**Course Syllabus**

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| **CNU International Summer Session** |

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| **Course Title** | | | Design and Application of Augmented Reality and Mixed Reality | | | | | | | | | | | | | | | | | | |
| **Course Type** | | | In-class | | | | | | | | **Credits**  **(hours)** | | | 3 (45 hours) | | | | | | | |
| **Department** | | | Education | | | | | | | | **Professor** | | | Inki Kim | | | | | | | |
| **Classification**  **(year in school)** | | | Graduate | | | | | | | | **Course Code** | | | GR23889 | | | | | | | |
| **Class room** | | | TBD | | | | | | | | **E-mail** | | | inkikim@illinois.edu | | | | | | | |
| **Prerequisite(s)** | | |  | | | | | | | | | | | | | | | | | | |
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| **Course objectives** | | | This course aims to provide a comprehensive, multi-disciplinary framework for understanding the intersection of human intelligence and artificial intelligence through advanced simulation techniques. Students will gain valuable skills to navigate the complex, rapidly evolving field of simulation in the context of both human and machine cognition. | | | | | | | | | | | | | | | | | | |
| **Course Summary** | | | This interdisciplinary course explores the emerging field of advanced simulation methodology at the intersection of human and artificial intelligence (AI). At the core of both human intelligence and AI lies the concept of simulation, which serves as a model of the real world. Historically, simulations in human intelligence have been shaped by the cognitive capabilities of their creators, while recent advances in AI are revolutionizing simulations in ways that go beyond human intelligence. This course will provide students with a comprehensive understanding of how simulations are applied in both human intelligence and AI, and how AI is increasingly using simulations to push the boundaries of its own development.  Through this course, graduate students and researchers will gain a deeper understanding of human intelligence, modern AI techniques, and their combined potential to drive advancements in the next generation of simulation methodologies. By examining cognitive neuroscience, psychology, AI algorithms, and simulation techniques, students will be equipped to explore cross-disciplinary solutions in areas like brain research, AI, and simulation-based intelligence.  The first part of this course is dedicated to review different aspects of human intelligence derived from cognitive neuroscience, philosophy, and psychology; the second part will provide a guided tour of recent AI methods and algorithms that are central to forming Artificial General Intelligence (AGI), with emphases on Representation Learning and Reinforcement Learning; the final part will review existing simulation principles, methods, and implementation as a basis to generate intelligence, by using Extended Reality (XR), or “metaverse”, as the platform. | | | | | | | | | | | | | | | | | | |
| **Teaching Methods** | | | **Teaching Methods** | | | | | | | | | | | | | | | | | | |
| Lecture | Presentation/Discussion | | | | Problem Based Learning | | | | Project Based Learning | Flipped Learning | | | Experiment/ Practices | | | | Others  (Describe) | |
| x | x | | | | x | | | |  |  | | |  | | | |  | |
| < Lecture>  Lecture will include real-world simulation examples drawn mostly from healthcare domain. By the end of this course, students will:   1. Understand the foundational concepts of simulation in both human intelligence and artificial intelligence. 2. Gain insights into the latest AI methods that are key to the development of Artificial General Intelligence (AGI), including Representation Learning and Reinforcement Learning. 3. Learn about the intersection of cognitive neuroscience, philosophy, and psychology in relation to human intelligence and its simulations. 4. Explore existing methods and techniques in simulation, and how these can be applied to advance human and machine intelligence. 5. Be equipped to conduct research and contribute to interdisciplinary solutions in areas like brain modeling, AI development, and advanced simulation techniques.   < Discussion>  Discussion sessions will be organized to inspire critical thinking on the above learning objectives. Students will be guided to form a group of discussion panelists to foster active debates.    < Problem Based Learning>  Two report assignments will be given to encourage problem-solving using simulation. | | | | | | | | | | | | | | | | | | |
| **Grading** | | | Mid-Term | Final | | Individual Tasks | | | Team Projects | | | Class participation | | | Attendance | | Others  (Describe) | | | | **Total** |
| **30** | **30** | | **10** | | | **10** | | | **10** | | | **10** | | **NA** | | | | **100** |
| ※ Pursuant Section 28 of the Guidelines on Class Management, grading methods can be adjusted for the physically impaired.  ※ Under Section 29 of the University Regulations on Academic Affairs, a student automatically fails a course in case of failure to attend more than 3/4 classes. (More than four(4) times absence) | | | | | | | | | | | | | | | | | | |
