

# WESTERN

## OUR NEW NORMAL



# Student Unit Enrolment Pathway Predictions – Understanding the “New Normal”

**Presenters: Shane Griffin, Pushkar Kadam, Vivek Dafre and Chris Wang**  
**Chair: Vicky Gravolin**

Presentations will be made available on the Conference website for your reference.

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# Student Unit Enrolment Pathway Predictions

How to Better Understand the 'New Normal'



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### The Problem

- We do not currently have an accurate way to predict student unit enrolment pathways

### Why is this an issue?

- The choices the students make has a direct impact on the timetable & therefore the workloads of teaching & support staff.



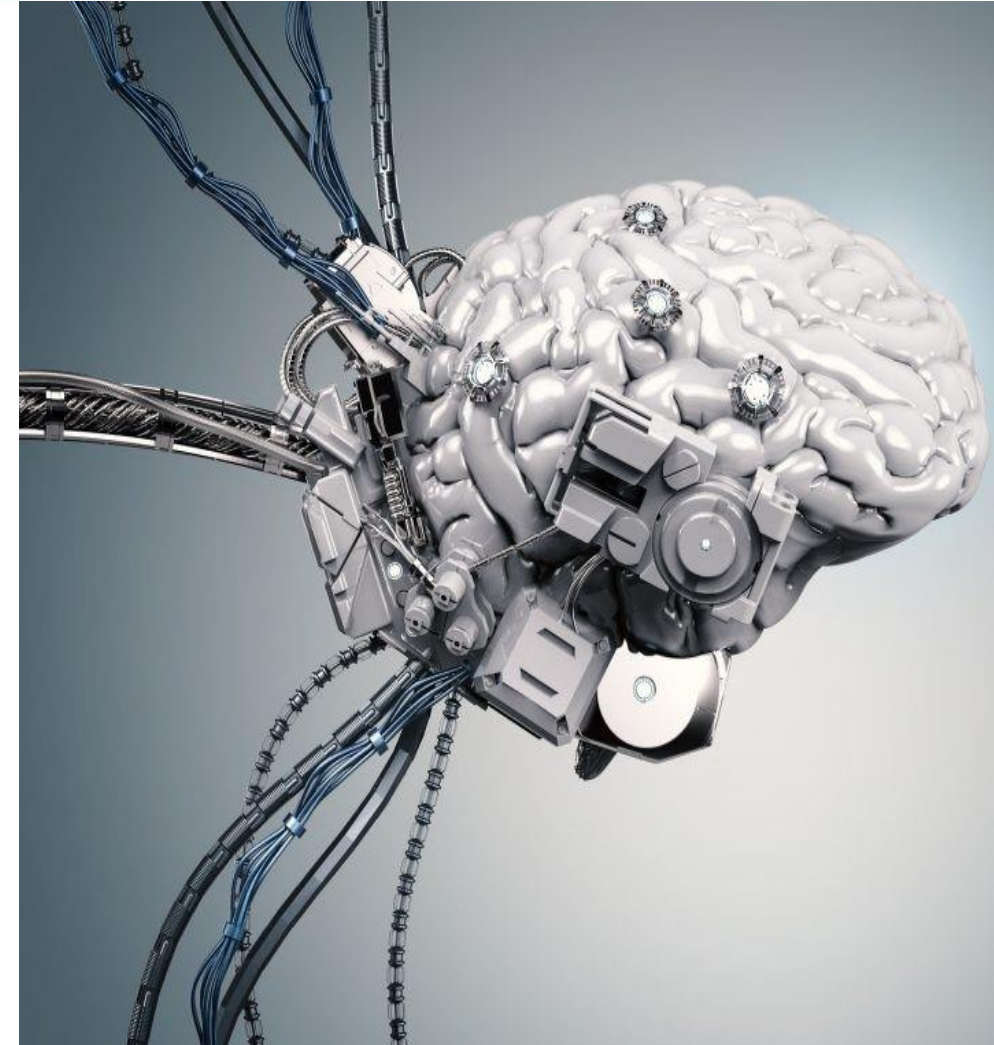
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### Why so complicated?

- At WSU many programs allow students a wide range of unit choices.
- The number of possible choices combined with large numbers of students creates a very large number of possible pathways.
- Understanding the probability of a student taking a pathway & how that effects unit enrolments requires deeper analysis.
- How can we better predict student movements especially in post COVID new normal?



