COLORADO STATE UNIVERSITY GLOBAL

CSC510: FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

Credit Hours: 3

Contact Hours: This is a 3-credit course, offered in accelerated format. This means that 16 weeks of material is covered in 8 weeks. The exact number of hours per week that you can expect to spend on each course will vary based upon the weekly coursework, as well as your study style and preferences. You should plan to spend 14-20 hours per week in each course reading material, interacting on the Discussion Boards, writing papers, completing projects, and doing research.

Faculty Information: Faculty contact information and office hours can be found on the faculty profile page.

COURSE DESCRIPTION AND OUTCOMES

Course Description:

In this graduate course, students will apply the principles associated with Artificial Intelligence (AI). Students will determine how to utilize structures to represent graphs associated with data exploration. Students will gain an understanding of how to effectively apply knowledge representation and techniques associated with AI reasoning. Topics that students will explore include techniques used to efficiently apply game theory, integer programming, continuous optimization, and probability analysis.

Course Overview:

This course will introduce you to the principles associated with Artificial Intelligence (AI). Throughout the course, you will explore and apply various AI methods and techniques that programmers and software developers use in numerous industry sectors. You will participate in discussions and utilize case studies and problem-based learning to understand and implement solutions to a variety of real-world problems. This course will use both theory and practical application of the information learned.

Course Learning Outcomes:

1. Identify intelligent search methods for a specific Artificial Intelligence problem.
2. Create an effective solution to solve a search problem using computational theories.
3. Explain the effects of intelligent decision-making in knowledge representation.
4. Implement solutions that utilize propositional logic and first-order logic.
5. Demonstrate how to use Bayesian probability to represent uncertainty in Artificial Intelligence.
6. Implement a solution that utilizes symbolic planning.
7. Explain the concepts associated with machine learning.

PARTICIPATION & ATTENDANCE

Prompt and consistent attendance in your online courses is essential for your success at CSU-Global Campus. Failure to verify your attendance within the first 7 days of this course may result in your withdrawal. If for some reason you would like to drop a course, please contact your advisor.

Online classes have deadlines, assignments, and participation requirements just like on-campus classes. Budget your time carefully and keep an open line of communication with your instructor. If you are having technical problems, problems with your assignments, or other problems that are impeding your progress, let your instructor know as soon as possible.

COURSE MATERIALS

Required:

1. Sharda, R., Delen, D., Turban, E. (2020). *Analytics, data science, & artificial intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc. eISBN: 9780135172940 or ISBN: 9780135192016

2. Web-Based Tools:
    - Python version 3.7 software
    - Pycharm IDE

NOTE: *All non-textbook required readings and materials necessary to complete assignments, discussions, and/or supplemental or required exercises are provided within the course itself. Please read through each course module carefully.*

COURSE SCHEDULE

Due Dates

The Academic Week at CSU-Global begins on Monday and ends the following Sunday.

- **Discussion Boards:** The original post must be completed by Thursday at 11:59 p.m. MT and Peer Responses posted by Sunday, 11:59 p.m. MT. Late posts may not be awarded points.
- **Opening Exercises:** Take the opening exercise before reading each week's content to see which areas you will need to focus on. You may take these exercises as many times as you need. The opening exercises will not affect your final grade.
- **Mastery Exercises:** Students may access and retake mastery exercises through the last day of class until they achieve the scores they desire.
- **Critical Thinking:** Assignments are due Sunday at 11:59 p.m. MT.

WEEKLY READING AND ASSIGNMENT DETAILS

Module 1: Introduction to Artificial Intelligence

Required Readings

- Chapter 1 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.

- Chapter 2 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Haenlein, M., & Kaplan, A. (2019). A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence. *California Management Review*, *61*(4), 5–14.
- Overgoor, G., Chica, M., Rand, W., & Weishampel, A. (2019). Letting the Computers Take Over: Using AI to Solve Marketing Problems. *California Management Review*, *61*(4), 156–185

Discussion (25 points)

Critical Thinking (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Essay - AI Safety

"**I don't want to really scare you, but it was alarming how many people I talked to who are highly placed people in AI who have retreats that are sort of 'bug out' houses, to which they could flee if it all hits the fan**." — James Barrat, author of *Our Final Invention: Artificial Intelligence and the End of the Human Era*, told the Washington Post.

The topic of AI safety has spawned an entire field of study based on the following questions:

- What could go wrong in the development and use of AI?
- What can we do now to mitigate risks of AI?

The concern is not about machines turning "evil." Nor is there a concern about them obtaining consciousness. Instead, what experts in the field of AI are concerned about is goal misalignment. It is already the case that AI can outperform human beings in a wide variety of narrow (but increasingly less narrow) tasks. While there is a strong argument that Artificial General Intelligence (AGI) is only decades away (less than a decade, according to some experts such as Ben Goertzel), it is not necessary that an AI have general intelligence to be dangerous to humans.

Sci-fi movie plots aside, any sufficiently advanced AI (even one that only understands a narrow domain) with goals or methods of achieving those goals that are misaligned with human interests, could create disastrous consequences for large groups of humans, if not all of us.

