NJ Big Data Alliance - Data Science Degree Alignment & Articulations

Lori Dars,
Rutgers, The State University of New Jersey

Rut Mehta, Suhani Patel, Ananya Rayapuraju, Jessica Rippman, Shriya Singaraju,
Master of Business and Science Externship Program

RUTGERS UNIVERSITY
Professional Science
Master's Program
Master of Business and Science

Externship Exchange

Pathways in Practice: Student Impact & Project Innovation

NJ Big Data Alliance - Data Science Degree Program Alignment and Articulation

June 4, 2025
The Hard Rock Hotel & Casino
Atlantic City, New Jersey

MBS-NJBDA-NJ Pathways Partnership

This project is a partnership between
Rutgers Masters in Business and Science Externship Program, The New Jersey Big Data Alliance, and NJ Pathways

Research Project to Align Data Science Curriculum between 2-year and 4-year institutions in New Jersey

Student Team Presentations:

- ***Summer 2024*** - Prerequisite data science courses/outlines likely to transfer
- ***Fall 2024*** – Relevant courses for 1st two years of a data science-related degree likely to transfer, and model syllabi creation
- ***Spring 2025*** - Reviewing/reconciling existing data science, math and computer science courses at New Jersey 2-year and 4-year colleges

//Data Science Curriculum Alignment Pathways Project//

Summer 2024

//Meet the team

Suhani Patel

MBS, UXD
Team Lead

Shriya Singaraju

SEBS,
Biotechnology

Saira Khan

SAS, Data Science &
Computer Science

Aryan Malik

SAS, Math & Economics
& Computer Science

Sara Shareef

SAS, Computer
Science

MBS ADVISORS

Dr. Karen Bemis

Assistant Director

Lori Dars

Senior Advisor

PROGRAM MENTOR

Dr. George Avirappattu

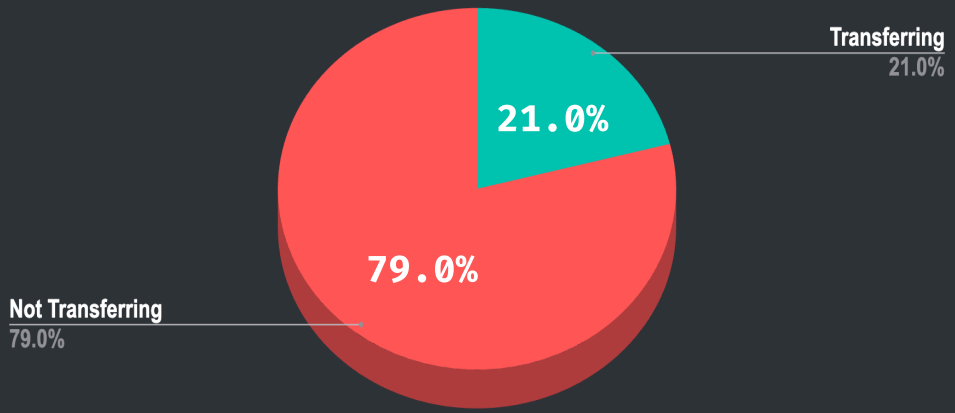
NJBDA/Kean University

//Background

18 Two-year colleges in NJ

23 Four-year colleges in NJ

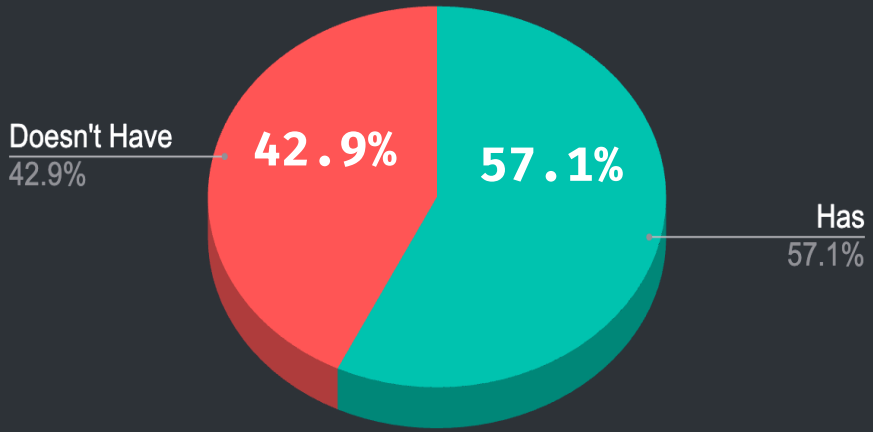
% of Students Transferring from Two-Year to Four-Year Institutions in New Jersey



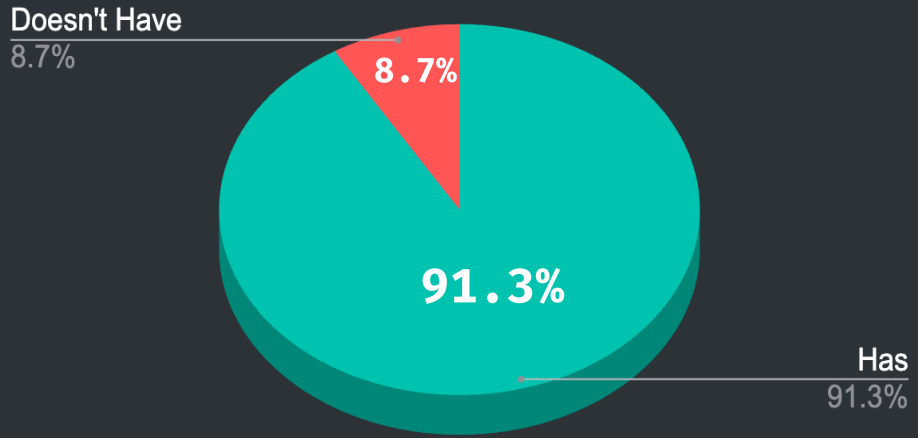
"NJBDA partnered with NJ Pathways on a "Data Science Curriculum Alignment and Articulation Agreement Pathways Project"

//Background

NJ Community Colleges Offering Data Science Programs*



NJ 4 Year Institutions Offering Data Science Programs



*as of Summer 2024

//Problem Statement & Goal

{// Overcome inconsistencies and standardize the course content map to facilitate smoother credit transfers for NJ students between 2-Year and 4-Year institutions. //}

- Enhance credit transfer for core DS courses
- Minimize redundant coursework, graduation time & financial burden
- Identify potential program-to-program articulation

//Project Approach

Mid June 2024 → Late June 2024 → Early July 2024 → Mid July 2024 → Late July 2024 → August 2024

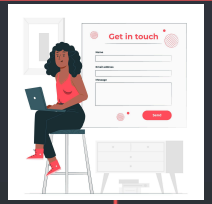
Data Collection

Identify target institutions

Collect data (courses, curriculum)

Sample Colleges

Rutgers
TCNJ
Ramapo
NJIT



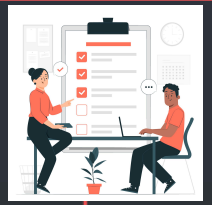
Outreach & Syllabus Collection

Contact for most updated syllabi

Course Content Analysis

Pre-req and first level data science courses

Compare, Identify gaps



Course Outline Development

Template creation

Course Outline Finalization

Present findings, recommendations to stakeholders

//Categorization of NJ 4-Year & 2-Year Colleges

Sheet: Categorization of Community Colleges in New Jersey based on Data Science Course Information						
Institution Name	Program URL(s)	Information Category	Notes	Categories		
Atlantic Cape	https://catalog.atlanticcape.edu/computer-information-systems/computer-information-systems	Comprehensive	Very very nice to use. Has all courses labeled and laid out in both timelines and requirements. All links work and provide course descriptions and details		Comprehensive Information	Detailed program requirements and course descrip available / syllabi
Brookdale	https://catalog.brookdalecc.edu/programs/MSDAT	Comprehensive	Has all requirements and prerequisites along with course descriptions and credit details		Moderate Information	Some detailed information available, but missing specific course descriptions / syllabi
Essex	https://catalog.essex.edu/about-academic-divisions/math-engineering-technology-computer-science-division/computer-science-as/	Moderate Information	Has all the course descriptions and general major requirments in one place, so its easy to locate. Not many data science courses, mainly programming. Also includes one course that could be transferrable		Limited Information	Very limited information available, with many gaps course descriptions / syllabi
Hudson *Has CONNECT program	https://www.hccc.edu/programs-courses/academic-pathways/stem/computer-science-as-bs.html	Moderate Information	There is no data science program. But easy access to course descriptions, but not that clear and detailed descriptions. Some courses are related to data science though. provides the pre-reqs for the classes as well			
Camden	https://www.camdencc.edu/program/data-science/	Limited Information	Curriculum plan available, lacks detailed information on courses offered			
Sussex	https://www.sussex.edu/academics/degrees/information-systems/	Limited Information	No Data Scienc program impletemented.			

//Syllabi Outreach

***This sheet details the list of professors, deans, department heads, and other university administration who were contacted to provide syllabi information for the data science courses at their respective institutions. This sheet includes the contact name, their position, and their contact information, as well as the date they were contacted and notes about information received from them.