# Project approach

## 01. STEP

Data Collection & cleaning

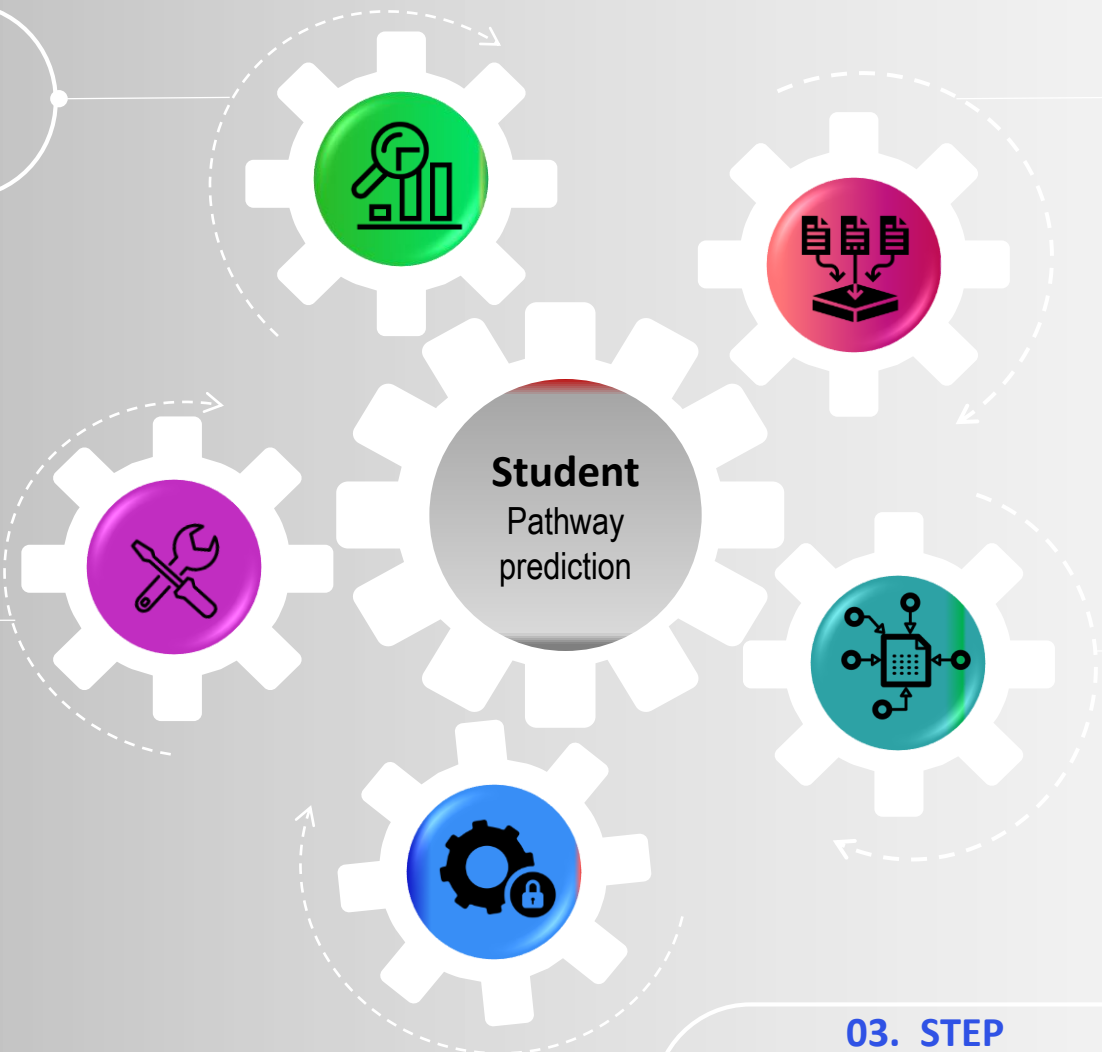
## 02. STEP

Challenges of handling Big Data  
Handling & Processing

## 03. STEP

Data security & confidentiality –  
Student ID encryption

**Student  
Pathway  
prediction**



## 04. STEP

Methods & Tools for Data modelling–  
Python, Network diagram & Machine  
Learning

