# http://www.ric.edu/webcommunications/images/SealWithText_Small_Black.pngUNDERGRADUATE CURRICULUM COMMITTEE (UCC)PROPOSAL FORM

|  |  |  |
| --- | --- | --- |
| A.1. [Course or program](#Proposal) | **CSCI 445 Reinforcement Learning and Autonomous Systems** |  |
|  |  |
| A. 1b. Academic unit | **School of Business**  |  |
| A.2. [Proposal type](#type) | **Course: creation**  |  |
| A.3. [Originator](#Originator) | **Timothy Henry** | [Home department](#home_dept) | **Computer Science and Information Systems** |
| A.4. [Context and Rationale](#Rationale) Must include additional information listed in smart tip for all [new programs](#type). If **online** course or program, you need to explain what mode(s) you plan to use and why you need that specific delivery.  | Reinforcement learning (RL) is a powerful branch of machine learning that has gained significant traction in recent years due to its ability to solve complex problems involving sequential decision-making under uncertainty. RL algorithms have demonstrated remarkable success in various domains, including robotics, game playing, and self-driving cars. The increasing prevalence of autonomous systems in our society necessitates a thorough understanding of RL principles and their applications. This course would provide students with the necessary knowledge and skills to navigate this rapidly evolving field and contribute to the development of intelligent and effective autonomous systems.The course would introduce students to the fundamental concepts of RL, including Markov decision processes, value functions, policy search algorithms, and exploration-exploitation trade-offs. Students would gain an understanding of how these concepts underpin the design and implementation of RL agents that can learn from their interactions with the environment and make optimal decisions in complex scenarios. Additionally, the course would explore the practical applications of RL in various domains, such as those listed earlier. By delving into these real-world examples, students would develop a critical understanding of how RL is transforming various industries and shaping the future of autonomous systems.The development and deployment of autonomous systems raise significant ethical and societal concerns, including issues of bias, fairness, safety, security, privacy, and transparency. An undergraduate course in reinforcement learning and autonomous systems would equip students with the knowledge and critical thinking skills to analyze and address these ethical challenges. Students would explore the potential implications of RL-powered autonomous systems on individuals, society, and the environment. They would also consider strategies for mitigating risks and ensuring that autonomous systems are developed and deployed in a responsible and ethical manner. |
| A.5. [Student impact](#student_impact)Must include to explain why this change is being made? | This course will be taken primarily by AI majors, but it can also serve as a very useful elective for CS and Data Science majors. |
| A.6. [Impact on other programs](#impact)  | Since this could serve as an elective for CS majors, that may reduce the number of students taking other 300- or 400-level CSCI elective courses. |
| A.7. [Resource impact](#Resource) | [*Faculty PT & FT*](#faculty):  | Existing CSCI faculty and/or adjunct faculty will teach the courses. Depending on the growth of the new AI Program, additional faculty and adjuncts may be needed. |
| [*Library*:](#library) | None |
| *Technology (for in person delivery)* | None. Courses will use existing classrooms and/or computer labs. |
| *Technology: (for online delivery. Must be RIC supported)* | None |
| [*Facilities*](#facilities): | None. Courses will use existing classrooms and/or computer labs. |
| A.8. [Semester effective](#Semester_effective) | **Fall 2024** | A.9. [Rationale if sooner than next Fall](#Semester_effective) | **N/A** |
| A.10. INSTRUCTIONS FOR CATALOG COPY: Use the Word copy versions of the catalog sections found on the UCC Forms and Information page. Cut and paste into a single file **ALL the relevant pages from the college catalog that need to be changed.** Use tracked changes feature to show how the catalog will be revised as you type in the revisions. If totally new copy, indicate where it should go in the catalog. If making related proposals a single catalog copy that includes all changes is preferred. Send catalog copy as a separate single Word file along with this form. |
| A.11. List here (with the relevant URLs), any RIC website pages that will need to be updated (to which your department does not have access) if this proposal is approved, with an explanation as to what needs to be revised: |
| A. 12 **Check to see if your proposal will impact any of our** [**transfer** **agreements,**](file:///Users/SAbbotson/Documents/Curriculum/ManualandWebsite/transfer%20agreements) **and if it does explain in what way. Please indicate clearly what will need to be updated, including any changes in prefix numbers/titles for TES. N/A** |
| A. 13 Check the section that lists “Possible NECHE considerations” on the UCC Forms and Information page and if any apply, indicate what that might be here and contact Institutional Research for further guidance. **N/A** |