"**The upheavals [of artificial intelligence] can escalate quickly and become scarier and even cataclysmic. Imagine how a medical robot, originally programmed to rid cancer, could conclude that the best way to obliterate cancer is to exterminate humans who are genetically prone to the disease**." — Nick Bilton, a tech columnist, wrote in the New York Times

Moreover, it is not just the media sounding the alarms. The AI safety issue is a genuine concern among leading computer scientists and AI experts. OpenAI, creators of the famous GPT-2 natural language transformer we have all heard so much about lately, are very concerned about AI safety (some in the field even say they go overboard). To address the issue of the misuse of AI, in this case, their GPT-2 language model, they released the model in gradually less handicapped versions, until the release of the final model on November 5, 2019. This tiered-release allowed time to monitor the uses of the model and research into countermeasures. There have been no malicious uses up to this point. In the realm of NLP, countermeasures often amount to the detection of generated text. This tiered release was controversial on several levels.

"**By their very nature, heuristic shortcuts will produce biases, and that is true for both humans and artificial intelligence, but the heuristics of AI are not necessarily the human ones**." — Daniel Kahneman

Aside from the potential for malicious use by humans, another very real danger is bias, which current AI systems have discovered. The cause is simple; Biased data leads to biased results. Biased data have led to issues with facial recognition for dark-skinned individuals. It has led to racial disparity in the justice system caused by bias in sentence-recommending systems. All of this is ultimately a reflection of human bias because humans gather and input the data (for now).

Consider artificial superintelligence - the concept that AI will achieve not only general intelligence but become magnitudes more intelligent than human beings can be. These two concepts - AGI and artificial superintelligence (sometimes known as ASI) - are not as clearly delineated as might appear. Intelligence may not necessarily manifest in a way that is recognizable to most people. More importantly, intelligence may operate with goals, assumptions, and values that are drastically different from human thought patterns. Despite being intelligent, most humans may not think of it as a thinking being; instead, it is just a really smart machine at its task but "dumb" in human terms. Nevertheless, what does that scenario look like?

Consider another popular AI safety scenario: The Paperclip Maximizer. This thought experiment goes something like this: An AI is put in charge of a factory that manufactures paper clips. In this hypothetical scenario, there is absolutely no concern for AI safety. The AI has all the tools and ways of interacting with the world it could ever need, and without any further rules, told (through its programming) that the goal of its existence is to maximize paperclips. Now, this AI will not be able to recite Shakespeare (presumably) or write a sonnet or fall in love and, perhaps, not even speak. However, it is superintelligent in regards to creating paperclips. It has general intelligence in the sense that it can understand any concept insofar as it relates to creating paperclips (and no further). Thus we could, in this hypothetical scenario, find ourselves in trouble dealing with a rogue AI that wants to demolish the world so it can create more paper clips. It does not care why. It is not human, and it was not programmed to care why. Reasoning may not work on it despite it having the ability to generalize concepts. Why? Because its goals are not incongruent with ours in that scenario. This thought experiment is popular for describing the depth of the problem of AI safety.

"**I'm increasingly inclined to think that there should be some regulatory oversight, maybe at the national and international level, just to make sure that we don't do something very foolish. I mean with artificial intelligence we're summoning the demon.**" — Elon Musk warned at MIT's AeroAstro Centennial Symposium

Write an essay further delving into the question of AI safety (referenced above). Points of focus could be:

- Exploring current cases of AI bias and error.
- Exploring how regulation and oversight might improve AI safety or how it might hinder development.
- Discuss the hype vs. the reality regarding AI safety. Does Elon Musk go too far with the way he speaks about AI? How will public education on the topic play a future role?
- What methods might you use to make AI safe? Can ethics or morals be codified into an AI program?
- Theoretically, how might we reconcile an AI which must achieve its goal with the many "wrong" ways of achieving said goals?
- What can research institutions do to enhance AI safety? Is OpenAIs approach a rational one? Why?

Your paper should be 4-5 pages in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Your submission should also include 4-6 references. The *CSU Global Library* is a good place to find these references.

OPTION #2: Presentation - AI Safety

"**I don't want to really scare you, but it was alarming how many people I talked to who are highly placed people in AI who have retreats that are sort of 'bug out' houses, to which they could flee if it all hits the fan**." — James Barrat, author of *Our Final Invention: Artificial Intelligence and the End of the Human Era*, told the Washington Post.

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The concern is not about machines turning "evil." Nor is there a concern about them obtaining consciousness (whatever that is!). Instead, what experts in the field of AI are concerned about is goal misalignment. It is already the case that AI can outperform human beings in a wide variety of narrow (but increasingly less narrow) tasks. While there is a strong argument that Artificial General Intelligence (AGI) is only decades away (less than a decade, according to some experts such as Ben Goertzel), it is not necessary that an AI have general intelligence to be dangerous to humans.

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intelligence may operate with goals, assumptions, and values that are drastically different from human thought patterns. Despite being intelligent, most humans may not think of it as a thinking being; instead, it is just a really smart machine at its task but "dumb" in human terms. Nevertheless, what does that scenario look like?

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Create a presentation, further delving into the question of AI safety (referenced above). Points of focus could be:

- Exploring current cases of AI bias and error.
- Exploring how regulation and oversight might improve AI safety or how it might hinder development.
- Discuss the hype vs. the reality regarding AI safety. Does Elon Musk go too far with the way he speaks about AI? How will public education on the topic play a future role?
- What methods might you use to make AI safe? Can ethics or morals be codified into an AI program?
- Theoretically, how might we reconcile an AI which must achieve its goal with the many "wrong" ways of achieving said goals?
- What can research institutions do to enhance AI safety? Is OpenAIs approach a rational one? Why?