Syllabi Contact Information and Status

Institution contacted	Contact Name	Position	Contact Info	Date Contacted	Follow-Up Date	Status	Notes
Ramapo	**Amanda Beecher**	Associate Professor of Mathematics Convener of Data Science MS in Applied Mathematics Program Director Ramapo College of New Jersey	abeecher@ramapo.edu	2024-06-24	2024-07-01	Received	Received Syllabi from Prof Amanda
	Sarah Stacey	Admissions Counselor	admissions@ramapo.edu				
	Nora	Transfer specialist	information@ramapo.edu				
TCNJ	**Dr. Su VanderSandt**	Department Chair	email: mathstat@, P) 609.771.2269	2024-06-24	2024-07-01	Pending	Contacted the department via phone; however, as of Friday, it seems they are on leave, and the call went straight to voicemail.
	Dr. David Reimer	Associate Department Chair	email: reimer@	2024-07-01			
	Dr. Cathy Liebars	Mathematics Education Coordinator	email: liebars@	2024-07-01			
	Laurie Wanat	Program Assistant	wanatl@	2024-07-01			
	Regina Littwin	Department Secretary	littwin@	2024-07-01			

//Selection of Sample Colleges

4-Year Institutions Studied

- NJIT
- Ramapo
- TCNJ
- Rutgers

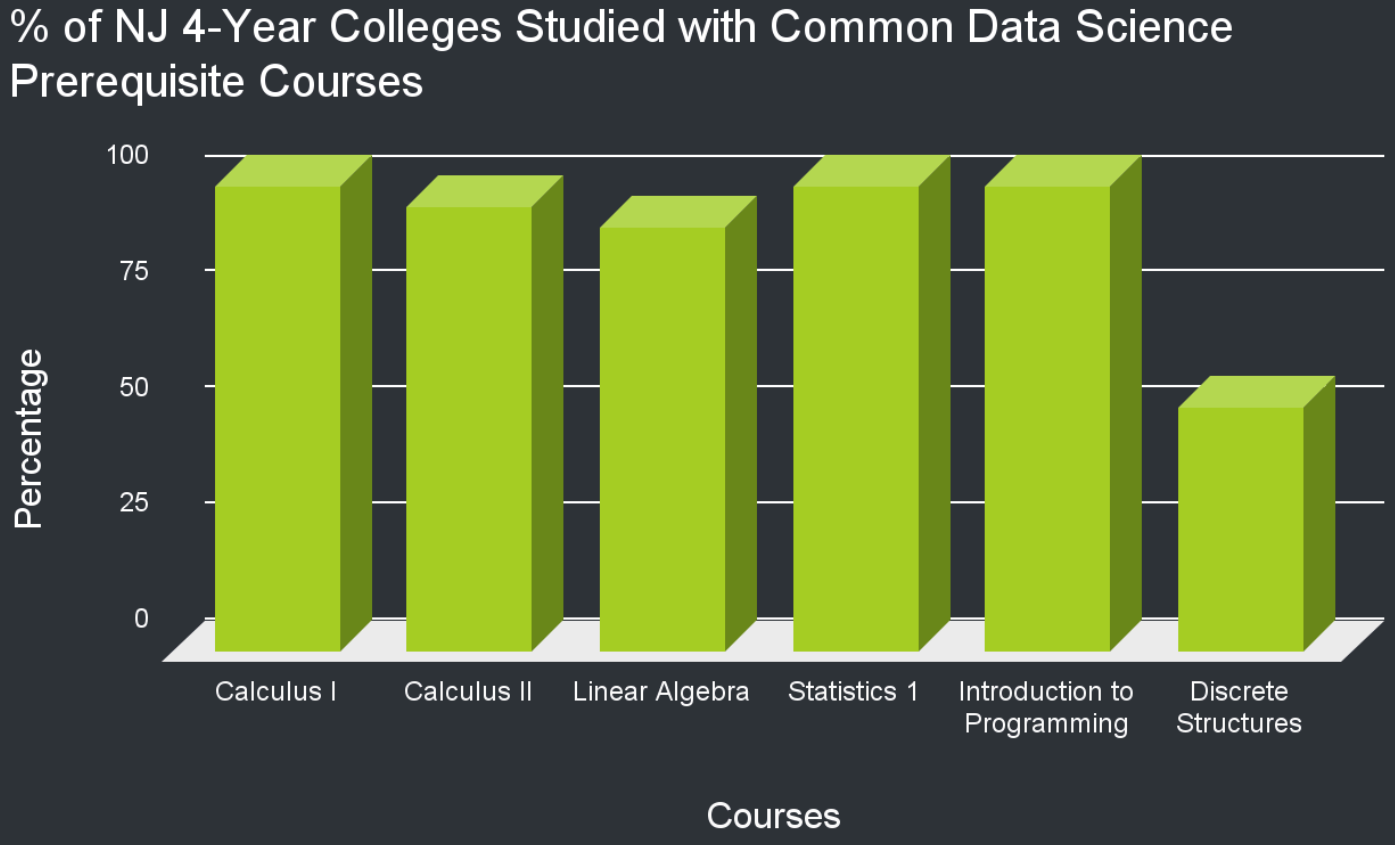
//List of Pre-Reqs for 4-Year Institutions

***This sheet details the list of 1st and 2nd year courses offered by the mentioned colleges that correlate with math, statistics, and science.

Required Correlate Courses

College	Course Code	Course	Pre-req
NJIT	MATH 111	Calculus I	University Mathematics B II - Trigonometry
	MATH 112	Calculus II	Calculus I
	MATH 337	Linear Algebra	Calculus II
	CS100	Roadmap to Computing (Intro to Programming)	
	MATH 244	Introduction to Probability Theory	Calculus II
RAMAPO	MATH 121	Calculus I	Precalculus
	MATH 262	Linear Algebra	Calculus I + Discrete Structures or Calculus I + Mathematical Structures
	MATH 237	Discrete Structures	Calculus I
	MATH 205	Mathematics Structures	Calculus I
TCNJ	MAT 127	Calculus I	Precalculus
	MAT 128	Calculus II	Calculus I
	MAT 205	Linear Algebra	Calculus II OR Discrete Mathematics
	STA 215	Statistical Inference and Probability	Calculus for Business and the Social Sciences OR Calculus I
	MAT 200	Discrete Mathematics	Calculus I
	STA 305	Regression Analysis	Statistical Inference and Probability
	STA 306	Multivariable Statistics	Statistical Inference and Probability
		Calculus I	

//Determination of Key Pre-Reqs



//List of Required Introductory Data Science Courses at 4-Year colleges

***This sheet details the list of introductory courses required for a data science major from the four institutions selected for the pilot study: TCNJ, NJIT, Rutgers, Ramapo. The sheet includes the course code, course title, list of pre-requisites, and the university the course is offered at.

Required CS Major / DS Specialization Introductory Core Courses

College	Course Code	Course	Pre-req
NJIT	CS 113	Introduction to Computer Science	CS 100 Roadmap to Computing or CS 103. Computer Science with Business Problems
	CS 114	Introduction to Computer Science II	CS 113 Introduction to Computer Science
	CS 241	Foundations of Computer Science I	CS 114 Introduction to Computer Science II and MATH 112 Calculus II
RAMAPO	DATA 101	Intro to Data Science	None
	CMPS 240	Data Analytics In Python	CMPS 130 Intro to Programming in PYTHON OR CMPS 148 COMPUTER SCIENCE II
	DATA 301	Data Analysis & Visualization	CMPS 240 Data Analytics In Python
TCNJ	CSC 220	Computer Science I	None
	CSC 230	Data Structures-Computer Science II	CSC 220 Computer Science I
		Data management for Data Science	CS 142 (Data 101: Data Literacy) OR CS 111 (Introduction to Computer Science)

//Proposed List of Introductory Data Science Courses

1. Introduction to Data Science
2. Ethics in Technology
3. Data Analytics/Data Management using Python
4. Data Visualization

//Course Content Compared Across Sample 4-Year Institutions

This sheet provides a comparative overview of the linear algebra topics covered across three universities: NJIT, Rutgers, and TCNJ. It lists specific topics in linear algebra and indicates their inclusion in the syllabi of each institution.

Linear Algebra

Topics	NJIT	RUTGERS	TCNJ
	School of Theoretical and Applied Science	School of Arts & Sciences	School of Science
	syllabi link	syllabi link	syllabi link
Matrix Operations and Properties	☑	☑	☑
Matrices	☑	☑	☑
Matrix Multiplication	☑	☑	☑
Matrix Algebra	☑	☑	☑
Invertibility	☑	☑	☑
Elementary Matrices	☐	☑	☐
Partitioned Matrices	☐	☑	☐
Inverse of a Matrix	☑	☑	☑
Block Multiplication	☑	☑	☑
LU Decomposition	☑	☑	☑
Systems of Equations	☑	☑	☑
Systems of Equations	☑	☑	☑
Homogeneous Systems	☐	☑	☐
Systems of Linear Equations	☑	☑	☑
Gaussian Elimination	☑	☑	☑
Reduced Row Echelon Form (RREF)	☑	☑	☑
Rank	☑	☑	☑
Nullity	☑	☑	☑

Courses include:

- Linear Algebra
- Statistics I
- Discrete Structures
- Calculus I and II
- Introduction to Programming

//Recommended Course Outlines

INTRODUCTION TO PROGRAMMING

Semester Hours: Four (4) credits

Prerequisites: None

Description

Introduces the fundamental concepts and software which are essential for theoretical computer science, and the role of programming in data science. Also introduces students to IDEs (e.g. Anaconda, Visual Studio Code) and setting up a programming environment. Topics include data types and expressions, debugging, functions and modules, file I/O, object-oriented programming, recursion, exceptions and assertions, collection data types, sorting algorithms, complexity analysis and counting operations, and searching.

I. Course Objectives

Upon completion of this course, the student should be able to:

1. Understand and utilize fundamental data types and expressions..
2. Implement conditional statements and loops, including nested statements and loops.
3. Design and use functions and modules, including recursion functions.
4. Apply principles of object-oriented programming (OOP) and understand its benefits in data science.

II. Course Content

Data Types and Expressions

- **Primitive Data Types**:
  - Integers, floats, strings, and booleans
- **Variable Declaration and Initialization**:
  - Naming conventions
  - Assignment operators
- **Expressions and Operators**:
  - Arithmetic, relational, and logical operators
  - Operator precedence and associativity

Debugging

- **Introduction to Debugging**:
  - Importance of debugging in programming
  - Common types of errors (syntax, runtime, logical)
- **Debugging Techniques**:
  - Using print statements
  - Using debugging tools in IDEs
- **Error Handling**:
  - Understanding and interpreting error messages

Decisions and Loops

- **Conditional Statements**:
  - If, else-if, else constructs

//Next Steps

3

Step 03 — Expand analysis to all NJBDA member universities

2

Step 02 — Identify gaps between course outlines and community college syllabi

1

Step 01 — Develop Course Outline for Introductory Data Science Courses

Introduction

18 2-year colleges in NJ

23 4-year colleges in NJ

NJBDA partnered with NJ Pathways on "Data Science Curriculum Alignment and Articulation Agreement Pathways Project"

Problem Statement

Overcome inconsistencies and standardize the course content map to facilitate smoother credit transfers for NJ students between 2-Year and 4-Year institutions.

Goals

Enhance credit transfer for core courses

Minimize redundant course work, financial burden & graduation time

Results

- Categorization of NJ Colleges based on information available
- Pre-req Courses List for 4-Year colleges
- Introductory Data Science Courses at 4-Year colleges
- Course Content Comparison by Topic Across 4-Year Colleges

→

Recommended Course Outline for Prerequisite Courses for 4-Year Colleges in NJ:

- **Introduction to Probability & Statistics**
- **Calculus I**
- **Calculus II**
- **Linear Algebra**
- **Discrete Structures**
- **Introduction to Programming**

Approach

Key Learnings

Detailed documentation is essential for future reference.

Implementing through selected institutions helps refine the approach and ensures feasibility.

Effective collaboration with faculty is crucial for the standardization of core course requirements.

THANK YOU!