**C.** [**NEW OR REVISED COURSES**](#delete_if) **THAT ARE DESIGNATED AS HYBRID**

|  |   | New |
| --- | --- | --- |
| C.1. [Course prefix and number](#cours_title)  |  | **CSCI 445** |
| C.2. Cross listing number if any |  | **N/A** |
| C.3. [Course title](#title)  |  | **Reinforcement Learning and Autonomous Systems** |
| C.4. [Course description](#description)  |  | **Students are introduced to reinforcement learning in autonomous systems. Students learn to apply reinforcement learning to solve of real-world problems, such as robotics, game playing, and self-driving cars.** |
| C.5. [Prerequisite(s)](#prereqs) |  | **CSCI 428** |
| C.6. [Offered](#Offered) please read the screen tips to do this correctly, alternate years needs to be assigned odd/even, and a specific semester. |  | **Fall**  |
| C.7. [Contact hours](#contacthours)  |  | **4** |
| C.8. [Credit hours](#credits) |  | **4** |
| C.9. [Justify differences if any](#differences) | N/A |

|  |  |  |
| --- | --- | --- |
| C.10. [Grading system](#grading)  |  | **Letter grade** |
| C.11. a. [Type of cours](#instr_methods)e  |  | **Lecture | Laboratory**  |
| C.11.b Instruction mode with percentage |  | **Hybrid:****51% in-person****49% online** Course will be offered one day a week in-person along with an in-person final project |
| Reminder: Instructors are responsible for ensuring their course meets accessibility standards and provides accommodations identified by Disability Services (find links).  |
| C.11.c. For online components only: How will students engage with the content  |  |  **Lectures (recorded) | Course readings | Videos or other recordings | Practice and lab activities | Online discussions**  |
| C.11.d. How will students engage with other students  |  | **In-class discussions | Class activities | Online discussion boards | Team/group projects** |
| C.12. CATEGORIES 12. a. [How](#required) to be used |  | **Restricted elective for major/minor** |
|  12 b. Is this an Honors  course? |  | **NO** |
|  12. c. [General Education](#ge) N.B. Connections must include at least 50% Standard Classroom instruction. |  | **NO**  |
|  12. d. Writing in the  Discipline (WID) |  | **NO** |
| C.13. [How will student performance be evaluated?](#performance)  |  | **Exams | Class Work | Quizzes | Projects | Discussion board**  |
| C.14 [Recommended class-size](#class_size) |  | **25 (computer lab)** |
| C.15. [Redundancy statement](#competing) |  | **No** |
| C. 16. Other changes, if any |  |

| C.17**.** [**Course learning outcomes**](#outcomes)**: List each one in a separate row** | [**Professional Org.Standard(s)**](#standards)**, if relevant** | [**How will each outcome be measured?**](#measured) |
| --- | --- | --- |
| Understand the basic concepts, theories, and principles underlying reinforcement learning (RL) and autonomous systems, including the understanding of agents, environments, states, actions, and rewards. |  | Homework, projects, in-class assignments, and labs. |
| Formulate problems using Markov Decision Processes (MDPs) and become proficient in implementing and comparing various reinforcement learning algorithms, including Q-learning, SARSA, and policy gradient methods. |  | Homework, projects, in-class assignments, labs and exams. |
| Apply RL concepts to real-world scenarios, particularly in the context of autonomous systems, including robotics and autonomous vehicles, to understand the challenges and practicalities of these applications. |  | Projects and labs. |
| Analyze the ethical and societal implications of autonomous systems, including bias, fairness, safety, security, privacy, and transparency. |  | Written homework, presentations, in-class assignments, and exams. |
| Communicate effectively about RL concepts, algorithms, and applications to both technical and non-technical audiences. |  | Written homework, presentations, in-class assignments, and exams. |

| C.18. [**Topical outline**](#outline)**:** |
| --- |
| **Week 1: Introduction to Reinforcement Learning*** Overview of reinforcement learning
* Markov decision processes
* Bellman equations