Your well-crafted presentation must include a minimum of 4-7 slides, include audio, and be 3-5 minutes in length.

Support your analysis using 4-6 references, cited using correct APA styling. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Submit your PowerPoint presentation using the file name CSC510_Module1CriticalThinking_Option2_<LastName>_<FirstName>.pptx

Portfolio Reminder

Your Portfolio Project will involve developing your alpha-version AI program in order to solve a real-world problem of your choosing. You do not have to begin right away, but you should be thinking of real-world problems that AI could help solve.

Throughout this course, you will be learning about many different methods and techniques used to give the software the ability to make intelligent decisions, derive actionable knowledge from data, and intelligently present relevant information to human users in an efficient way. Your final project will help you to interfuse and apply these concepts, taking them out of the world of theory and into a real-world software solution.

Your program will interact with human beings to support decision-making processes by delivering relevant information about the problem. You will use Python to write your program, and you will operationalize the methods and techniques you will learn in this course. You have complete freedom of choice regarding the use-case and the strategy for your program, including the techniques and tools you decide to use. Also, your final project submission will include either a 3-5 page essay or a presentation with a minimum of 10 slides introducing your project. Both options will require at least 12 references using proper APA citation referencing sources used in developing your program, such as techniques and methods used.

Module 2: Foundational Theories and Their Application

Required Readings

- Chapter 5 Section 2 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Chapter 6 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Muggleton, S. (2014). Alan Turing and the Development of Artificial Intelligence. *AI Communications*, *27*(1), 3–10.

Discussion (25 points)

Critical Thinking (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Essay - Multidisciplinary Challenges and Outcomes

Read the following article:

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., … Williams, M. D. (2019). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*.

The years ahead will provide many challenges as AI technologies rapidly integrate into everyday aspects of our lives. These challenges will touch all disciplines and all niches in society and range from legal, economic, social, implementational, and ethical.

Address one or more of the following questions in essay form. Your essay should consist of a minimum of 4-5 properly constructed pages in the form of a Word document. Support your analysis using at least four authoritative literary sources, cited using correct APA styling.

- What likely challenges do you see as being the most impactful on society? Why?
- What response do you think governing entities should have to AI technologies and their offshoots in the way of regulation and legal intervention? Justify your stance.
- What significant economic changes produced by the AI revolution do you think will be more apparent in people's everyday lives? Do you think all impacts will be obvious to the average

person? Which impacts do you think will be more obvious, and which ones will be less obvious, and why? Does how obvious the effect of the technology is on the individual necessarily correlate with the strength of the effect?
- Which challenges do you think will produce the most opportunity?

Your paper should be 4-5 pages in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Your submission should Include 4-6 references in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Essay - Use Case for Smart Governance

Read the following paper:

Kankanhalli, A., Charalabidis, Y., & Mellouli, S. (2019). IoT and AI for Smart Government: A Research Agenda. *Government Information Quarterly*, *36*(2), 304–309.

The third Industrial Revolution, the computer revolution, led to the rise of e-governance. The fourth Industrial Revolution is leading the transformation of e-governance into "smart governance." Address one or more of the following questions in essay form. Your essay should consist of a minimum of 4-5 properly constructed pages (1200-1500 words) in the form of a Word document. Support your analysis using at least four authoritative literary sources, cited using correct APA styling.

- What challenges might smart governance need to overcome? Propose methods for smart governance that could meet these challenges.
- What advantages and benefits might smart governance bring to society? Propose specific methods and policies that you believe would lead to a positive balance of benefits that outweigh potential negatives, and discuss how to minimize or eliminate those negatives.
- In what ways can IoT technologies be leveraged to enhance smart governance? Propose methods of combining IoT with AI for smart governance. Please describe specific methods and proposals.

Your paper should be 4-5 pages in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Include 4-6 references in addition to the course textbook. The CSU Global Library is a good place to find these references.

Portfolio Milestone (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Choosing a Use-Case Scenario - Paper

Your final Portfolio Project will be a fully-functioning AI program built to solve a real-world problem of your choosing, utilizing the tools and techniques outlined in this course. Your program will interact with human beings to support decision-making processes by delivering relevant information about the problem.

For your first milestone, it will be necessary to choose a use-case scenario for which to deploy your project.

Write at least a paragraph outlining your chosen use-case scenario. Include a general description of the problem, the function your solution will perform, and a generalized strategy of how your solution might solve the problem. While writing, assume your ideas will change before we reach the end of this course!