//Concept Map

2-Year Institutions

Document Available Courses

Collect Curricula & Align by content

Incorporate Data Science standards

Document Major/Core Requirements

4-Year Institutions

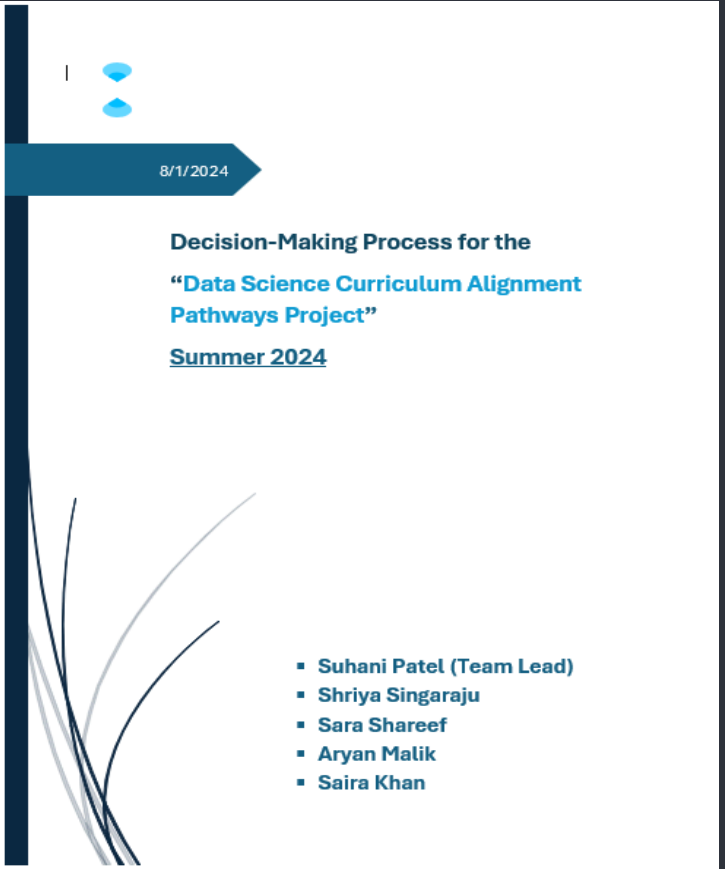
Standardize Coursework:

- Find common course content amongst 4 year institutions
- Develop pre-requisite course content outlines
- Establish agreed upon data science core course content

Recommend Articulations to NJBDA/Pathways

//Decision Making Process White Paper

{// To enhance the project impact, analyze course offerings at two-year colleges to identify curriculum gaps and opportunities to improve transferability.//}



//Course Content Compared Across Sample 4-Year Institutions

*Description: This sheet provides a comprehensive list of topics covered in Introduction to Programming across three selected four-year institutions. It includes the links to detailed syllabi and indicates which institution teaches each topic.

INTRO TO PROGRAMMING			
Topics	**RAMAPO***	**RUTGER8**	**NJIT**
	School of Theoretical and Applied Science	School of Arts & Sciences	Ying Wu College of Computing
	syllabi link	syllabi link	syllabi link
Introduction to programming	☑	☑	☑
Overview of Programming	☐	☐	☐
Programming Environment	☐	☐	☐
Data Types and Expressions	☑	☑	☑
Primitive Data Types	☐	☐	☐
Variable Declaration and Initialization	☐	☐	☐
Expressions and Operators	☐	☐	☐
Debugging	☑	☑	☑
Introduction to Debugging	☐	☐	☐
Debugging Techniques	☐	☐	☐
Error Handling	☐	☐	☐
Decisions and Loops	☑	☑	☑
Conditional Statements	☐	☐	☐
Loops	☐	☐	☐
Control Flow	☐	☐	☐
Functions and Modules	☑	☑	☑
Functions	☐	☐	☐
Modules	☐	☐	☐
Recursion	☐	☐	☐
File I/O	☐	☑	☑
Reading and Writing Files	☐	☐	☐
File Handling Exceptions	☐	☐	☐

//Course Content Compared Across Sample 4-Year Institutions

** This sheet provides a standardized comparison of the syllabi for the Discrete Structures course across colleges. The format is designed to list the topics covered that are common to all colleges offering the course, followed by topics unique to each college.

DISCRETE STRUTURES			
Topics	**RAMAPO**	**RUTGERS**	**TCNJ**
	School of Theoretical and Applied Science	School of Arts & Sciences	School of Science
	syllabi link	syllabi link	syllabi link
Modeling Computation	☐	☑	☐
Languages and Grammar	☐	☑	☐
Finite State Machines	☐	☑	☐
Turing machines*	☐	☑	☐
Boolean Functions	☐	☑	☐
Representations	☐	☑	☐
Logic Gates*	☐	☑	☐
Minimization of circuits*	☐	☑	☐
Probability	☑	☐	☐
Summations	☐	☑	☐
Truth Tables	☐	☑	☑
Intro to Graph Theory	☐	☐	☑
Mathematical notation	☐	☐	☑

//Course Content Compared Across Sample 4-Year Institutions

*Description: This sheet provides a comprehensive list of topics covered in Intro Statistics across three selected four-year institutions. It includes the links to detailed syllabi and indicates which institution teaches each topic. Only NJIT and TCNJ require this.

Intro to Statistics		
Topics	**NJIT**	**TCNJ**
	Ying Wu College of Computing	Department of Mathematics and Statistics
	syllabi link	syllabi link
Sample Space, Events	☑	☑
Counting	☑	☐
Probability	☑	☑
Conditional Probability	☑	☐
Independence	☑	☑
Arithmetic Rules of Probabilities	☑	☐
Bayes Rule	☑	☐
Random Variable	☑	☐
Discrete Probability Distribution	☑	☐
Continuous Probability Distribution	☑	☐
Joint Probability Distribution	☑	☐
Mean and Variance	☑	☑
Binomial Distribution	☑	☐
Hypergeometric Distribution	☑	☐
Possion Distribution	☑	☐
Continuous Uniform Distribution	☑	☐
Normal Distribution	☑	☑
Normal Approximation of Distributions	☑	☑
Gamma Distribution	☑	☐
Exponential Distribution	☑	☐
Transformations of Distributions	☑	☐
Moment Generating Functions	☑	☐

//Course Content Compared Across Sample 4-Year Institutions

*Description: This sheet provides a comprehensive list of topics covered in Calculus 2 across three selected four-year institutions. It includes the links to detailed syllabi and indicates which institution teaches each topic. Ramapo was not included as it does not require calculus 2.

Calculus II			
Topics	**RUTGERS**	**NJIT**	**TCNJ**
	School of Arts & Sciences	Ying Wu College of Computing	Department of Mathematics and Statistics
	syllabi link	syllabi link	syllabi link
Definite Integrals	☑	☑	☑
Indefinite Integrals	☑	☑	☑
Area Between Curves	☑	☑	☑
Volume - Cross Sections	☑	☑	☑
Volume - Shell Method	☑	☑	☑
Arc Length	☑	☑	☑
Integration by Parts	☑	☑	☑
Trig Integrals	☑	☑	☑
Trig Substitutions/Equivilancies	☑	☑	☑
Improper Integrals	☑	☑	☑
Series and Sequences	☑	☑	☑
Infinite Series	☑	☑	☑
Series Tests	☑	☑	☑
Taylor Series	☑	☑	☑
Maclaurin Series	☑	☑	☑
Taylor Expansion/Convergence	☑	☑	☑
Polar Coordinates	☑	☑	☑
Calculus in Polar	☑	☑	☑
Parametric Equations	☑	☑	☑
Complex Numbers	☑	☐	☐
Complex Arithmetic	☑	☐	☐
Eulers Notation	☑	☐	☐
Complex Numbers in Polar Coordinates	☑	☐	☐
Roots of Complex Numbers	☑	☐	☐
Intro to Differential Equations	☑	☐	☐

//Key Learnings

Enhanced skills in analyzing and interpreting large datasets.

– **Sara**

Informative visual representation of large raw data sets.

– **Suhani**

Learned to collaborate effectively with peers from diverse academic backgrounds

– **Saira**

Gained insight into the institutional transfer process

– **Shriya**

Developed skills for collecting large data quickly (and dealing with its struggles)

– **Aryan**

Fall 2024 - Data Science Curriculum Alignment Project
NJBDA and NJ Pathways

Streamlining credit transfers for degrees in data science

Meet The Team

Jessica Rippman - Team Lead

B.A. Mathematics (Statistics) @ Rowan University

Simra Ahmed

B.S. Computer Science @ Ramapo College

Rebecca Feit

B.S. Computer Science @ Ramapo College

Pranjal Karanjkar

B.S. Business Analytics @ Rutgers University

Aliaksandra Voitsik

B.S. Mathematics (Data Analytics) @ Kean University

RUTGERS MBS ADVISORS

Dr. Karen Bemis
Assistant Director

Lori Dars
Senior Advisor

MENTOR

George Avirapattu
Faculty, Kean University

Project Approach

Step 1

Identify NJ institutions with most transfer students and US schools with top data science programs.

Step 2

Select a sample of schools to research.

Step 3

Identify requirements for the first 2 years of a degree in data science.

Step 4

Organize course requirements for each school into a spreadsheet

Step 5

Collect and analyze the syllabi for similar learning objectives.

Step 6

Construct course outlines and create a 2-year roadmap.

