# CIS 530: Introduction to Artificial Intelligence
# CIS 730: Artificial Intelligence
## Fall 2021

**Hours**: 3 hours, additional 3-hour project options available (CIS 690, CIS 798, or CIS 890)
**Prerequisite**: **CIS 300**, Data Structures and Algorithms, **CIS 501**, Software Architecture (or equivalent programming background)
**Textbook:** Russell, S. J., & Norvig, P. (2020) *Artificial Intelligence: A Modern Approach,* 4th edition. Englewood Cliffs, NJ: Prentice-Hall. ISBN-13: 978-0134610993. See: http://aima.cs.berkeley.edu
**Venue**: MWF 09:30 – 10:20 U.S. Central Time, 0093 Engineering Hall (CIS 530 A: Reference #10777; CIS 730 A: Reference #10790) & online via Global Campus (CIS 730 ZA: Reference #17869; CIS 730 ZB for Data Analytics certificate)
**Instructor**: William H. Hsu, Department of Computer Science


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TA: Talha Zaidi — TA Hours: 14:00 – 15:30 Wed, 10:00 – 11:00 Thu at DUE 1119
TA Email: tzaidi@ksu.edu — **Instructional alias**: CIS730TA-L@listserv.ksu.edu


**Office hours:** 10:30 – 11:30 Mon, 13:00-14:00 Tue, 11:30-12:30 Wed, 13:30,-14:30 Fri or by appointment
**K-State Canvas page redirector:** https://bit.ly/kstate-aiclass-2021 (http://www.kddresearch.org/page/63)
**Public mirror web page**: https://bit.ly/kstate-cis530-public, https://bit.ly/kstate-cis730-public
**MediaSite lectures**: Linked from K-State Canvas (https://k-state.instructure.com/courses/110823)

Course Description

This course provides fundamental background in intelligent systems for graduate and advanced undergraduate students. Topics to be covered include intelligent agents, problem-solving, uninformed and informed (heuristic) search, logical and probabilistic knowledge representation, logical and probabilistic inference, foundations of classical and universal planning, essentials of machine learning, neural networks, and genetic and evolutionary computation. A survey of computer vision and natural language processing (NLP) problems and techniques is also presented. Applications to practical design and development of intelligent systems will be emphasized, leading to individual projects on current topics and applications in AI.

Course Requirements

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|---|---|---|---|
| **Exams (no proctor required)** | Midterm exam | 20% | 45% |
| | 1 final exam | 25% | |
| **Homework and class participation** | Highest 7 scores of 4 problem sets, 6 machine problems | 14% (2% each) | 24% |
| | 10 Labs | 10% (1% each) | |
| **Term project (one of five topics)** | Plan writeup / intermediate interview<br>Merit (orig. / func. / effort / compl)<br>Report<br>Presentation & Recording | 4% (2% each)<br>16% (4% each)<br>3%<br>2% | 25% |
| **Class participation** | Attendance / **Using Global Campus**<br>Discussions **(TopHat / Global Campus)**<br>Quiz questions **(TopHat / Global Campus)** | 1%<br>2%<br>3% | 6% |

Selected reading (on reserve in K-State CIS Library):

- Poole, D. & Mackworth, A. (2017). *Artificial Intelligence: Foundations of Computational Agents, 2nd edition.* Cambridge, UK: Cambridge University Press.
- Luger, G. F (2009). *Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th ed.* Reading, MA: Addison-Wesley.
- Rich, E., & Knight, K. (1990). *Artificial Intelligence, 2nd ed.* New York, NY: McGraw-Hill, 1990.

Additional bibliography (excerpted in course notes and handouts):

- Goodfellow, I., Bengio, Y., Courville, A., & Bach, F., (2016). *Deep Learning*. Cambridge, MA: MIT Press.
- Nilsson, N. J. & Genesereth, M. R. (1987). *Logical Foundations of Artificial Intelligence*. San Mateo, CA: Morgan-Kaufmann.