For your benefit, here are some resources regarding the current uses of AI in the field:

- Dillon, J. D. (2020). The Path to AI. *TD: Talent Development*, *74(1)*, 24. (To view this reading, please open the link provided and download the "PDF full text.")
- Dovey Fishman, T., & Eggers, W. D. (2017). AI-Augmented Human Services. *Policy & Practice (19426828)*, 75(6), 26. (To view this reading, please open the link provided and download the "PDF full text.")
- Everson, K. (2019). Five Keys to Intelligently Deploy AI and Automation. *Policy & Practice (19426828)*, 77(4), 24. (To view this reading, please open the link provided and download the "PDF full text.")
- Heller Christian H. (2019). Near-Term Applications of Artificial Intelligence: Implementation Opportunities From Modern Business Practices. *Naval War College Review, 72(4)*, 73. (To view this reading, please open the link provided and download the "PDF full text.")
- Newcombe, T. (2018). Practically Speaking: Everyday uses of artificial intelligence that can talk, listen and see are coming. Is government ready? *Government Technology, 31(5)*, 24–28. (To view this reading, please open the link provided and download the "PDF full text.")

Your submission should be a paragraph in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Include at least one reference in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Choosing a Use-Case Scenario - Presentation

Your final Portfolio Project will be a fully-functioning AI program built to solve a real-world problem of your choosing, utilizing the tools and techniques outlined in this course. Your program will interact with human beings to support decision-making processes by delivering relevant information about the problem.

For your first milestone, it will be necessary to choose a use-case scenario for which to deploy your project.

Create a presentation of at least 3-5 slides describing your use case scenario. Include a general description of the problem, the function your solution will perform, and a generalized description of the strategy your solution might use to solve the problem. While creating your presentation, assume your ideas will change before we reach the end of this course!

For your benefit, here are some resources regarding current uses of AI in the field:

- Dillon, J. D. (2020). The Path to AI. *TD: Talent Development*, *74(1)*, 24. (To view this reading, please open the link provided and download the "PDF full text.")
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Your PowerPoint should consist of a minimum of 3-5 slides.

Support your analysis using at least one authoritative source, cited using correct APA styling. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Submit your PowerPoint presentation using the file name CSC510_Module2PortfolioMilestone_Option2_<LastName>_<FirstName>.pptx.

Module 3: Tools in AI Development

Required Readings

- Al-Bdour, G., Al-Qurran, R., Al-Ayyoub, M., & Shatnawi, A. (2019). A detailed comparative study of open source deep learning frameworks.
- Bridgwater, A. (2019). The Latest Intelligence on Deep Learning Tools. *Computer Weekly*, 15.
- Bridgwater, A., & Saran, C. (2019). Inside the Ai Developer's Toolbox. *Computer Weekly*, 19.

Discussion (25 points)

Critical Thinking (100 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Hand-Made Shallow ANN in Python

Using your research and resources, write a basic 2-layer Artificial Neural Network utilizing static backpropagation using Numpy in Python. Your neural network can perform a basic function, such as guessing the next number in a series. Using the activation function of your choice to calculate the predicted output ŷ, known as the feedforward function, and updating the weights and biases through gradient descent (backpropagation) based on your choice of a basic loss function.

Your ANN should include the following features:

- An input layer that takes input data as a matrix receives and passes it on,
- A hidden layer,
- An output layer, and
- Weights between the layers.

Also, your ANN should demonstrate it can perform the following functions:

- Multiply the input by a set of weights (via matrix multiplication),
- Apply deliberate activation function for every hidden layer,
- Return an output,
- Calculate error by taking the difference from the desired output and the predicted output, giving us the gradient descent to provide our loss function,
- Apply loss function to weights, and
- Repeat this process no less than 1,000 times to train the ANN.

Your submission should be a script with the .py extension. It should be able to be activated easily and have the ability to accept simple inputs, such as a series of a particular number of variables or digits, in a

manner that is clear to the user and predict and visually the final variable in the input set. The input and output are up to you. Keep it simple.

OPTION #2: Tensorflow ANN Model

Examine the following first-party resource: Tensorflow 2 Quickstart for Beginners.

Using Tensorflow and your own research, write a basic Tensorflow ANN model to perform a basic function of your choosing. Your submission should be inference-ready upon execution, and include all model checkpoints necessary for inference. Your submission should include a self-executable Python script, which model inference can be confirmed. The executable script should visually display results. Accuracy will not be graded but must run without error and display classification results on-screen.

Portfolio Milestone (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Project Update - Paper

Neural networks can be leveraged for many "fuzzy" tasks and are extremely useful for classifying data. Conduct research on the use-case scenario you have chosen. Using what you have learned, write at least a paragraph expressing your thoughts on if and how your chosen use-case scenario uses neural networks.

Your submission should be a paragraph in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Include at least one reference in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Project Update - Presentation

Neural networks can be leveraged for many "fuzzy" tasks and are extremely useful for classifying data. Conduct research on the use-case scenario you have chosen. Using what you have learned, write at least a paragraph expressing your thoughts on if and how your chosen use-case scenario uses neural networks.

Your PowerPoint should consist of a minimum of 3-5 slides.

Support your analysis using at least one authoritative source, cited using correct APA styling. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Submit your PowerPoint presentation using the file name CSC510_Module3PortfolioMilestone_Option2_<LastName>_<FirstName>.pptx.

Module 4: Intelligent Search Methods

Required Readings

- François, A., Cappart, Q., & Rousseau, L. M. (2019). How to Evaluate Machine Learning Approaches for Combinatorial Optimization: Application to the Travelling Salesman Problem. Retrieved from https://arxiv.org/abs/1909.13121?
- Zhou, R., & Hansen, E. A. (2006). Breadth-first heuristic search. *Artificial Intelligence*, *170*(4), 385–408. https://doi.org/10.1016/j.artint.2005.12.002

Discussion (25 points)

Critical Thinking (100 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Informed Search Heuristics with SimpleAI

Heuristic search functions used in Informed Search methods represent a compelling AI development strategy capable of performing many possible functions and solving a wide variety of problems.