School Selection Process

The Integrated Postsecondary Education Data System

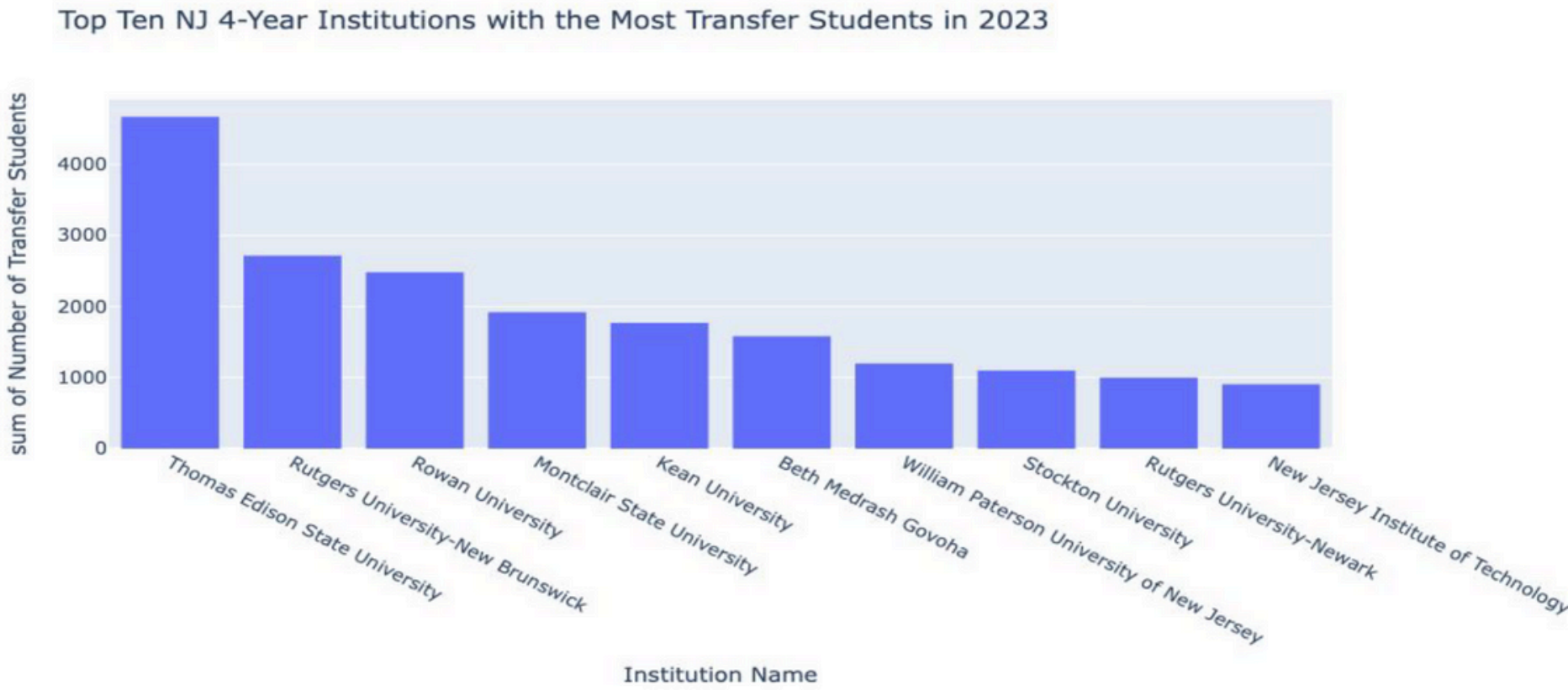
IPEDS Integrated Postsecondary Education Data System

What is IPEDS?

- A comprehensive **data collection system** managed by the National Center for Education Statistics (NCES)
- **Gathers information** from all U.S. colleges, universities, and technical/vocational institutions that participate in federal student financial aid programs
- **Collects data** on enrollments, program completions, graduation rates, faculty and staff, finances, institutional prices, and student financial aid

Link to the Integrated Postsecondary Education Data System:
https://nces.ed.gov/ipeds/use-the-data

School Selection Process



School Selection Process

Expanding Our Research Scope

Initial NJ Focus: Rowan, Rutgers, Montclair, and Kean

Added 10 "Gold-Standard" Data Science Programs:

- In-state: NJIT, Ramapo College, St. Peter's University
- National leaders: Purdue, Michigan, UC Berkeley, UPenn, Northwestern, NYU, Carnegie Mellon

Selection Process: Based on US News "2025 Best Undergraduate Data Science Programs" rankings and mentor recommendations

Link to article:

https://www.usnews.com/best-colleges/rankings/computer-science/data-analytics-science?_sort=rank&_sortDirection=asc

Action: Obtaining Syllabi

Step 1

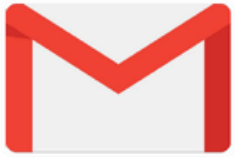
Search for recommended 4-year roadmaps for each university online.

Step 2

Determine required Data Science/Math courses within first two years.

Step 3

Enter course information into spreadsheet & determine courses to analyze.



Step 4

Email school advisors/professors to obtain syllabi.

First Two Years of Data Science Courses by School

Insitution	Course Code	Course Name	Prerequisite courses	Credits	Notes	Recommended Semester
Montclair State University	CSIT 104	Python Programming I	None	3	Introduction to basic computational concepts; legal and ethical issues in computing and information technology. Main	1st
	CSIT 114	Python Programming II	CSIT 104 Python Programming I	3	This is an intermediate-level Python programming course. It is a continuation of CSIT 104. It will cover topics such as	2nd
	CSIT 213	Data Structures and Algorithms in Python	CSIT 114 Python Programming II	3	This course will teach the creation and manipulation of in-memory data structures including lists, queues, trees, stacks, heaps	3rd
	CSIT 230	Computer Systems	CSIT 111 Fundamentals of Java Programming **OR** CSIT 114 Python Programming II **AND** CSIT 170 Discrete Mathematics; MATH 122 Calculus I **OR** AMAT 120 Applied	3	This course aims to introduce the fundamental aspects of computer systems from the hardware and software point of	4th
	CSIT 359	Data Visualization	CSIT 213 Data Structures and Algorithms in Python	3	This course provides fundamental exploratory techniques to summarize and visualize data sets. R and Python	4th
Kean University	CPS 2231	Computer Programming	CPS 1231 and Math 1054	4	Fundamental computing and programming concerts; use of systems software; problem solving; design of algorithms using a	Freshmen, 1st
	CPS 2232	Data Structures	CPS 2231 and MATH 2110	4	The course covers the theory of Abstract Data Types (ADTs), applications and implementations of the classical ADTs	Freshmen, 2nd
	CPS 2390	Computer Organization and Architecture	CPS 2231 and MATH 2110	3	Fundamental concepts of Instruction Set Architecture (ISA) and Assembly Language	Sophomore, 3rd
	CPS 3250	Computer Operating Systems	CPS 2232 and CPS 2390	3	Concepts, structure and mechanisms of operating systems, types of operating systems, CPU scheduling, memory	Sophomore, 4th

Splitting up Core Courses

Required Core Courses (math/science/statistics)

- Classes that were math-focused
  - Already completed by previous group, so we did not focus on these.

Required CS Major / DS Specialization Introductory Core Courses

- Classes focused on core Data Science and/or Computer Science principles
  - Focused on these for our analysis to efficiently continue research.

Compiling Common Courses

“Introduction to Programming” Courses (10/10 schools)
“Data Structures” Courses (8/10 schools)
“Introduction to Data Science” Courses (10/10 schools)
“Statistics/Probability for Data Science” Courses (10/10 schools)
“Ethics for Technology/Data Science” Courses (7/10 schools)

- Later decided to include “Data Visualization”
  - Course can be taught at a low-level without many prerequisites.

- Using these common courses as a base, we then looked for syllabi at each school for these courses.

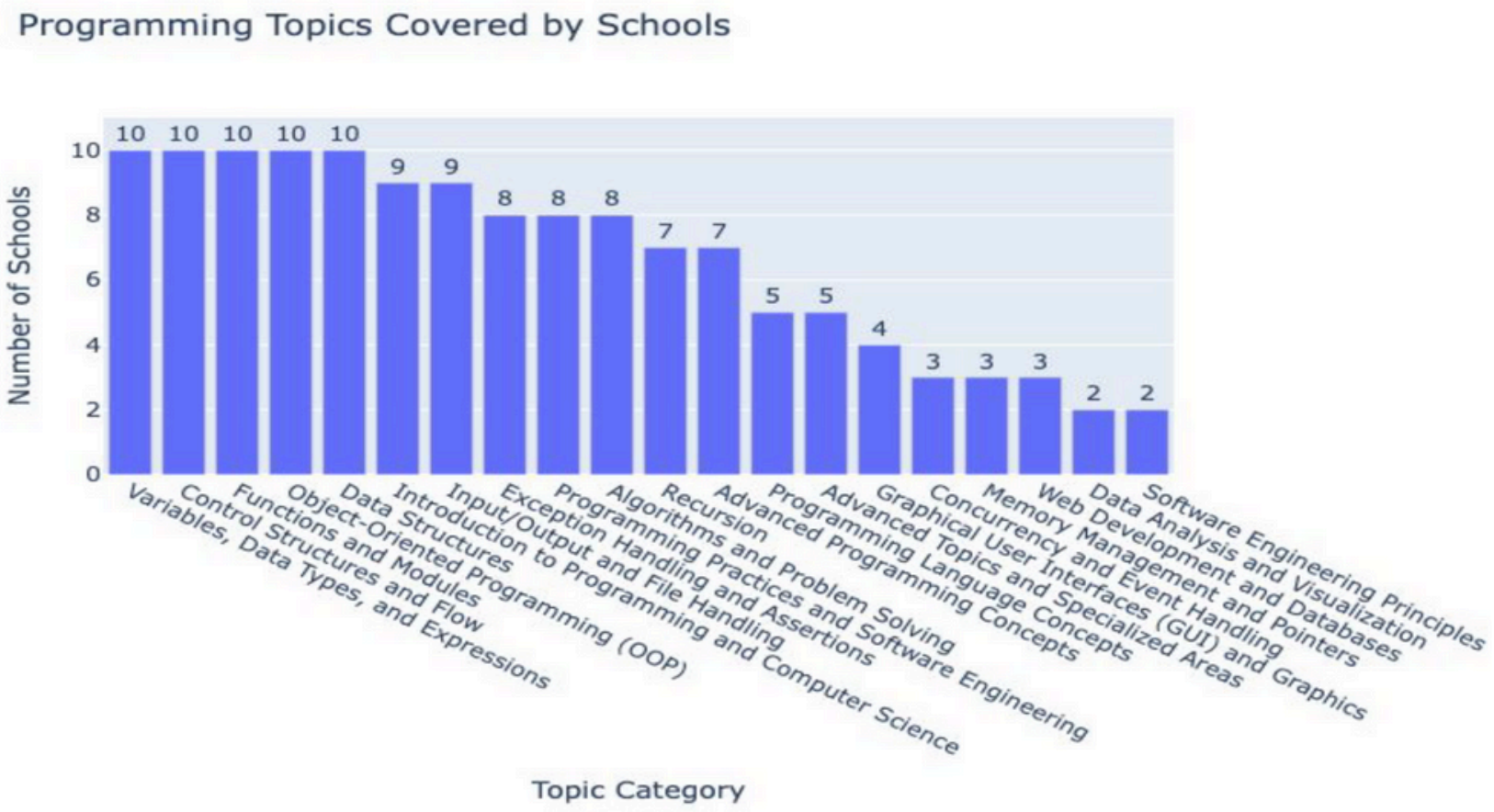
Data Structures Checklist Ex.

