



**Carnegie Mellon University**

School of Computer Science

Executive & Professional Education

# Artificial Intelligence

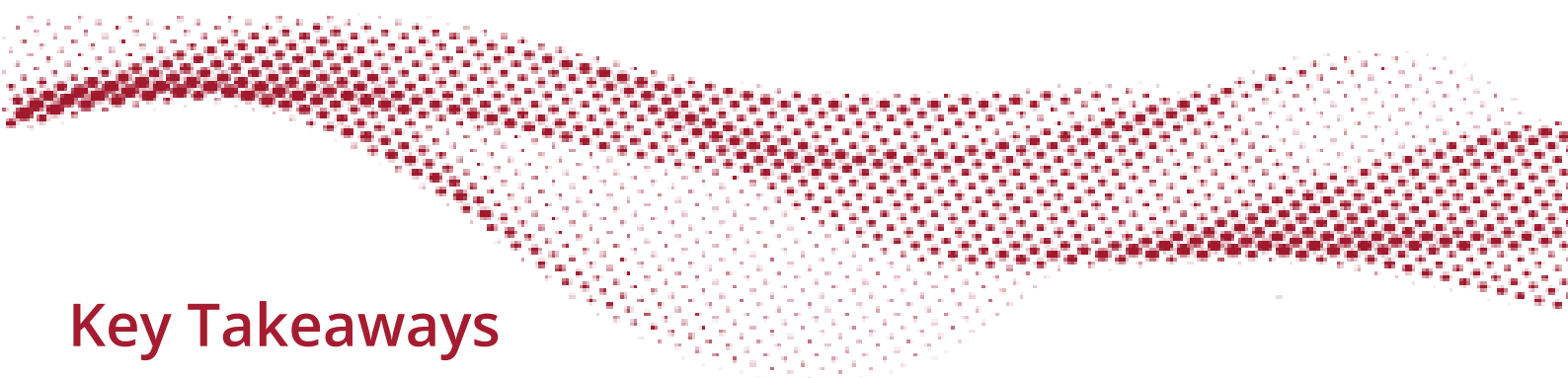
Learn practical methods for solving  
problems with AI

# Overview

The artificial intelligence (AI) revolution is reshaping our world and delivering disruptive innovations that are changing the way we live, work, travel, and more. As a result, the demand for skilled professionals who can harness AI's power is also on the rise.

In the Artificial Intelligence program, you'll get a comprehensive overview of the theory and practice of artificial intelligence. The program is focused on modern computational techniques for representing task-relevant information and making intelligent decisions.

As a participant, you'll gain practical, real-world experience by considering the use and development of decision support systems for medical environments, recommender systems for supported ad targeting, and intelligent systems for autonomous work environments and processes. And because the problem-solving methods presented are applicable across a wide range of industrial, civil, medical, financial, robotic, and information systems, you'll complete the program with the skills you need to help your organization stay ahead of the technology curve — and take your skills for applying AI-powered solutions to the next level.

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## Key Takeaways

In this program, you will:

- Identify reasonable representations for given AI problems
  - Consider the use of basic symbolic and numeric techniques
  - Apply algorithms to representations when finding solutions to AI problems
  - Examine how AI is incorporated into various AI applications
  - Evaluate the ethical and societal implications of the field of AI
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- A decorative graphic in the bottom right corner consisting of several overlapping red geometric shapes, including rectangles and parallelograms, creating a modern, abstract design.

# Who Should Attend?

This program is designed for participants interested in expanding their knowledge of emerging technologies, such as artificial intelligence, gaining a deeper understanding of AI tools and techniques.

This program may be most suitable for:

**Software Developers/Technology Professionals** seeking to gain a foundational understanding of artificial intelligence processes and apply them in their work.

Representative roles include:

- Software Engineer
- Software Developer
- Automation Engineer
- Design Engineer
- Full Stack Developer
- Front-End Developer
- Back-End Developer

**Data Science Professionals** looking to develop an understanding of modern computational techniques for developing AI-based solutions.

