at least two examples of a transformation of a data source from one sensory domain to another, eg, tactile data interpreted as single-band 2d images [Usage]</li> <li>• Implement a feature-extraction algorithm on real data, eg, an edge or corner detector for images or vectors of Fourier coefficients describing a short slice of audio signal [Usage]</li> <li>• Implement a classification algorithm that segments input percepts into output categories and quantitatively evaluates the resulting classification [Usage]</li> <li>• Evaluate the performance of the underlying feature-extraction, relative to at least one alternative possible approach (whether implemented or not) in its contribution to the classification task (8), above [Usage]</li> </ul>
Readings : [Nil01], [RN03], [Pon+14]	

## 8. WORKPLAN

### 8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

### 8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

### 8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

## 9. EVALUATION SYSTEM

\*\*\*\*\* EVALUATION MISSING \*\*\*\*\*

## 10. BASIC BIBLIOGRAPHY

- [De 06] L.N. De Castro. *Fundamentals of natural computing: basic concepts, algorithms, and applications*. CRC Press, 2006.
- [Gol89] David Goldberg. *Genetic Algorithms in Search, Optimization and Machine Learning*. Addison Wesley, 1989.
- [KF09] Daphne Koller and Nir Friedman. *Probabilistic Graphical Models: Principles and Techniques - Adaptive Computation and Machine Learning*. The MIT Press, 2009. ISBN: 0262013193.

- [Mit98] M. Mitchell. *An introduction to genetic algorithms*. The MIT press, 1998.
- [Mur12] Kevin P. Murphy. *Machine Learning: A Probabilistic Perspective*. The MIT Press, 2012. ISBN: 0262018020.
- [Nil01] Nils Nilsson. *Inteligencia Artificial: Una nueva visión*. McGraw-Hill, 2001.
- [Pon+14] Julio Ponce-Gallegos et al. *Inteligencia Artificial*. Iniciativa Latinoamericana de Libros de Texto Abiertos (LATIn), 2014.
- [RN03] Stuart Russell and Peter Norvig. *Inteligencia Artificial: Un enfoque moderno*. Prentice Hall, 2003.