**05. STEP**  
Analyse Test results – Actual Vs  
prediction  
Identify best prediction model/ Tool

student_id	course_code	unit_cohort	unit_code	unit_name	outcome_date	teaching_calendar	grade
10003099	3740	Bachelor of Engineering (Honours)	200237	Mathematics for Engineers 1	2017-11-21 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	300021	Electrical Fundamentals	2017-11-21 00:00:00	Spring Session	C
10003099	3740	Bachelor of Engineering (Honours)	301079	Graphics 3: 3D Engineering Specifications and Visualisation	2018-11-07 00:00:00	Autumn Session	C
10003099	3740	Bachelor of Engineering (Honours)	300762	Fluid Mechanics	2018-11-07 00:00:00	Autumn Session	D
10003099	3740	Bachelor of Engineering (Honours)	300761	Advanced Mechanics of Materials	2018-05-12 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	300480	Dynamics of Mechanical Systems	2018-05-12 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	300040	Mechanics of Materials	2018-07-31 10:06:45	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300040	Mechanics of Materials	2018-11-07 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300035	Kinematics and Kinetics of Machines	2018-11-07 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	200238	Mathematics for Engineers 2	2018-05-12 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	200238	Mathematics for Engineers 2	2018-02-22 00:00:00	Summer A Session	FNS
10003099	3740	Bachelor of Engineering (Honours)	301079	Graphics 3: 3D Engineering Specifications and Visualisation	2018-11-07 00:00:00	Autumn Session	C
10003099	3740	Bachelor of Engineering (Honours)	300761	Advanced Mechanics of Materials	2018-05-12 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	300762	Fluid Mechanics	2018-11-07 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300040	Mechanics of Materials	2018-07-31 10:06:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300040	Mechanics of Materials	2018-11-07 00:00:00	Autumn Session	P
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10003099	3740	Bachelor of Engineering (Honours)	200238	Mathematics for Engineers 2	2018-05-12 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	200238	Mathematics for Engineers 2	2018-02-22 00:00:00	Summer A Session	P
10003099	3740	Bachelor of Engineering (Honours)	300965	Engineering Materials	2017-11-21 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	300964	Introduction to Engineering Practice	2017-06-28 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300963	Engineering Physics	2017-06-28 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300743	Mathematics for Engineers Preliminary	2017-06-28 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300463	Fundamentals of Mechanics	2017-11-21 00:00:00	Spring Session	P
10003099	3740	Bachelor of Engineering (Honours)	300027	Engineering Computing	2017-06-28 00:00:00	Autumn Session	P
10003099	3740	Bachelor of Engineering (Honours)	300480	Dynamics of Mechanical Systems	2018-05-12 00:00:00	Spring Session	P
8066	8062	Doctor of Philosophy - Psychology	800163	HDR - Under Examination			
	8062	Doctor of Philosophy - Psychology	800163	HDR - Under Examination			
		Doctor of Philosophy - Psychology	800027	Higher Degree Research Thesis - Psych			
		Doctor of Philosophy - Psychology	800027	Higher Degree Research Thesis - Psych			

# Data Collection & Challenges of Big Data

- Data extracted from Callista & Data Warehouse tables
- Need to handle 1.2 mill datapoints (1GB)
- Cannot be handled in Excel
- Data organization can't be done manually.
- Needed to use CSV format & work in Python.

The collage shows several data visualization components:

- Pivot Tables:** Multiple pivot tables with dropdown menus for row and column labels. One table shows a 4x4 grid of 1s and 0s. Another shows a 4x4 grid with values like -1, 1, 2, 0.
- Data Tables:** Small tables with columns labeled 'Physics', 'Chemistry', 'Maths', 'Biology' and rows of numerical data.
- Charts:** A small bar chart with three bars of varying heights.

student_id	course_code	unit_cohort	unit_code	unit_name	outcome_date	teaching_calendar	grade	mark
10003099	3740	Bachelor of Engineering (Honours)	200237	Mathematics for Engineers 1	2017-11-21 00:00:00	Spring Session	P	5
10003099	3740	Bachelor of Engineering (Honours)	300021	Electrical Fundamentals	2017-11-21 00:00:00	Spring Session	C	7
10003099	3740	Bachelor of Engineering (Honours)	301079	Graphics 3: 3D Engineering Specifications and Visualisation	2018-11-07 00:00:00	Autumn Session	C	7
10003099	3740	Bachelor of Engineering (Honours)	300762	Fluid Mechanics	2018-11-07 00:00:00	Autumn Session	D	7
10003099	3740	Bachelor of Engineering (Honours)	300761	Advanced Mechanics of Materials	2018-05-12 00:00:00	Spring Session	P	6
10003099	3740	Bachelor of Engineering (Honours)	300480	Dynamics of Mechanical Systems	2018-05-12 00:00:00	Spring Session	P	6
10003099	3740	Bachelor of Engineering (Honours)	300040	Mechanics of Materials	2018-07-31 10:06:45	Autumn Session	P	6
10003099	3740	Bachelor of Engineering (Honours)	300040	Mechanics of Materials	2018-11-07 00:00:00	Autumn Session	P	6
10003099	3740	Bachelor of Engineering (Honours)	300035	Kinematics and Kinetics of Machines	2018-11-07 00:00:00	Autumn Session	P	6
10003099	3740	Bachelor of Engineering (Honours)	200238	Mathematics for Engineers 2	2018-05-12 00:00:00	Spring Session	P	6
10003099	3740	Bachelor of Engineering (Honours)	200238	Mathematics for Engineers 2	2018-02-22 00:00:00	Summer A Session	FNS	6
10003099	3740	Bachelor of Engineering (Honours)	301079	Graphics 3: 3D Engineering Specifications and Visualisation	2018-11-07 00:00:00	Autumn Session	C	6
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# Data Collection & Challenges of Big Data