Representative roles include:

- Data Scientist
- AI Application Engineer
- Data Engineer
- Senior Data Engineer

**Other Professionals** who want to develop decision support systems (such as medical support or recommender systems), plan and monitor AI systems, develop mixed initiatives, and bring humans into the AI loop.

Representative roles include:

- Project Manager
- Support Analyst
- Information Technology professionals



# Program Curriculum

Structured as an online program, content is shared via recorded faculty videos and office hours with learning facilitators.



## Module 1: Search

Evaluate search as a technique to find a solution to an artificial intelligence (AI) problem with a set of goal criteria:

- Learn how search formalizes the process of looking for solutions to a problem.
- Evaluate the trade-offs and potential information that can be applied to different search problems, and gain an understanding of which algorithms to choose for which types of problems.



## Module 2: State and Action Representation

Construct state and action representations for complex search problems, and describe how they affect search performance:

- Translate a problem from an English statement into something AI can understand by understanding options and formulating the states and actions in a way that is efficient for solving problems.
- Appreciate the complexity of going from an intuitive understanding of the state to something that the computer can understand/handle.



## Module 3: Constraint Satisfaction

Formulate a problem as a set of constraints with an objective and apply relevant algorithms to find a solution efficiently:

- Engage in activities to appreciate that not all problems are state/action transitions.
- Identify when the objective is to solve for a set of values, and apply strategies to accomplish this goal.



## Module 4: Probability and Markov Processes

Consider that many aspects of the world are probabilistic, and evaluate how to translate that in AI:

- Demonstrate familiarity with probabilistic approaches to AI, and implement algorithms to solve probabilistic sequential decision problems.
- Taking probabilities into account, consider models that can make more robust and valued decisions.



## Module 5: Machine Learning Models

Reflect on machine learning (ML) as a popular approach employed to help businesses understand their data:

- Evaluate ML as a technique for finding patterns in data.
- Explore popular ML algorithms and their corresponding data requirements.



## Module 6: Practical Machine Learning

Consider the many nuances to training and evaluating ML algorithms, and explore the various ideas to help train better ML models:

- Appreciate the difficulty of finding or producing clean, usable mass data.
- Analyze tuning hyperparameters that affect model performance and evaluate and select models properly.



## Module 7: Randomized Algorithms

Recognize that real-world problems have state spaces that are infeasible to search systematically:

- Appreciate that randomized algorithms are typically not guaranteed to find optimal solutions within finite time; they often find very good solutions fairly efficiently compared to systematic search.
- Demonstrate the applicability of randomized search techniques and understand when such approaches are appropriate to use.



## Module 8: Common AI Applications Models

Appreciate the range of AI techniques used in common AI applications, such as information retrieval, personal assistants, and recommender systems.

- Consider how AI systems can efficiently search through large quantities of text to answer user questions.
- Review popular approaches to systems that recommend items for human use, such as movies, restaurants, and news articles.



## Module 9: Human-AI Interaction

Appreciate that AI systems do not act in a vacuum; they are typically completing tasks for or with people:

- Consider common approaches to integrating human feedback into AI systems.
- Review current trends and challenges in AI systems that interact with people.



## Module 10: Autonomous Agents

Evaluate the emerging use of AI in systems that can operate autonomously (perceiving the environment, planning and executing actions, and adapting to unpredictable situations):

- Reflect on how reliably achieving complex tasks in dynamic environments is difficult and requires the careful integration of numerous AI techniques.
- Analyze and evaluate trade-offs in algorithmic and architectural techniques used to create intelligent autonomous agents that can handle complex, uncertain, and dynamic situations.



# Program Exercises

Throughout the program, you'll have the opportunity to apply your understanding of the content by completing computational problems and evaluating AI applications and methods in the context of practical problems. Advanced learners can complete "stretch" assignments that allow them to think more deeply and apply their skills more rigorously.