NJ PATHWAYS
Aligning Education to Build an Innovative Workforce

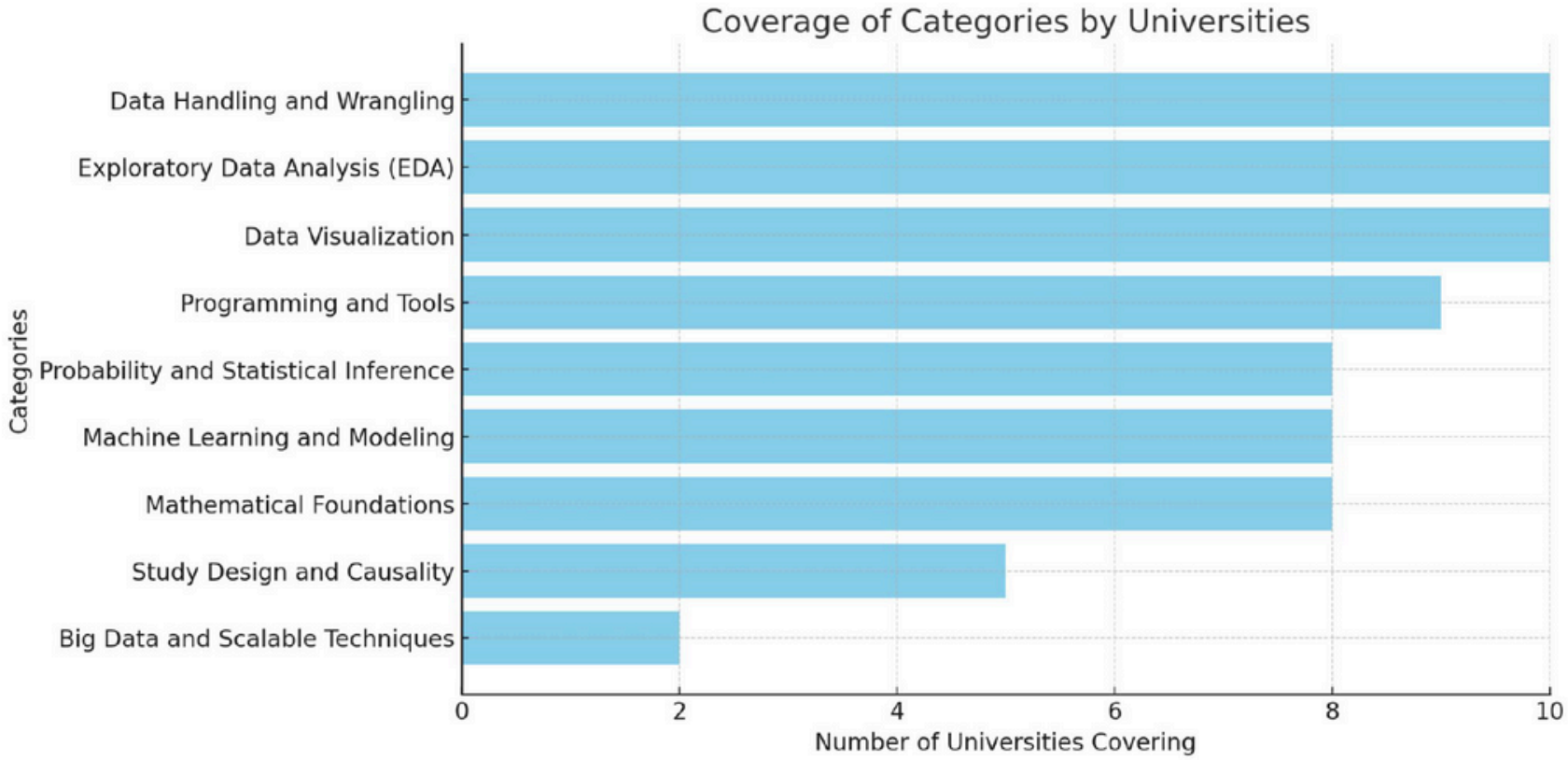
NJ Big Data Alliance

Topic	Berkeley	NYU	Rutgers	Michigan	Kean	Ramapo
Introduction to Data Structures	☑	☑	☑	☑	☑	☑
Object-Oriented Principles	☑	☑	☑	☑	☑	☑
File I/O	☐	☑	☐	☑	☐	☑
Exception Handling	☐	☑	☐	☑	☐	☐
Recursion	☑	☑	☑	☑	☑	☑
Lists	☑	☑	☐	☑	☑	☑
- Array-based List	☑	☑	☐	☑	☑	☑
- Linked List (Singly)	☑	☑	☐	☑	☑	☑
- Doubly Linked List	☑	☑	☐	☐	☐	☐

Programming Topics



Introduction to Data Science



Course Outlines & Roadmap

- Introduction to Data Science
- Statistics/Probability for Data Science
- Introduction to Programming in Python
- Data Structures
- Data Visualization
- Ethics for Data Science/AI

Course Outlines - Results

Recommended course outline

DATA VISUALIZATION

Semester Hours: 3 credits
Prerequisites: Introduction to Data Science and Introduction to Python Programming

Description

This course introduces students to the fundamental principles, tools, and techniques of data visualization. It emphasizes the role of visualization in exploring data, communicating insights, and making data-driven decisions. Topics include design principles, perception and cognition, advanced visualization techniques, interactive dashboards, and storytelling with data. Students will gain hands-on experience with popular visualization tools and programming libraries, creating meaningful visualizations tailored to specific audiences and contexts.

I. Course Objectives

1. Utilize a variety of tools and programming libraries to create effective data visualizations.
2. Apply design principles and an understanding of perception and cognition to visualization design.

Course Outlines - Results

Recommended course outline

Introduction to Data Visualization

- Definition and Purpose
  - What is data visualization?
  - Importance in data analysis and communication
- Historical Evolution of Data Visualization
- Types of Data and Visualizations
  - Quantitative vs. categorical data
  - Matching data types to appropriate visualizations

Visualization Tools and Software

- Overview of Popular Tools:
  - Tableau: Basic usage and advanced features (e.g., filters, dashboards)
  - R (ggplot2, Shiny): Creating and customizing visualizations
  - Python (Matplotlib, Seaborn, Plotly): Static and interactive visualizations
- Comparative Analysis of Tools:
  - Strengths and limitations of different platforms
- Hands-on Practice with Selected Tools

Design Principles and Perception

- Core Design Principles:
  - Clarity, simplicity, and accessibili
  - Gestalt principles of visual organizati
- Visual Perception and Encoding:
  - How users perceive visual elements like color and size
  - Effective use of visual channels (position, color, shape)
- Aesthetics and Accessibility:
  - Color theory and palettes
  - Designing for diverse audiences (e.g., colorblind users)

Roadmap - Results

Should Intro to Python be a 1 or 2 credit class?

Freshman Year (18 Credits)

Semester	Course Name	Credits
Semester 1	Calculus I	4
	Intro to Programming (Python)	4
Total Credits		**8**
Semester 2	Calculus II	4
	Intro to Data Science	3
	Intro to Programming (Java or C++)	3
Total Credits		**10**

Is another programming language class necessary?

Roadmap - Results

Sophomore Year (17 Credits)

Semester	Course Name	Credits
Semester 3	Data Structures	4
	Linear Algebra OR Discrete Math	3
	Statistics/Probability for Data Science	4
Total Credits		**11**
Semester 4	Data Visualization	3
	Data Ethics	3
Total Credits		**6**

Project Insights

- Core data science courses often differ in topics and learning outcomes.
- A standardized curriculum would set clear benchmarks, reducing learning gaps and redundancies.
- Standardization will help students retain credits and save time when moving between institutions.

Data Science Curriculum Alignment Project

Introduction

NJBDA partnered with NJ Pathways on "Data Science Curriculum Alignment and Articulation Agreement Pathways Project".

Problem Statement

1. Transfer credit issues
2. Cost and time delays
3. Career uncertainty

Goals

Approach

Collect syllabi from 4-year institutions and gold standard schools.

↓

Analyze collected syllabi to identify overlaps and gaps within core Data

Results

Recommended Courses:

- Introduction to Programming in Python
- Statistics/Probability for Data Science
- Ethics for Data Science / AI
- Data Visualization
- Introduction to Data Science
- Data Structures

Key Learnings

- Core data science courses often differ in topics and learning outcomes.

- A standardized curriculum would set clear benchmarks, reducing learning gaps and redundancies

THANK YOU!

NJBDA and NJ Pathways Data Science Curriculum Alignment and Articulation Agreement Project - Spring 2025

Meet The Team

Ananya Rayapuraju
Business Analytics & IT
Rutgers University

David Lopez
Data Science
Ramapo College

Muhammad Zohab
Computer Science
Saint Peter's University

Rut Mehta
B.S. in Business Analytics & IT, Computer Science
Rutgers University

Thomas Ampadu
B.S in Computer Science
NJIT

RUTGERS MBS ADVISORS

Karen Bemis
Associate Director, MBS Externship

Lori Dars
Senior Advisor, MBS Externship

PROGRAM MENTOR

George Avirappattu
Professor of Mathematics,
Kean University

COMMUNITY COLLEGE ADVISOR

Nick Picioccio
Professor of Computer Science,
Middlesex College

Problem Statement / Goals

Problem Statement

Community college students in New Jersey often face barriers when transferring Data Science-related credits to four-year institutions

Goals

Identify insights and possible trends for classes not transferring between 2-year colleges and 4-year institutions

Develop course recommendations for colleges to consider and implement for improved Data Science course equivalency

What is NJ Transfer?

- Primary background research for our team was extracting qualitative information about the workings of NJ Transfer from Thea Olsen: Executive Director, New Jersey Statewide Transfer Initiative

How does NJ Transfer work?

Course Created at CC

01

When a course is **created**, and added to the NJ Transfer website/bank, the NJ Transfer system **pings** the administrator at 4-year universities to determine **course equivalencie**s in their institution. They send it back.

Course equiv matrix

02

NJ Transfer builds a **course equivalency database**, storing equivalencies from **every CC to each participating university**.

Transfer Program Search

03

At the start of each year (ideally), the 4 year university sends an **Recommended Transfer Program (RTP)**. Using the database, NJ Transfer **back searches** to fill in all of the requirements of the program.