Please take a look at the following resource: Simple AI

Examine the examples given under the "samples" directory in the simpleai Github page (available through resource given above).

Define a simple real-world search problem requiring a heuristic solution. You can base the problem on the 8-puzzle (or n-puzzle) problem, Towers of Hanoi, or even Traveling Salesman (if you dare!). The problem and solution can be utilitarian or entirely inventive.

Write an interactive Python script (using either simpleAI's library or your resources) that utilizes either Best-First search, Greedy Best First search, Beam search, or A* search methods to calculate an appropriate output based on the proposed function. The search function does not have to be optimal nor efficient but must define an initial state, a goal state, reliably produce results by finding the sequence of actions leading to the goal state. Submission should be in an easily executable Python file alongside instructions for testing. Please include in your submission the type of search algorithm used along with at least a paragraph justifying your choice. In your justification, consider the following questions as a guide:

- Is your search method complete? Is it admissible?
- Does it use an evaluation function?
- Is it space-efficient?
- What are the advantages and disadvantages of your chosen search method, and how do they fit the intended function?

OPTION #2: Uninformed Search Methods in Python

Often called blind search methods because they do not have additional information about state or search space other than how to traverse the tree, Uninformed Search algorithms define a problem in graph form containing the start node and the goal node. A strategy describes the manner the algorithm traverses the search tree while storing all possible traversable nodes from the current node as the "fringe." The sequence of nodes successfully leading from the start node to the goal node is output as the solution.

Uninformed search functions can be built-in Python without outside libraries. Define a simple real-world search problem requiring a heuristic solution. You can base the problem on the 8-puzzle (or n-puzzle) problem, Towers of Hanoi, or even Traveling Salesman. The problem and solution can be utilitarian or entirely inventive.

Write an interactive Python script (using either simpleAI's library or your resources). This script should use either the Breadth-First Search, Uniform Cost Search, Depth First Search, or Iterative Deepening Depth First Search methods to calculate an appropriate output based on the proposed function. The search function does not have to be optimal nor efficient but must define a start node, a goal node, and

reliably produce a solution by finding the sequence of actions leading from the start node to the goal node. Submission should be in an easily executable Python file alongside instructions for testing. Please include in your submission the type of search algorithm used along with at least a paragraph justifying your choice. In your justification, consider the following questions as a guide:

- Is your search method complete? Is it admissible?
- Does it use an evaluation function?
- Is it space-efficient?
- What are the advantages and disadvantages of your chosen search method, and how do they fit the intended function?

Portfolio Milestone (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Project Update - Paper

Write at least a paragraph describing how you might use intelligent search methods in your chosen use-case scenario. Which search methods might you choose to use? To what task will these search methods be applied?

Your submission should be a paragraph in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

OPTION #2: Project Update - Presentation

Create a presentation consisting of 3-5 slides describing how you might use intelligent search methods in your chosen use-case scenario. Which search methods might you choose to use? To what task will these search methods be applied?

Your PowerPoint should consist of a minimum of 3-5 slides.

Support your analysis using at least one authoritative source, cited using correct APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Submit your PowerPoint presentation using the file name CSC510_Module4PortfolioMilestone_Option2_<LastName>_<FirstName>.pptx.

Portfolio Reminder

If you have not yet begun the development of your final Portfolio Project, please take a look at the requirements and come up with an actionable plan. No matter what, please start.

Module 5: Cognitive Systems: Knowledge Representation and Decision Making

Required Readings

- Chapter 8 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Chapter 12 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Brock, D. C. (2018). Learning from Artificial Intelligence's Previous Awakenings: The History of Expert Systems. *AI Magazine*, *39*(3), 3-15.

- Muhammad, L. J., Garba, E. J., Oye, N. D., & Wajiga, G. M. (2019). Modeling Techniques for Knowledge Representation of Expert System: A Survey. *Journal of Applied Computer Science & Mathematics*, *13*(28), 39-44.
- Reitsma, J. P., van Paassen, M. M. (René), & Mulder, M. (2019). Methodology Comparison for Designing a Decision-making Support System. *IFAC PapersOnLine*, *52*(19), 157–162. https://doi.org/10.1016/j.ifacol.2019.12.167

Discussion (25 points)

Critical Thinking (100 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Corti: A Cognitive DSS Case-Study

Corti is an intelligent partner that helps emergency medical professionals make life-saving decisions. It leverages several machine learning techniques to analyze the speech of emergency services callers in jeopardy. It not only identifies the caller's situation and location by parsing their speech, but it also analyzes verbal descriptions to develop an "understanding" of the caller's situation. It can then use this knowledge to simplify the dispatch process by retrieving map data and automatically ordering a dispatch; it also makes recommendations to the caller to assist them in managing their situation while they wait for emergency services. It understands verbal answers to questions that assist its expert system in recommending the best course of action. As a Decision Support System (DSS), Corti is an example of a cognitive computing system.

In order to understand the function and usefulness of Corti, please watch the following demonstration video by clicking on the hyperlink.