**Week 2: Value Functions*** State-value function
* Action-value function
* Bellman optimality equations

**Week 3: Policy Search Algorithms*** Dynamic programming
* Policy iteration
* Value iteration

**Week 4: Monte Carlo Methods*** Monte Carlo estimation
* Monte Carlo control
* Q-learning

**Week 5: Reinforcement Learning for Self-Driving Cars*** Perception
* Planning
* Control

**Week 6: Reinforcement Learning for Robotics*** Motion control
* Path planning
* Grasping and manipulation

**Week 7: Reinforcement Learning for Game Playing*** AlphaGo
* Atari games (Breakout, Space Invader, etc.)
* Deep Q-networks

**Week 8: Exploration-Exploitation Trade-offs*** Epsilon-greedy exploration
* Upper confidence bound (UCB) algorithm
* Softmax exploration

**Week 9: Drones on Land, Sea and Air** * Exploration of hazardous environments
* First responder assistance
* Security Monitoring
* LAWS (Lethal Autonomous Weapons Systems)

**Week 10: Reinforcement Learning Projects*** Students begin to work in teams to develop RL project (DeepRacer or Robotics)

**Week 11: Ethical and Societal Implications of Autonomous Systems*** Bias and fairness
* Safety and security
* Privacy and transparency

**Week 12: Path Planning and Decision Making*** Path Planning Algorithms
* Decision Making in Autonomous Systems
* Integration of RL in Autonomous Systems

**Week 13: Advanced Reinforcement Learning Topics*** Deep reinforcement learning
* Multi-agent reinforcement learning
* Hierarchical reinforcement learning

**Week 14: Reinforcement Learning Projects Presentations*** Students wrap up final project.

**Week 15: Reinforcement Learning Projects Presentations*** Students will present their projects to the class (DeepRacer competition).
 |

**G. Signatures**

* **Changes that affect General Education in any way MUST be approved by ALL Deans and COGE Chair**.
* Changes that directly impact more than one department/program MUST have the signatures of all relevant department chairs, program directors, and their relevant dean (e.g. when creating/revising a program using courses from other departments/programs). Check UCC manual 4.2 for further guidelines on whether the signatures need to be approval or acknowledgement.
* Proposals that do not have appropriate approval signatures will not be considered.
* Type in name of person signing and their position/affiliation.
* Send electronic files of this proposal and accompanying catalog copy to curriculum@ric.edu to the current Chair of UCC. Check UCC website for due dates. **Do NOT convert to a .pdf.**

##### G.1. Approvals: required from programs/departments/deans who originate the proposal. THESE may include multiple departments, e.g., for joint/interdisciplinary proposals.

| Name | Position/affiliation | [Signature](#_Signature" \o "Insert electronic signature, if available, in this column) | Date |
| --- | --- | --- | --- |
| Suzanne Mello-Stark | Chair of Computer Science and Information Systems | \*approved by email | 2/23/24 |
| Marianne Raimondo | Dean of School of Business | \*approved by email | 2/23/24 |

##### G.2. [Acknowledgements](#acknowledge): REQUIRED from OTHER PROGRAMS/DEPARTMENTS (and their relevant deans if not already included above) that are IMPACTED BY THE PROPOSAL. SIGNATURE DOES NOT INDICATE APPROVAL, ONLY AWARENESS THAT THE PROPOSAL IS BEING SUBMITTED. CONCERNS SHOULD BE BROUGHT TO THE UCC COMMITTEE MEETING FOR DISCUSSION; all faculty are welcome to attend.