Manual updates

04

If there is a change in equivalency, the NJ Transfer team will need to **manually update** records. Furthermore, if a 4 year university creates a **new course** that is equivalent to a CC course, that also has to be done manually

Approach

To **increase the transferability** of data science courses/curriculums from NJ community colleges to four-year institutions

Gathering Data Science/Math/CS **Syllabi and Curriculums**

Perform **manual analysis** (excel) for detailed understanding of data, structure, insights

Perform **automated analysis (python)** for speed and high volume processing to extract global insights

Combine both analysis streams to create **recommendations**

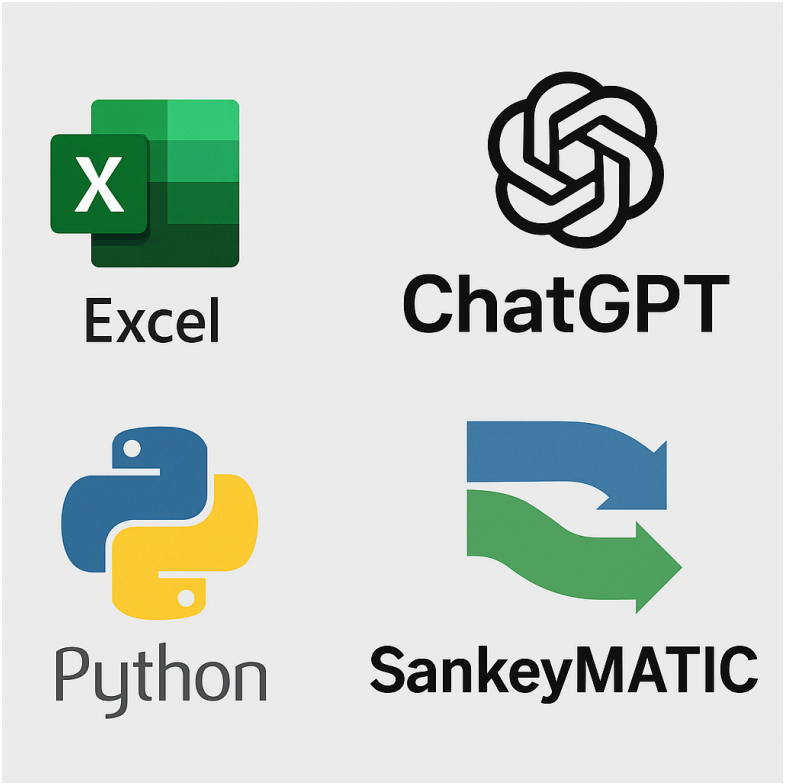
Reaching out to **points of contact** at colleges for **course alignment**

Future Steps

Developing **Articulation Agreements** between Community Colleges and 4-Year Colleges

Software Tools Used

- **ChatGPT**
  - Image Creation/ Visualization Generation
  - Content Drafting
  - Data Analysis for Recommended Courses
- **Python**
  - Syllabus Library Creation
  - Data Cleaning & Standardization
- **Excel**
  - Initial Data Creation
  - Collaborative Sharing between Partners
- **SankeyMatic and Canva**
  - Visualization generation



Why These Community Colleges Were Chosen

Choosing Community Colleges

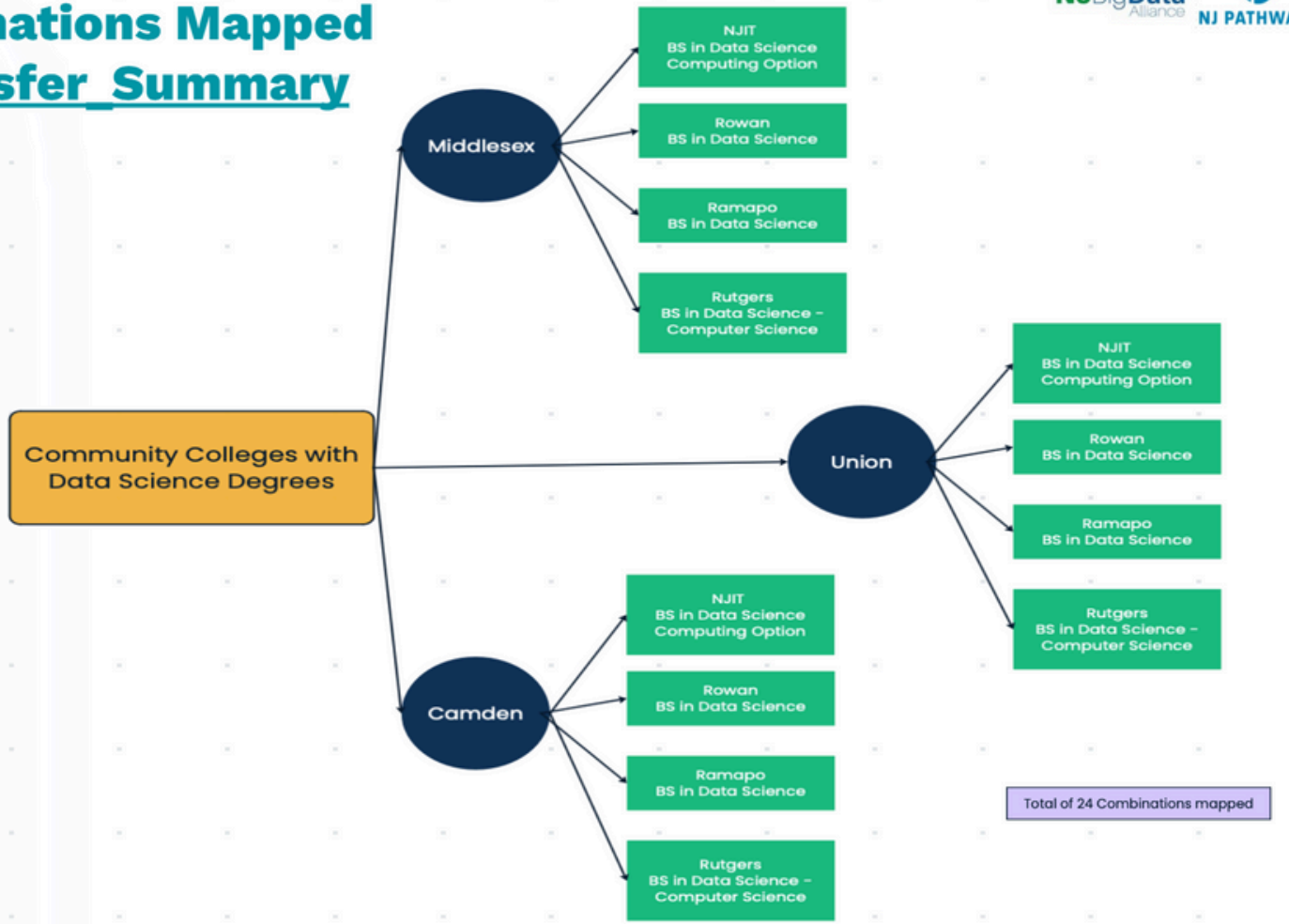
- **Middlesex, Union, and Camden:**
  - Offer a dedicated **A.S. degree in Data Science**
  - Clear pathway for students pursuing Data Science
- **Brookdale, Morris, and Essex:**
  - No standalone A.S. in Data Science
  - Offer **Data Science options** within Computer Science or Math programs
  - Provide foundational exposure to the field through related coursework

Why These 4-Year Institutions Were Chosen

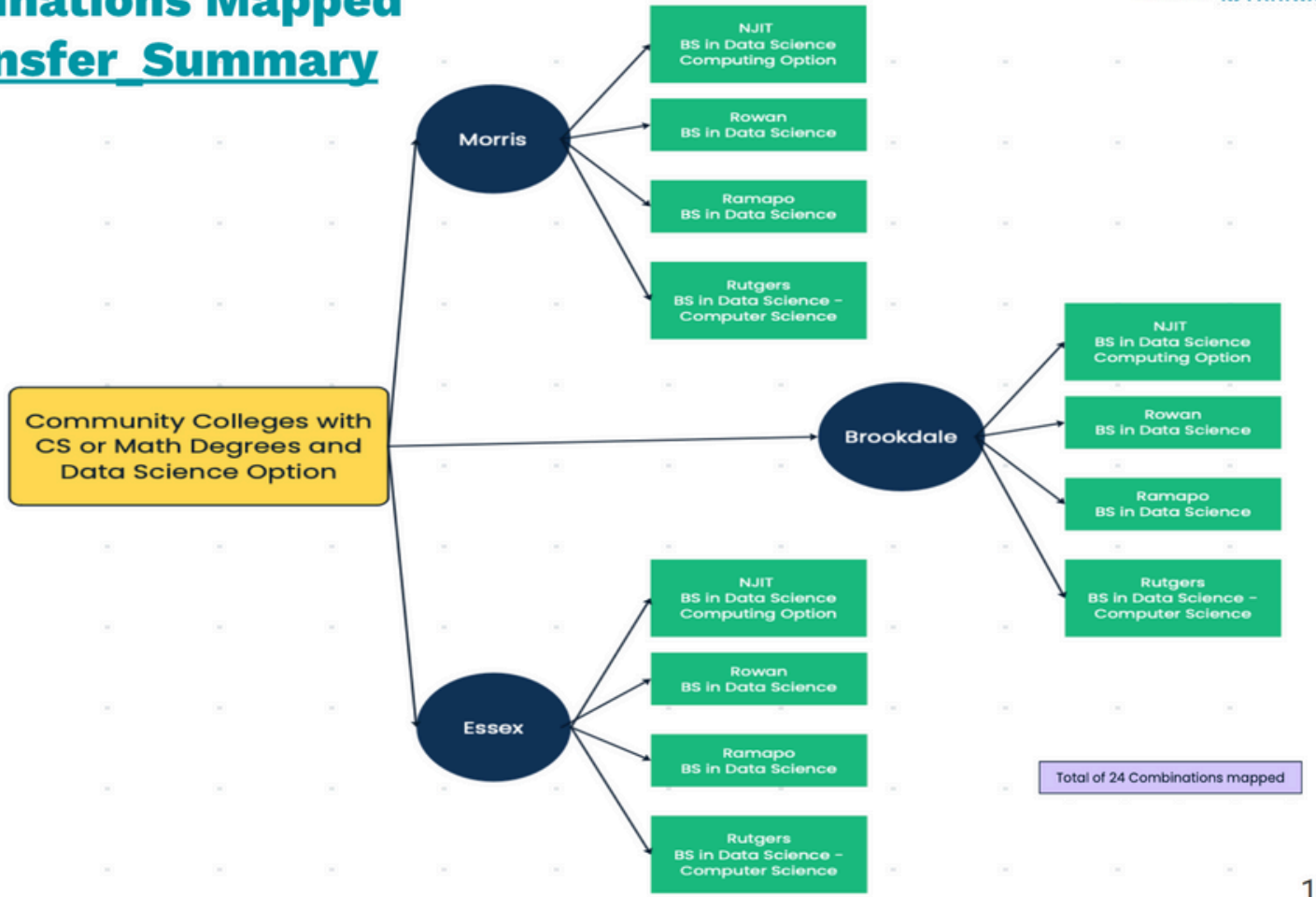
Choosing 4-Year Institutions

- Selected **NJIT, Ramapo, Rowan, and Rutgers**
  - Chosen based on **highest transfer student enrollment** among New Jersey four-year institutions