You can access more information on Corti by clicking on the hyperlink.

Dispatchers in Copenhagen, who are well trained, can recognize cardiac arrest from descriptions over the phone around 73% of the time. Corti does better, however. In one early study, the machine learning model knew the calls were reporting cardiac arrest 95% of the time.

Pretty amazing, is it not? Cognitive decision support systems like this will become more and more common in every field. These systems provide human beings with accurate and relative information as fast and efficiently - and as within context- as possible. The more accurate these systems become, the more ubiquitous they will become as well, in every industry and domain. The use-case potential for these systems is enormous.

Think of an industry or domain of expertise that has not yet seen widespread integration of cognitive expert systems such as Corti. With this industry or domain in mind, address one or more of the following questions in essay form. Your essay should consist of a minimum of 4-5 properly constructed pages in the form of a Word document. Support your analysis using at least four authoritative literary sources, cited using correct APA formatting.

1. As cognitive AI systems assist us in more and more everyday decisions, both in the workplace and our personal lives, what level of responsibility should the developers of these systems have?
2. According to your research, what domains of application or industries would benefit most from these types of cognitive DSS systems? What niches to fill? Which potential applications stand to create the most significant effect on its respective industry?

3. Cognitive computing, by definition, includes humans in its activity, presenting relevant and accurate data to the user as efficiently as possible. What methods might AI developers utilize to be inclusive of the user while also taking actions or making decisions autonomously if necessary? How can we balance this in a way that keeps the human user comfortable with the interaction without taking away the user's sense of autonomy? What aspects of presenting information in an intelligent interface might cause people to feel irrelevant or unimportant to the process (especially as the technologies become more autonomous and capable?)
4. When AI decision support systems can analyze data and devise solutions more effectively than humans, the most important aspect of the user-AI interaction becomes the interface. Chatbots and verbal interfaces often combine with visual interfaces for representing data to the user.
5. Is there a specific use-case for cognitive decision support systems in the industry or domain of expertise that you had in mind that you can imagine being possible to develop? Explain the purpose and function of your hypothetical DSS application and describe, in as much technical detail as possible, what structure it might take. Describe the interface, how it represents knowledge to the user, its inputs, and outputs. Describe the types of modeling you would use and how the programs knowledge hierarchy might work, the type of logic it might use to make decisions, and what level of autonomy it might have. Finally, describe the impact it might have on the industry in which it exists.
6. A system like Corti must use much hierarchically organized domain-specific knowledge. At the same time, a system with features as advanced as Corti leverages a lot of Machine Learning techniques for identifying and classifying data in order to represent knowledge to the human user(s). Examine, in detail, ways this either is accomplished in known applications or make proposals for how such a system might combine symbolic planning with machine learning techniques within a specific field or domain—reference specific methods. Use your example to discuss how knowledge abstraction hierarchies can be engineered for domain-specific knowledge and explain in detail how ML techniques might be used in conjunction with a hierarchical symbol system to produce useful DSS systems.

Your paper should be 4-5 pages in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Include 4-6 references in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Developing Expert Systems Hands-On

You can describe a Decision Support System as an expert system with an intelligent user interface that delivers accurate information that is as relevant to the context as possible. A DSS has a "triptych" structure; in other words, three parts:

1. The decision model,
2. Application-specific knowledge hierarchy, and
3. Intelligent user interface.

In other words, it is not inaccurate to say that a DSS is a form of intelligent interface overlaid atop a (usually domain-specific) expert system.

Using suggested resources below or your resources, write your simple expert system. It should have the following features:

1. A rule structure with at least a half a dozen IF-THEN rules.
2. A variety of possible "fact" variables to analyze
3. A specific output consisting of a domain-relevant recommendation.

The function and domain of your expert system is your choice. The final submission must include an easily executable Python file alongside a text file containing facts to input for easy testing, as well as an explanation of the expected function.

Resources for Expert System creation in Python:

- Pyknow (GNU LESSER GENERAL PUBLIC LICENSE)
- clipspy (Python binding library for CLIPS)
- Pyke (Expert system engine for Python inspired by Prolog)
- You can also write your rules from scratch!

Portfolio Milestone (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Knowledge Representation - Paper

Consider your chosen use-case scenario. Write at least a page addressing the following questions:

- How will your program represent knowledge to the user? How can you utilize what you have learned in your module to deliver information efficiently and within context? What machine learning techniques might assist with deciding how to present information?
- How will your program represent knowledge within its decision models? How will you represent and use information within the program?
- How will your program preprocess data? What will it do with this data? What machine learning techniques might assist with deciding how to present information?
- Considering what you have learned about expert systems, in what ways can you leverage expert system principles and rules-based logic in your solution?

Your submission should be a page in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Include at least one reference in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Knowledge Representation - Presentation

Consider your chosen use-case scenario. Write at least a page addressing the following questions:

- How will your program represent knowledge to the user? How can you utilize what you have learned in your module to deliver information efficiently and within context? What machine learning techniques might assist with deciding how to present information?
- How will your program represent knowledge within its decision models? How will you represent and use information within the program?
- How will your program preprocess data? What will it do with this data? What machine learning techniques might assist with deciding how to present information?
- Considering what you have learned about expert systems, in what ways can you leverage expert system principles and rules-based logic in your solution?