Examples of program exercises include:



Implement and utilize Depth-first and Breadth-first Search to solve common search problems.



Define a state representation and informative heuristics to find optimal shipping routes.



Frame common problems as Constraint Satisfaction Problems (CSP) and solve them with efficient algorithms and heuristics.



Clean, visualize, and summarize data to use for comparing, selecting, and training multiple machine learning models for predicting housing prices.



# Visual Case Study: Human-AI Interaction

As part of an original visual case study, you will deploy a new AI application for use in hospitals. The application will assess the vital signs of patients on a hospital floor and rank the patients in terms of priority for the doctor to visit them.

As part of the visual case study, you will:

- Be immersed in a simulated environment where you will define considerations for an AI system interacting with humans, ensuring the deployment is usable, explainable, transparent, fair, and ethical.
- Be presented with various scenarios to support decision making as you build the AI application.
- Present a business case to deploy this AI application at the end of the module.

## Program Experience



Office Hours With  
Learning Facilitators



Knowledge Checks



Dedicated Program  
Support Team



Case Studies



Programming  
Assignments



Discussion Boards



Wikis/Crowdsourced  
Activities



Scenario and  
Problem-Based  
Learning



# Program Faculty



## **Stephanie Rosenthal**

**Assistant Teaching Professor, Carnegie Mellon University, School of Computer Science**

Stephanie Rosenthal is an Assistant Teaching Professor at Carnegie Mellon University School of Computer Science. She has many years of experience in higher education teaching robotics, artificial intelligence, and applied data analytics. Her practitioner experience

includes industry and government, with organizations such as Microsoft, Intel, the Department of Defense, and a robotics startup. Her research on AI and human-computer interaction aim to improve the decision making and performance of intelligent systems. She holds a PhD in Computer Science from Carnegie Mellon University.



## **Reid Simmons**

**Research Professor and Director of the Bachelor Science in Artificial Intelligence (BSAI), Carnegie Mellon University, School of Computer Science**

Reid Simmons is a Research Professor and Director of the BSAI at Carnegie Mellon University School of Computer Science. As head of the Reliable Autonomous Systems Lab, the research investigates

developing reliable, highly autonomous systems (especially mobile robots) that operate in rich, uncertain environments. As well as being a research professor at CMU, he served as Program Director at the National Science Foundation, overseeing the National Robotics Initiative and Smart and Autonomous Systems programs. He has contributed to hundreds of publications related to AI and has several decades of research experience in the field. He holds a PhD in Artificial Intelligence from the Massachusetts Institute of Technology (MIT).