Results: Combinations Mapped on Master_Transfer_Summary



Results: Combinations Mapped on Master_Transfer_Summary



Results + Insights

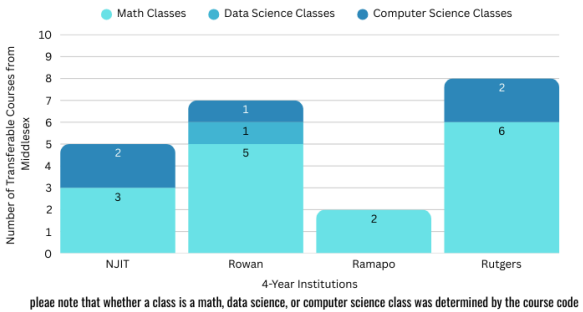
Transfer Landscape is Inconsistent but Navigable

- Core courses like Calculus I & II, Linear Algebra, and Intro to Programming generally transfer well across most institutions
- Intro to Data Science and Discrete Structures are critical courses in 4-year curricula but inconsistently offered at 2-year colleges

Transfer Gaps Exist Between 2-Year and 4-Year Institutions

- Some courses transfer only as electives, not at all, or require bundling
- Ramapo consistently accepts the fewest credits, while NJIT and Rowan are more transfer-friendly for technical subjects

Best Transfer: Middlesex → 4-Year Institutions

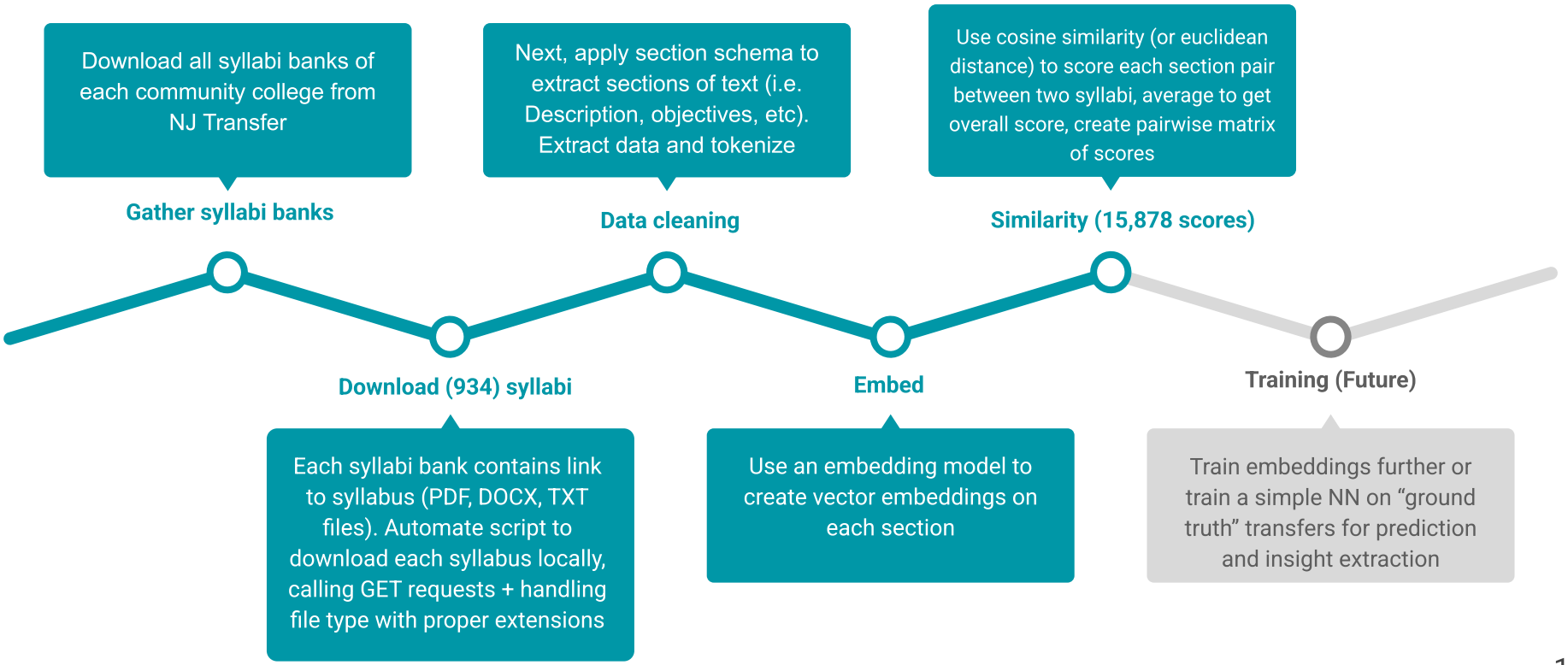


pleae note that whether a class is a math, data science, or computer science class was determined by the course code

Most Challenging Transfer: Brookdale → 4-Year Institutions

	A	B	C	D	E	F	G	H	I	J
1	2-Year College	2-Year Code	2-Year Course Name	NJIT	Rowan	Ramapo	Rutgers	Notes		
2	Brookdale	MATH171	CALCULUS I	1	1	1	1	Universal transfer		
3	Brookdale	MATH172	CALCULUS II	1	1	0	1	No Ramapo equivalent		
4	Brookdale	COMP171	PROGRAMMING I	0	0	0	1	Requires additional courses*		
5	Brookdale	MATH131	STATISTICS	0	0	0	1	Only Rutgers		
6	Brookdale	MATH132	INTRO DATA SCIENCE + APPLIED STATS	0	0	1	0	Ramapo DATA 101		

Methods: Python + AI -> Syllabi Matching



2-Year Recommended College Courses

Course Number	Course Name	Credits
First Semester		
	Calculus 1	4
	Statistics for Data Science	3
	Intro to Programming for Data Science I (Python)	3
Second Semester		
	Calculus II	4
	Data Science 101	3
	Intro to Programming for Data Science II (Python)	3
Third Semester		
	Linear Algebra	3
	Data Science Elective	3
Fourth Semester		
	Discrete Mathematics/Structures	3
	Probability	3
	Data Ethics	3

Last Semester's Team Reccomendations Below:

Course Number	Course Name	Credits
First Semester		
	Calculus 1	4
	Intro to Programming (Python 1)	3
	Intro to Data Science	3
Second Semeste	Calculus II	4
	Python 2 (Programming II)	3
Third Semester	Data Structures	3
	STEM or Math Elective	3
	Statistics for Data Science	3
Fourth Semester		
	Data Visualization	3
	Data Ethics	3
	STEM-relative or free elective	3

Recommendations

Potential NJ Transfer Enhancements

- List all schools in NJ Transfer's course-level search, allowing for accurate advising
- Add Syllabi Banks for 4-Year Institutions
- Incentivize 4-year schools to provide data to NJ Transfer on a regular basis*
- Alert 2-year and 4-year administrators to return course equivalencies when a new course is added/modified

Next Steps

Next Steps for Transfer Summary Sheet

- **Expansion Opportunities**: Add more courses and institutions pairings to our analysis
- **Identify what's "missing":** Identify key content differences between similar courses
- **Outreach:** Reach out to school reps to discuss course revisions based on findings

Next Steps with Python

- **With More Syllabi**:
  - Train embeddings to align transferable course content.
- **Without More Syllabi**:
  - Use existing matrix to extract and analyze high-similarity course pairs.
    - False positives? Improve embeddings or refine sectioning.
    - True similarity but no transfer? Investigate reasons (objectives, language, tech, etc.).:
- Use mean embedding vectors to design an "ideal" 4-year Data Science syllabus.

Thank You and Acknowledgements

- Thank you to our Rutgers MBS advisors Dr. Karen Bemis and Lori Dars
- Thank you to our mentor Dr. George Avirappattu
- Thank you to Nick Picioccio
- Thank you to Thea Olsen
- Thank you to the New Jersey Big Data Alliance
- Thank you to the MBS Externship Exchange program
- Thank you to the prior externship teams involved
- Thank you to New Jersey Pathways

Questions?

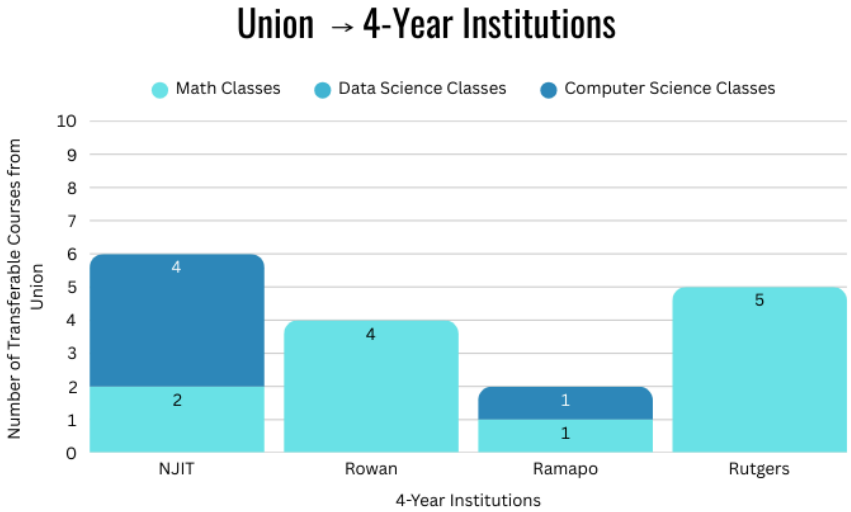
Supplemental Information

Results: Data Summarization

- **2YR_DS_Degrees** – 2-year NJ colleges offering Data Science degrees
- **2YR_CS_Math_Degrees** – 2-year NJ colleges offering Computer Science or Mathematics degrees with a Data Science option
- **4YR_DS_Degrees** – 4-year NJ colleges offering Data Science degrees
- **Master_Transfer_Summary** – Summary of transferable courses from 2-year to 4-year NJ colleges
- **Gold_Star_Colleges** – Courses offered in the first four semesters at ten gold-star 4-year colleges
- **Recommended_2YR_Courses** – Recommended Data Science, Computer Science, and Math courses for 2-year NJ colleges that will transfer to 4-year colleges