Your PowerPoint should consist of a minimum of 3-5 slides.

Support your analysis using at least one authoritative source, cited using correct APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Submit your PowerPoint presentation using the file name CSC510_Module5PortfolioMilestone_Option2_<LastName>_<FirstName>.pptx.

Module 6: Statistical Modeling and Visualization

Required Readings

- Chapter 3 in Sharda, R., Delen, D., Turban, E. (2020). Analytics, Data Science, & Artificial Intelligence (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Chapter 8 in Sharda, R., Delen, D., Turban, E. (2020). Analytics, Data Science, & Artificial Intelligence (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Chapter 5 Section 7 & Section 8 in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.
- Domingos, P., & Lowd, D. (2019). Unifying Logical and Statistical AI with Markov Logic. *Communications of the ACM*, *62*(7), 74–83. https://doi.org/10.1145/3241978

Discussion (25 points)

Critical Thinking (100 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Naive Bayes Classifier

Naive Bayes classifiers are quick and easy to code in Python and are very efficient.

Naive Bayes classifiers are based on Bayes' Theorem and assume independence among predictors (hence the "Naive" terminology). Not only are Naive Bayes classifiers handy and straightforward in a pinch, but they also outperform many other methods without the need for advanced feature engineering of the data.

Check out the following section in your textbook for further information on Naive Bayes classification:

Chapter 5 Section 7 (pp. 278-292) in Sharda, R., Delen, D., Turban, E. (2020). *Analytics, Data Science, & Artificial Intelligence* (11th ed.). Hoboken, NJ: Pearson Education, Inc.

Using scikit-learn, write a Naive Bayes classifier in Python. It can be single or multiple features. Submit the classifier in the form of an executable Python script alongside basic instructions for testing.

Your Naive Bayes classification script should allow you to:

- Calculate the posterior probability by converting the dataset into a frequency table.
- Create a "Likelihood" table by finding relevant probabilities.
- Calculate the posterior probability for each class.
- Correct Zero Probability errors using Laplacian correction.

Your classifier may use a Gaussian, Multinomial, or Bernoulli model, depending on your chosen function. Your classifier must properly display its probability prediction based on its input data.

Check out scikit-learn and its documentation at the scikit-learn website.

OPTION #2: Random Forest Classifier

Random Forest classifiers are a form of ensemble modeling that utilizes multiple decision trees and features randomness at training time. Random Forest then averages the trees to result in a classification or regression output.

Random Forest classification enjoys excellent predictive performance with reliable feature importance estimates and efficient estimates of test error resulting in a lower cost of repeated model training associated with cross-validation.

There are a few disadvantages, too, such as high memory and CPU overhead, slower predictions, and less interpretability.

Using scikit-learn, write a Random Forest classifier in Python. Submit the classifier in the form of an executable Python script alongside basic instructions for testing.

Your Random Forest classifier should allow you to:

- Calculate the posterior probability by converting the dataset into a frequency table.
- Create a "Likelihood" table by finding relevant probabilities.
- Calculate the posterior probability for each class.
- Correct Zero Probability errors using Laplacian correction.

Check out scikit-learn and its documentation at the scikit-learn website.

Portfolio Milestone (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Paper - Classification

Write at least a paragraph discussing ways you might leverage classification of any kind to deliver results in your program.

Your submission should be a paragraph in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style. Include at least one reference in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Presentation - Classification

Create a presentation discussing ways you might leverage classification of any kind to deliver results in your program.

Your PowerPoint should consist of a minimum of 3-5 slides.

Support your analysis using at least one authoritative source,

cited using correct APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Submit your PowerPoint presentation using the file name CSC510_Module6PortfolioMilestone_Option2_<LastName>_<FirstName>.pptx.

Module 7: Reasoning Systems and Logic

Required Readings

- Davis, E., & Marcus, G. (2015). Commonsense Reasoning and Commonsense Knowledge in Artificial Intelligence. *Communications of the ACM*, *58*(9), 92–103. https://doi.org/10.1145/2701413
- Ghahramani, Z. (2015). Probabilistic machine learning and artificial intelligence. *Nature*, *521*(7553), 452. https://doi.org/10.1038/nature14541
- Wang, F., & Rompf, T. (2018). From Gameplay to Symbolic Reasoning: Learning SAT Solver Heuristics in the Style of Alpha(Go) Zero. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=edsarx&AN=edsarx.1802.05340&site=eds-live

Discussion (25 points)

Portfolio Milestone (25 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: Paper - First-Order Logic

Write at least a paragraph discussing ways you might leverage first-order logic to deliver results in your program.

Your submission should be a paragraph in length and conform to APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Include at least one reference in addition to the course textbook. The CSU Global Library is a good place to find these references.

OPTION #2: Presentation - First-Order Logic

Create a presentation examining ways you might leverage first-order logic to deliver results in your program.

Your PowerPoint should consist of a minimum of 3-5 slides.

Support your analysis using at least one authoritative source, cited using correct APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Submit your PowerPoint presentation using the file name CSC510_Module7PortfolioMilestone_Option2_<LastName>_<FirstName>.pptx.

Portfolio Reminder

Your Portfolio Project will be due by the end of Module 8, which is the end of next week. Please plan accordingly.

