

# From Java to Python: Revamping CS2 for a Cohesive Curriculum

## Muhlenberg College

Contributed by Proyash Podder, [proyashpodder@muhlenberg.edu](mailto:proyashpodder@muhlenberg.edu) and Hamed Yaghoobian, [hamedyaghoobian@muhlenberg.edu](mailto:hamedyaghoobian@muhlenberg.edu)

## Institutional and departmental context

- Location: Allentown, Pennsylvania
- Undergraduate student body size: 1788 students
- Degree(s) offered:
- Department/major name: Math, Computer Science and Statistics,
- Number of contributing faculty: 3/12 FTE
- Number of majors annually: approximately 70 majors
- Does the department offer any graduate programs? None.
- Other context:

## Description of Curricular Innovation

### Introduction

Computer science education continually evolves to reflect industry trends, technological advances, and emerging pedagogical practices. At our institution, the introductory computer science curriculum historically consisted of two branches of CS1—*Introduction to Game Programming* and *Introduction to Data Science*—both taught in Python. These courses are designed to provide students with foundational Python programming skills while introducing them to game development and data analysis.

Traditionally, *CS2* followed CS1 and was taught in Java, focusing on object-oriented programming (OOP) and recursion. However, this approach created challenges due to the abrupt language transition and the lack of foundational data structure coverage, hindering students' progression into advanced coursework.

To address these limitations, we redesigned the CS2 course to use Python, creating a more cohesive and progressive learning pathway. This innovation introduces foundational data structures, enabling a smoother transition to the *Data Structures and Algorithms* course (CSI 220). This narrative outlines the rationale, implementation, benefits, and challenges of this transition.

### Rationale for the Change

The decision to transition CS2 from Java to Python was driven by the need to address key challenges:

1. **Consistency in Programming Language:** Aligning CS1 and CS2 with Python allows students to master a single programming language, reducing cognitive load. Previously, the switch to Java disrupted the learning process and diluted students' mastery of either language.
2. **Insufficient Data Structure Coverage:** Historically, CS2 did not address data structures, leaving CSI 220 to cover all foundational and advanced content within one semester. Introducing data structures in CS2 distributes the content more effectively, allowing deeper exploration of advanced topics in CSI 220.
3. **Streamlined Learning Pathway:** Python's continuity across CS1 and CS2 facilitates a seamless progression, enabling students to focus on advanced concepts and applications without the distraction of learning a new language.
4. **Practical Relevance:** Students struggled with implementing machine learning and AI projects in electives and research due to inadequate Python proficiency. Transitioning CS2 to Python equips students with the skills necessary for these applications, fostering independence and deeper conceptual understanding.

## Curriculum Design

The redesigned CS2 course builds on CS1 fundamentals and introduces advanced topics using Python's versatility. Key components include:

1. **Review of Python Fundamentals:** A quick refresher on variables, loops, conditionals, and basic data structures ensures a solid foundation.
2. **Object-Oriented Programming (OOP):** Core OOP concepts such as classes, objects, methods, and inheritance are explored with practical applications.
3. **Recursion:** Recursive algorithms are introduced with examples like factorial calculations and tree traversals.
4. **Foundational Data Structures:** Topics such as linked lists, stacks, and queues are covered, including their implementation and use cases.

This structure supports a more balanced and comprehensive progression to CSI 220, allowing the advanced course to focus on complex algorithms and data structures.

## Benefits of the Transition

1. **Enhanced Learning Experience:** The updated curriculum provides a deeper and more engaging exploration of programming concepts.
2. **Improved Python Proficiency:** A consistent language focus enhances students' confidence and fluency.
3. **Efficient Progression:** Foundational data structures in CS2 alleviate the content load in CSI 220, enabling in-depth study of advanced topics.
4. **Alignment with Industry Trends:** Python's prevalence in fields like data science and AI increases the curriculum's relevance and employability of graduates.

## Challenges and Limitations

1. **Balancing Curriculum Scope:** Careful consideration is required to avoid overwhelming students while ensuring adequate preparation for CSI 220.
2. **Resource Development:** Transitioning the course required significant effort in designing new materials and assessments tailored to Python.

This curricular innovation addresses longstanding challenges in the CS2 structure, providing a more cohesive and practical pathway for students. By fostering Python proficiency and introducing data structures earlier, this redesign equips students with the skills needed for advanced coursework, research, and industry applications.