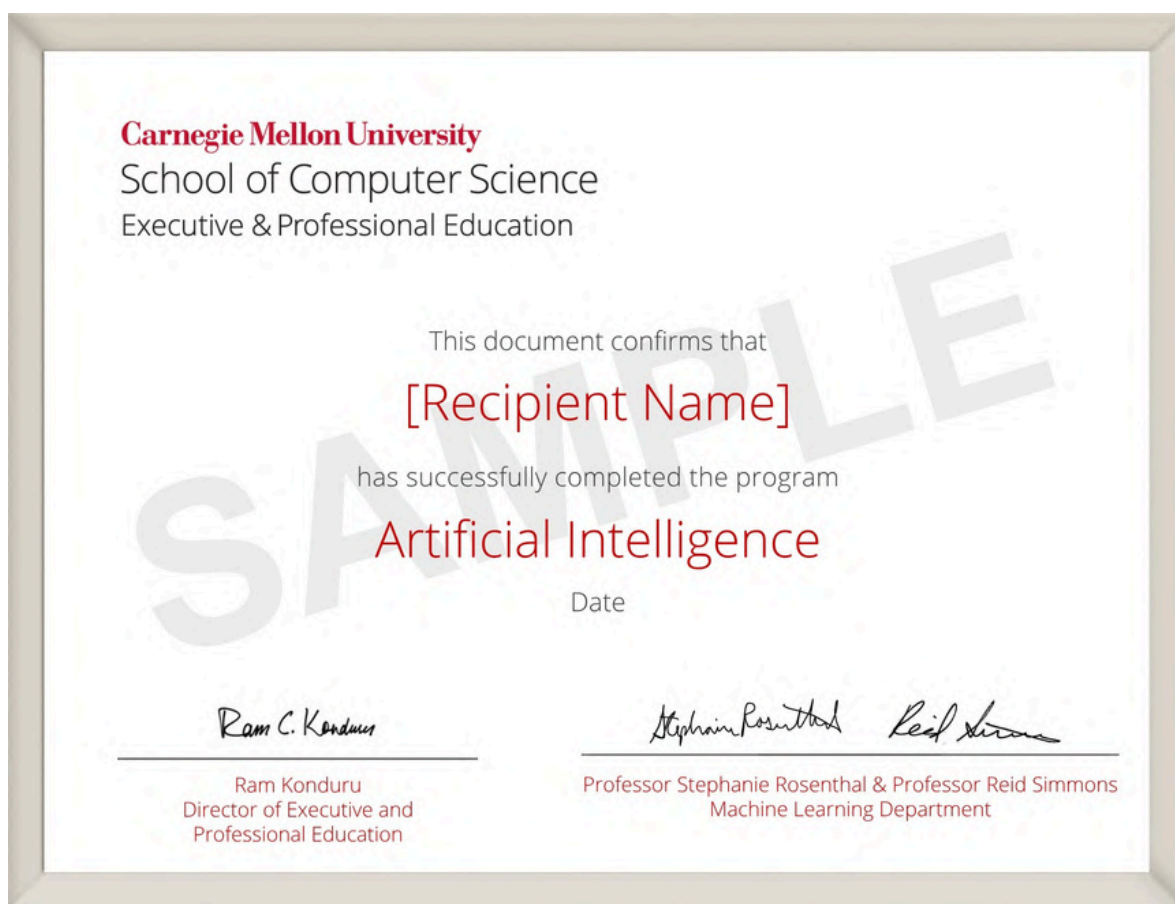


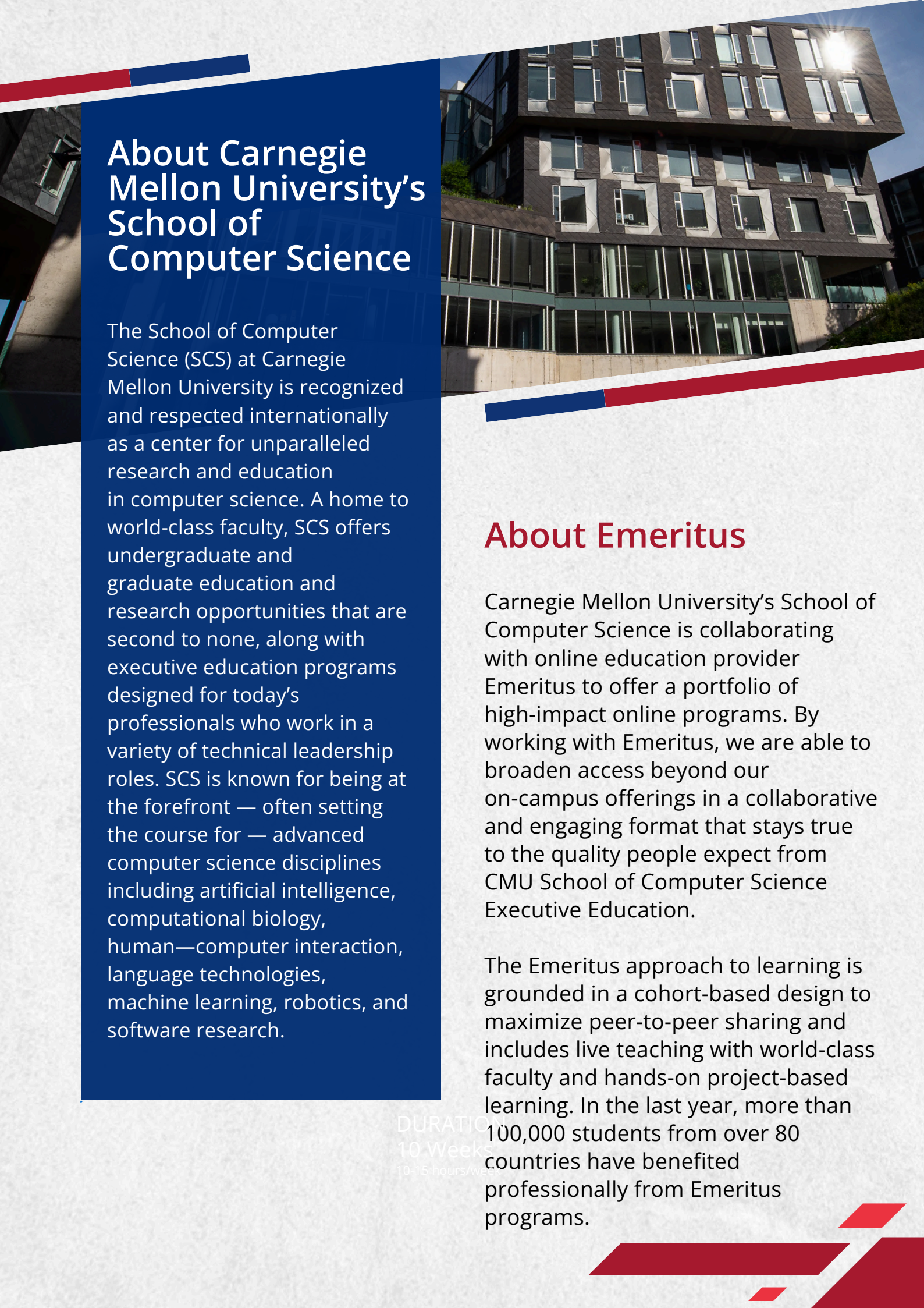
# Program Prerequisites

Functional knowledge of calculus, linear algebra, probability, and statistics is beneficial. Participants should also have a working-level knowledge of Python, algorithm design, and data structures.

## Certificate

Upon successful completion of the program, participants will receive a verified digital certificate of completion from Carnegie Mellon University School of Computer Science Executive Education.





# About Carnegie Mellon University's School of Computer Science

The School of Computer Science (SCS) at Carnegie Mellon University is recognized and respected internationally as a center for unparalleled research and education in computer science. A home to world-class faculty, SCS offers undergraduate and graduate education and research opportunities that are second to none, along with executive education programs designed for today's professionals who work in a variety of technical leadership roles. SCS is known for being at the forefront — often setting the course for — advanced computer science disciplines including artificial intelligence, computational biology, human—computer interaction, language technologies, machine learning, robotics, and software research.

DURATION  
10 Weeks  
10-15 hours/week

## About Emeritus

Carnegie Mellon University's School of Computer Science is collaborating with online education provider Emeritus to offer a portfolio of high-impact online programs. By working with Emeritus, we are able to broaden access beyond our on-campus offerings in a collaborative and engaging format that stays true to the quality people expect from CMU School of Computer Science Executive Education.

The Emeritus approach to learning is grounded in a cohort-based design to maximize peer-to-peer sharing and includes live teaching with world-class faculty and hands-on project-based learning. In the last year, more than 100,000 students from over 80 countries have benefited professionally from Emeritus programs.

## CONNECT WITH A PROGRAM ADVISOR

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**DURATION**  
10 Weeks  
8-10 hours/week



**FORMAT**  
Online



**PROGRAM FEE**  
US\$2,500