Results: Union -> 4-Year Institutions

- **CST206 – Data Science** only transfers to Ramapo; *not accepted* as an Intro to Data Science course at other major colleges.
- **MAT267 – Discrete Mathematics** transfers to Rutgers as Intro to Discrete Structures I,
  but **does *not* transfer to Ramapo's Discrete Structures**, raising consistency concerns.
- **CST261 – Data Structures** expected to align with Rowan's Principles of Data Structures,
  but **only transfers to NJIT as Intro to CS II**.
- **MAT171 - Unified Calculus I** successfully transfers to all universities
  MAT172 - Unified Calculus II transfers to NJIT, Rowan,
  MAT271 - Rutgers **Unified Calculus III** transfers to Rutgers and Rowan
- **MAT265 - Linear Algebra** only transfers to Rutgers
- Only two courses transfer from Union to Ramapo–which is a point of concern to further look into



pleae note that whether a class is a math, data science, or computer science class was determined by the course code

Results: Camden to 4-Year Institutions

Math Alignment

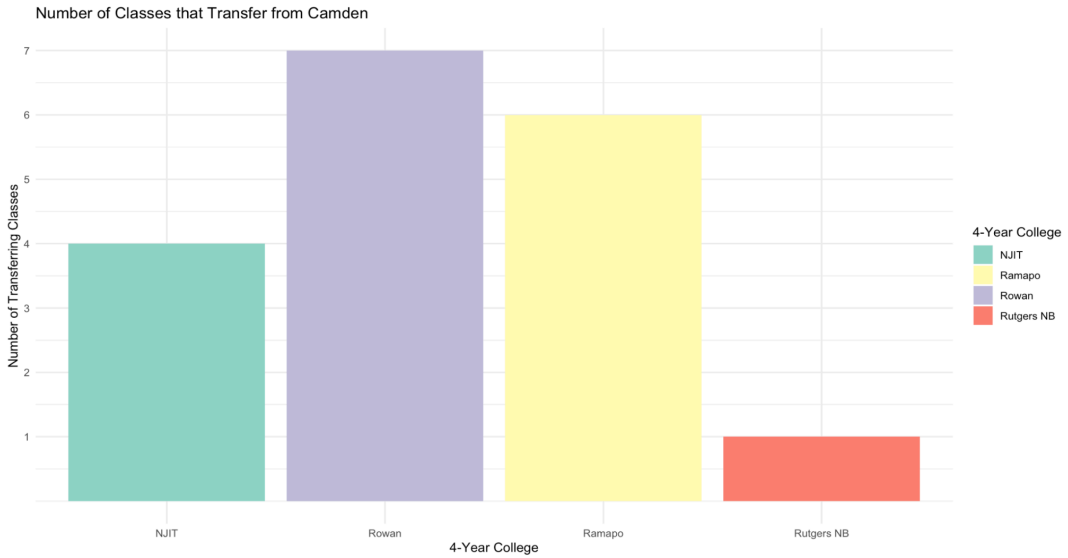
- **Calculus I, II,** and **Linear Algebra** transfer well to **NJIT**, **Rowan**, and **Ramapo**
- **Discrete Math** transfers to **Rowan** but not **Ramapo or Rutgers**

Computer Science Transfers

- **Intro to Python** courses are accepted well to **NJIT**, **Rowan**, and **Ramapo**.
- **Computer Science II** courses transfer to **NJIT** and **Rutgers**, but not to **Rowan** or **Ramapo**

Data Science Courses

- **Data Science I & II** transfer to **Rowan** and **Ramapo**



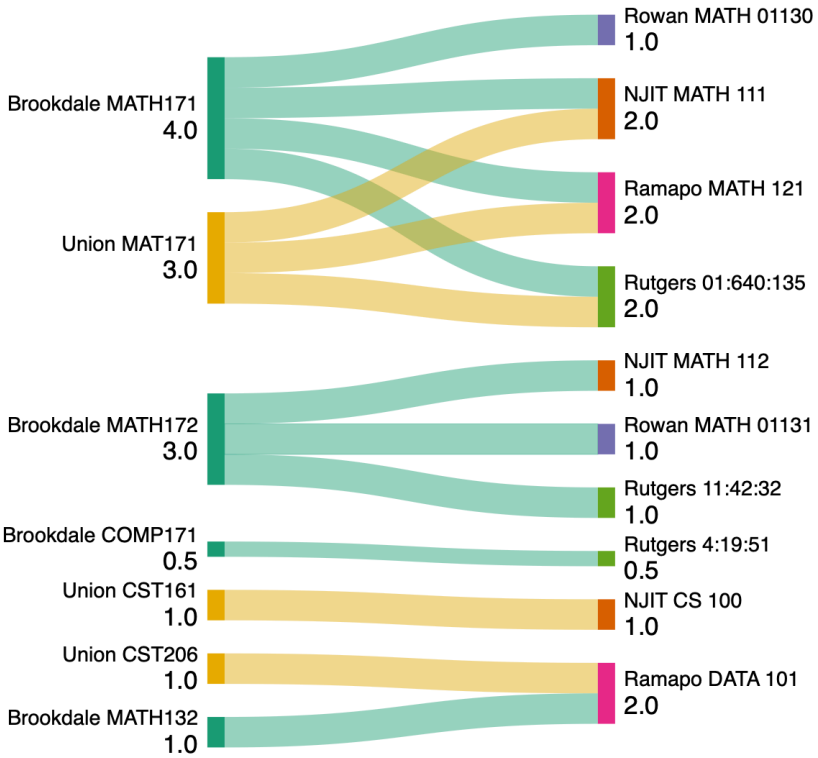
Results - Brookdale to 4-Year Institutions (cont.)

New Opportunities

- Facilitate Syllabus Sharing: Encourage colleges to publish detailed syllabi
- Pilot Inter-School Course Reviews: Create joint faculty panels for course audits
- Reward Transfer-Friendly Design:Incentivize transparent, equitable transfer practices

Recommendations

- Align Core Courses: Standardize outcomes for Calculus, Programming, Data Structures
- Improve Elective Recognition: Accept more advanced CS/DS electives (e.g., AI, Web Dev)
- Fix Credit Conversion Issues: Promote consistent 4cr = 4cr transfers across schools



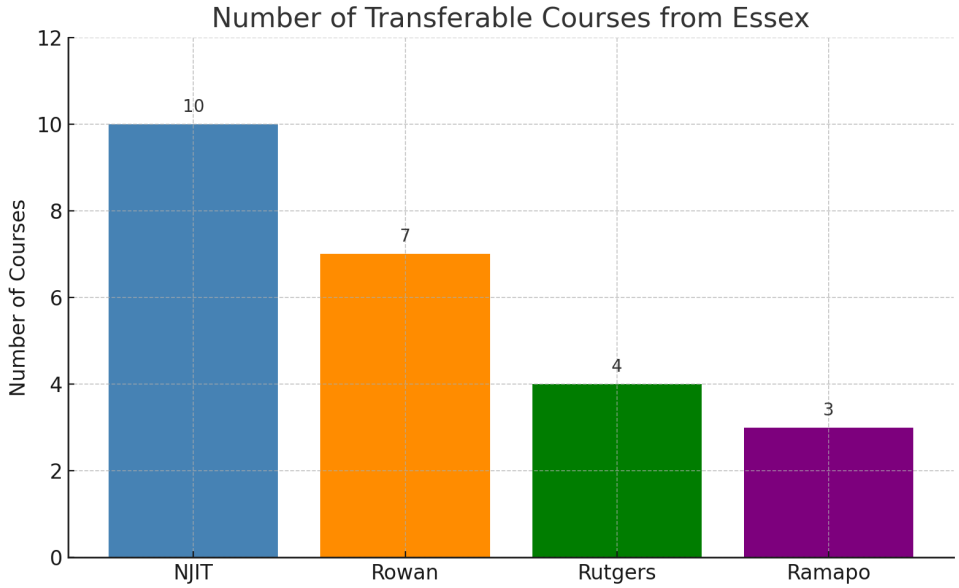
Results: Essex County College to 4-Year Institutions

- Some courses fully match (like CSC121 → CS100 at NJIT), while others only partially map, require grouping (like CSC121 + CSC122 + CSC225 = 4 credits at Rutgers), or are missing direct equivalents (e.g., CSC137 not existing at Rowan).

Key Insights:

- **Standard Core Courses:** Certain courses like Calculus I, Calculus II, Linear Algebra, Discrete Mathematics, Computer Science I & II are required everywhere.

- **Data Science Emphasis:** Newer electives like Data Science Introduction, Information Visualization, Statistical Learning are built into transfer pathways, particularly at Rowan and Rutgers.



Results: Morris to 4-Year Institutions

Math Alignment

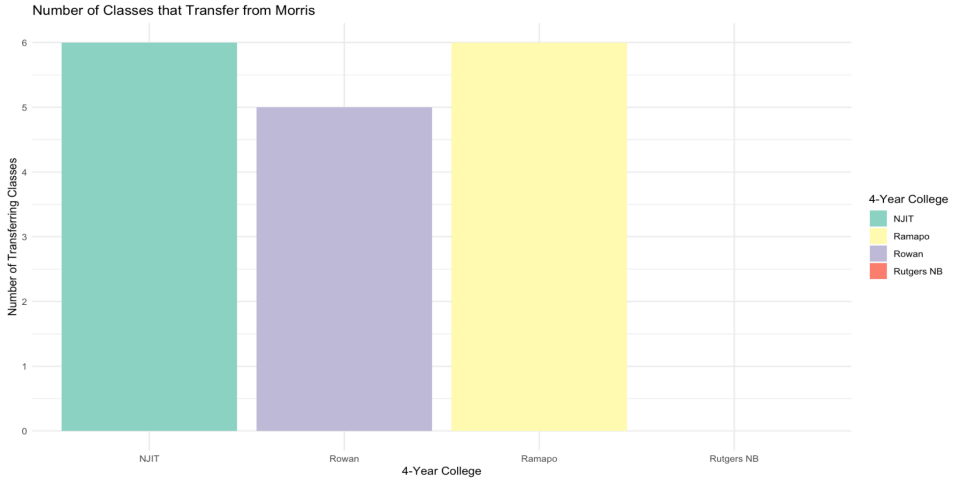
- **Calculus I & II, Linear Algebra**: Transfer to **NJIT**, **Rowan**, and **Ramapo**
- **Calculus III**: Transfers to **Rowan**
- **Discrete Math**: Transfers to **Rowan** and **Ramapo**

Computer Science & Programming

- **Intro to Python course**: Transfers to **NJIT**, **Rowan**, and **Ramapo**
- **Computer Science II** : Transfers to **NJIT** only
- **Data Structures**: Transfers to **NJIT** and **Rowan**

Data Science Alignment

- **Intro to Data Science**: Transfers to **Ramapo**
- **Data Science Programming**: Transfers to **Ramapo**



Results: Most Common Classes That Transfer (Morris and Camden)

1. **Calc I**
2. **Calc II**
3. **Linear Algebra**
4. **Intro to Computer Programming(Python)**
5. **Intro to Data Science**