| **Accommodations for Handicapped** | | | - Visually impaired: provision of course related materials in audio, note taking helper, permission to record the lecture  - Audibly impaired: provision of course related materials in visual, note taking helper, permission to have e-learning lectures in sign language or shorthand  - Physically or mentally challenged: provision of course related materials, note taking helper, permission to record the lecture   * Any other requests that are considered necessary: provision of assisted   ingress and egress to the classrooms and other supports | | | | | | | | | | | | | | | | | | |
| **Textbooks & References** | | | | | | | | | | | | | | | | | | | | | |
| Category | Title | | | | Author | | | | | | | Publisher | | | | | | | Year of publication | | |
| Main textbook |  | | | |  | | | | | | |  | | | | | | |  | | |
| Others |  | | | |  | | | | | | |  | | | | | | |  | | |
| Reference |  | | | | | | | | | | | | | | | | | | | | |
| **Daily Course Schedule** | | | | | | | | | | | | | | | |
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| **Day**  **(3hurs)** | **Lecture Topic** | **Hours per day** | **Method of Instruction** | **Class Materials & Assignments** |
| 1 | **Introduction to Simulation and Intelligence**   * Definitions and history of simulation in human and machine intelligence * The role of simulation in understanding and modeling the real world * The interplay between simulation, learning, and intelligence * The ethical and philosophical implications of simulating intelligence |  | Lecture | Slides/ Demos |
| 2 | **Cognitive Neuroscience and Human Intelligence**   * Key principles in cognitive neuroscience related to learning and intelligence * Simulation of neural processes in understanding human cognition * Neuroplasticity and its relationship with the adaptability of human intelligence * Case studies of brain regions involved in simulations of real-world tasks |  | Lecture | Slides/ Demos |
| 3 | **Philosophy and Psychology of Human Intelligence**   * Conceptual frameworks for understanding human intelligence (e.g., dual-process theory, embodied cognition) * Cognitive models of perception, memory, and decision-making * Simulations of human cognition from a psychological and philosophical perspective * Cognitive biases and their role in the design of simulations |  | Lecture and Discussion | Slides/ Demos |
| 4 | **Human Simulation Techniques**   * Modeling cognitive processes through simulation * Applications of simulation in cognitive training and rehabilitation * Human-centered simulation tools and their use in decision-making and problem-solving * Review of current research in human intelligence simulation |  | Lecture and Problem-Based Learning | Slides/ Demos |
| 5 | **Introduction to AI and Representation Learning**   * The evolution of AI and the development of representation learning * Understanding deep learning models and their use in simulation * Embedding real-world complexity in AI representations * Application of representation learning in simulation-based AI systems |  | Lecture and Problem-Based Learning | Slides/ Demos |
| 6 | **Reinforcement Learning and Simulation**   * Overview of reinforcement learning (RL) and its applications * Simulation as a tool for training RL agents * Exploration vs. exploitation in RL-based simulation environments * Case studies: RL in robotics, autonomous vehicles, and gaming |  | Lecture and Problem-Based Learning | Slides/ Demos |
| 7 | **Path to Artificial General Intelligence (AGI)**   * Defining AGI and the challenges of creating AGI * How simulations are used in the development of AGI * Interdisciplinary approaches to advancing AGI through simulation * Discussion on the potential of AGI surpassing human-level intelligence in simulations |  | Lecture and Discussion | Slides/ Demos |
| 8 | **Integration of AI and Simulation**   * Synergies between AI techniques and simulation methods * AI as a tool for enhancing and generalizing human intelligence simulations * The future of AGI and simulation-based learning * Applications in healthcare, education, and autonomous systems |  | Lecture | Slides/ Demos |
| 9 | **Simulation as a Tool for Modeling Human and Machine Cognition**   * Overview of modern simulation methodologies and platforms * Advances in virtual reality (VR) and augmented reality (AR) for human simulation * Human-in-the-loop simulations and their relevance to AI * Case studies on complex simulation environments |  | Lecture and Problem-Based Learning | Slides/ Demos |
| 10 | **Simulation Systems and AI-Driven Models**   * Building AI-powered simulation platforms * Multi-agent systems and their role in simulation * Simulations for collaborative AI models and human-machine interaction * Review of current trends in AI-driven simulation systems |  | Lecture and Problem-Based Learning | Slides/ Demos |
| 11 | **Evaluating and Improving Simulations**   * Methods for assessing the effectiveness of simulations in AI and human intelligence * Validation and optimization of simulation models * Challenges in scaling simulations to real-world applications * Ethical considerations in the use of AI-driven simulations |  | Lecture and Discussion | Slides/ Demos |

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| **References** |
| * **“How to Create a Mind: The Secret of Human Thought Revealed”** by Ray Kurzweil * **“Artificial Intelligence: A Modern Approach”** by Stuart Russell and Peter Norvig * **“Cognition: Exploring the Science of the Mind”** by Daniel Reisberg * **Selected research papers and case studies** (provided throughout the course) |