Module 8: Symbolic Planning

Required Readings

- Gordon, D., Fox, D., & Farhadi, A. (2019). What Should I Do Now? Marrying Reinforcement Learning and Symbolic Planning. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=edsarx&AN=edsarx.1901.01492&site=eds-live

- Tanneberg, D., Rueckert, E., & Peters, J. (2019). Learning Algorithmic Solutions to Symbolic Planning Tasks with a Neural Computer. Retrieved from https://arxiv.org/abs/1911.00926?
- Yang, F., Lyu, D., Liu, B., & Gustafson, S. (2018). PEORL: Integrating Symbolic Planning and Hierarchical Reinforcement Learning for Robust Decision-Making. Retrieved from https://arxiv.org/abs/1804.07779?

Discussion (25 points)

Portfolio Project (200 points)

Choose one of the following two assignments to complete this week. Do not complete both assignments. Identify your assignment choice in the title of your submission.

OPTION #1: AI Use-Case Problem With Solution - Paper

Your final Portfolio Project will be a fully-functioning AI program built to solve a real-world problem of your choosing, utilizing the tools and techniques outlined in this course. Your program will interact with human beings to support decision-making processes by delivering relevant information about the problem.

Your final project submission should include a self-executable Python program. The program should be complete and straightforward to test. The program should leverage methods learned from at least 2 of the modules from this course. The submission must function and be a reasonable attempt at a solution for your chosen problem. The solution does not have to be correct or useful in the real world, but the solution MUST provide reasonable answers without error.

In addition to your program, your submission should include a 3-5 page essay describing the final version of your AI program, the use-case it intends to solve, and the methods you used toward that goal. In your paper, please address the following details:

- The tools, libraries, and APIs utilized,
- Search methods used and how they contributed toward the program goal,
- Inclusion of any deep learning models,
- Aspects of your program that utilize expert system concepts,
- How your program represent knowledge, and
- How symbolic planning is used in your program (remember, symbolic planning is not limited to robot navigation!)

Important: Your final submission will also be required to include at least 12 references, from which your work is based. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

OPTION #2: AI Use-Case Problem With Solution - Presentation

Your final Portfolio Project will be a fully-functioning AI program built to solve a real-world problem of your choosing, utilizing the tools and techniques outlined in this course. Your program will interact with human beings to support decision-making processes by delivering relevant information about the problem.

Your final project submission should include a self-executable Python program. The program should be complete and straightforward to test. The program should leverage methods learned from at least 2 of the modules from this course. The submission must function and be a reasonable attempt at a solution for your chosen problem. The solution does not have to be correct or useful in the real world, but the solution MUST provide reasonable answers without error.

In addition to your program, your submission should include a PowerPoint presentation with a minimum of 10 slides, describing the final version of your AI program, the use-case it intends to solve, and the methods you used toward that goal. In your presentation, please address the following details:

- The tools, libraries, and APIs utilized,
- Search methods used and how they contributed toward the program goal,
- Inclusion of any deep learning models,
- Aspects of your program that utilize expert system concepts,
- How your program represent knowledge, and
- How symbolic planning is used in your program (remember, symbolic planning is not limited to robot navigation!).

Your PowerPoint should consist of a minimum of 10 slides.

Support your analysis using at least 10 authoritative literary sources, cited using correct APA style. The CSU Global Writing Center offers resources on how to format your assignment and cite sources in APA style.

Important: Your final submission will also be required to include at least 12 references, from which your work is based. Please feel free to utilize the CSU Global Library to find resources to help you.

Submit your PowerPoint presentation using the file name CSC510_Module8PortfolioFinalProject_Option2_<LastName>_<FirstName>.pptx.

COURSE POLICIES

Grading Scale	
A	95.0 – 100
A-	90.0 – 94.9
B+	86.7 – 89.9
B	83.3 – 86.6
B-	80.0 – 83.2
C+	75.0 – 79.9
C	70.0 – 74.9
D	60.0 – 69.9
F	59.9 or below

Course Grading

20% Discussion Participation
45% Critical Thinking Assignments
35% Final Portfolio Project

IN-CLASSROOM POLICIES

For information on late work and incomplete grade policies, please refer to our **In-Classroom Student Policies and Guidelines** or the Academic Catalog for comprehensive documentation of CSU-Global institutional policies.

Academic Integrity
Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /re-purposing your own work (see *CSU-Global Guide to Writing and APA Requirements* for percentage of repurposed work that can be used in an assignment), unauthorized possession of academic materials, and unauthorized collaboration. The CSU-Global Library provides information on how students can avoid plagiarism by understanding what it is and how to use the Library and Internet resources.

Citing Sources with APA Style
All students are expected to follow the *CSU-Global Guide to Writing and APA Requirements* when citing in APA (based on the APA Style Manual, 6th edition) for all assignments. For details on CSU-Global APA style, please review the APA resources within the CSU-Global Library under the "APA Guide & Resources" link. A link to this document should also be provided within most assignment descriptions in your course.

Disability Services Statement
CSU–Global is committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Disability Resource Coordinator at 720-279-0650 and/or email ada@CSUGlobal.edu for additional information to coordinate reasonable accommodations for students with documented disabilities.

Netiquette

Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on Discussion Boards and other postings within or connected to the online classroom. If you have concerns about something that has been said, please let your instructor know.