## Course Calendar

| Lectures | Date | Topic | Reading in R&N 4e |
|---|---|---|---|
| 0 | Mon 23 Aug 2021 | Course overview: AI, intelligent agents | Preface, Chapter 1 |
| 1 | Wed 25 Aug 2021 | Problem solving, rationality, search intro | 2.1 – 2.5, 3.1 |
| 2 | Fri 27 Aug 2021 | Uninformed search: DFS, BFS, DLS, B&B | 3.2 – 3.4 |
| 3 | Mon 30 Aug 2021 | IDDFS, SMB; Informed search: A/A* | 3.5.1 – 3.5.2 |
| 4 | Wed 01 Sep 2021 | Informed: A*, IDA/SMA, heuristics | 3.5.2 – 3.5.7, proj. topics |
| 5 | Fri 03 Sep 2021 | Informed: continuous gradients, SA, GA | 4 (esp. 4.1 – 4.2) |
| 6 | Wed 08 Sep 2021 | Informed: hill-climbing, beam, greedy | 5.1 – 5.3 |
| 7 | Fri 10 Sep 2021 | Games: intro, minimax, static evaluation | 5.3 – 5.4; plan drafts due |
| 8 | Mon 13 Sep 2021 | Games: alpha-beta, expectiminimax | 6.1 – 6.2; project plans |
| 9 | Wed 15 Sep 2021 | Constraint Sat. Problems; **AI apps 1 of 3** | 6.3 – 6.6 |
| 10 | Fri 17 Sep 2021 | CSP: backtracking, FC/CP, arc consistency | 7.1 – 7.4; **plan revs. due** |
| 11 | Mon 20 Sep 2021 | Logical agents, propositional logic in AI | 7.5 – 7.8 |
| 12 | Wed 22 Sep 2021 | Fwd./backward chaining, resolution, Rete | 8.1 – 8.2 |
| 13 | Fri 24 Sep 2021 | First-Order Logic: syntax, semantics | 8.3 – 8.4, 9.1 |
| 14 | Mon 27 Sep 2021 | FOL: inference, unification, proofs | 9.2 – 9.4 |
| 15 | Wed 29 Sep 2021 | FOL: theorem proving, clausal form | 9.5 |
| 16 | Fri 01 Oct 2021 | FOL: resolution, Prolog; **AI apps 2 of 3** | 9 |
| 17 | Mon 04 Oct 2021 | Rules, expert systems; Knowledge Eng. | 10 |
| 18 | Wed 06 Oct 2021 | Decidability; planning: intro, classical | 11 |
| **19** | **Fri 08 Oct 2021** | **Intro to description logic, ontologies** | **12.1 – 12.2** |
| 20 | Mon 11 Oct 2021 | Planning: overview, classical | 22.1 – 22.3, 23.4 – 23.5 |
| 21 | Wed 13 Oct 2021 | Plans: graph, HTNs, coercion, conditional | 12.3 |
| | | **Midterm Exam (Online / Open-Textbook)** | **1 – 3, 4.1 – 4.3, 5 – 10.3** |
| **22** | **Fri 15 Oct 2021** | **Plans: monitoring/replanning, lifelong** | **12; interim reports** |
| 23 | Mon 18 Oct 2021 | Uncertain reasoning: fuzzy logic, probability | 12; interviews; Vision 1 |
| 24 | Wed 20 Oct 2021 | Uncertainty: Bayes nets; **AI apps 3 of 3** | 13, P&M 8 |
| 25 | Fri 22 Oct 2021 | Markov Decision Processes & Reinf. Learn. | 17, P&M 8 |
| 26 | Mon 25 Oct 2021 | Machine Learning: intro, taxonomy | 19.1 – 19.2 |
| 27 | Wed 27 Oct 2021 | ML: supervised, classification | 19.2 |
| 28 | Fri 29 Oct 2021 | ML: decis. trees, linear/logistic regression | 19.3, 19.6 |
| 29 | Mon 01 Nov 2021 | ML: neural network foundations, perceptron | 21.1 – 21.2 |
| 30 | Wed 03 Nov 2021 | ML: multi-layer perceptrons, gradients | 21.2, 21.4 |
| 31 | Fri 05 Nov 2021 | Deep Learning basics: convolution, sparsity | 21.3 – 21.5 |
| 32 | Mon 08 Nov 2021 | ML: support vector machines | 19.7 |
| 33 | Wed 10 Nov 2021 | DL: activation func., regression, Comp. Vis. | 21.2-5, Stanford CV lect. |
| 34 | Fri 12 Nov 2021 | ML: unsupervised (hier. & partitional clust.) | 19.7.1, 20.3, P&M 10 |
| 35 | Mon 15 Nov 2021 | DL: natural language models | 24 |
| 36 | Wed 17 Nov 2021 | ML: scikit-learn classification, regr., clust. | sklearn handout & docs |
| 37 | Fri 19 Nov 2021 | ML: Reinforcement Learning – Q-learning | 22.1 – 22.3, P&M 9 |
| 38 | Mon 29 Nov 2021 | DL: deep RL – deep Q nets, model-based | DRL lecture (Kathpalia) |
| 39 | Wed 01 Dec 2021 | DL: deep RL – actor-critic, policy gradient | 22.4 – 22.5; Vision 2 |
| 40 | Fri 03 Dec 2021 | Ethics of artificial intelligence | 26, 27.3 – 27.4 |
| **41** | **Mon 06 Dec 2021** | **Review; special topic (philosophy of AI)** | **1-11, 12-14, 18, 22-27** |
| 42 | Wed 08 Dec 2021 | Blitz talks, project highlights, presentations | – |
| | | **FINAL (Online / 13 – 17 Dec 2021)** | **1-11, 12-14, 18, 22-27** |

Lightly-shaded entries denote due dates of written problem sets: Lecture 5, 10, 13, 19.
Heavily-shaded entries denote due dates of machine problems (Programming HW): 7, 16, 24, 27, 30, 33
Aqua-shaded entries denote lab days (usually every other Wednesday): 2, 4, 8, 11, 14, 17, 25, 28, 31, 34
Green-highlighted entries denote project milestones and Yellow-highlighted entries denote interview dates.

**The above due dates are for on-campus students. Global Campus (distance) student due dates for home works and projects are 48 hours later, by default.**

**Green font: exam review day; blue font: exam day; red font: post-exam / model solution release**

Project reports are due on Fri 17 Dec 2021, with final interviews starting on Fri 03 Dec 2021.