- Requires higher computing power.
- Required use of a high performance computer
- Computations initially took 90min of computation time
- Require smart programming to reduce this to 2-3min

PC	CM	MB	PM	CB
-1	-1	3	-2	2
-1	2	-1	1	1
-1	1	-1	0	0
-2	2	-1	0	1
0	-1	1	-1	0

PC	CM	MB	PM	CB	PB
0	0	1	0	1	1
0	1	0	1	1	1
0	1	0	1	1	0
0	1	0	1	1	0
1	0	1	0	1	1

PC	CM	MB	PM	CB	PB
1	1	0	0	0	1
1	0	1	1	1	0
1	1	1	0	0	1
0	0	1	0	1	1
0	1	1	1	0	0

PC	CM	MB	PM	CB	PB
0	0	0	0	0	1
0	0	0	1	1	0
0	1	0	0	0	0
0	0	0	0	1	0
0	0	1	0	0	0
0	1	1	1	2	1

PC	CM	MB	PM	CB	PB
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	1	1
0	0	1	0	0	0
0	0	1	1	1	1
0	0	1	0	0	0
Sum	4	4	5	4	4

student\_pathways/ Instance Overview Nectar Da

Not Secure | 43.240.97.18/tree/student\_pathways

jupyter Logout

Files Running Clusters

Select items to perform actions on them. Upload New

	Name	Last Modified
	..	seconds ago
<input type="checkbox"/>	adjacency_method	a month ago
<input type="checkbox"/>	student_data	a month ago
<input type="checkbox"/>	adjacency_method.ipynb	a month ago
<input type="checkbox"/>	data_processing.ipynb	Running 16 days ago
<input type="checkbox"/>	networkx_trials.ipynb	Running 15 days ago
<input type="checkbox"/>	README.md	a month ago
<input type="checkbox"/>	requirements.txt	a month ago

dashboard.rc.nectar.org.au/project/

Nectar Research Cloud cwproj Support Ticket chris.wang@westernsydney.edu.au

Project

API Access Project / Compute / Overview

Compute

Overview

Instances Images Key Pairs Server Groups Volumes Container Infra Network Orchestration Database DNS Object Store Share

### Limit Summary

#### Compute

Resource	Used	Limit
Instances	Used 2 of 4	4
VCPUs	Used 2 of 4	4
RAM	Used 8GB of 16GB	16GB

#### Volume

Resource	Used	Limit
Volumes	Used 0 of 30	30
Volume Snapshots	Used 0 of 30	30
Volume Storage	Used 0Bytes of 30GB	30GB

#### Network

Resource	Used	Limit
Network	Used 0 of 30	30

# Data Security:

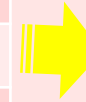
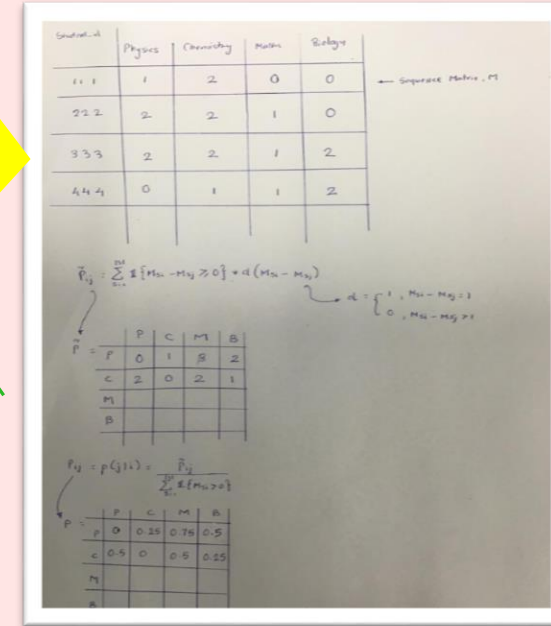
- Student was encrypted so that it is de-identified even to us.
- Stored inside secure space in University domain.



# Concept & Pilot Run

## Student Unit choices & Pilot analysis :

1 <sup>st</sup> Year	2 <sup>nd</sup> Year	3 <sup>rd</sup> Year
Chemistry 1 (C1)	Chemistry 2 (C2)	Chemistry 3 (C3)
Biology 1 (B1)	Biology 2 (B2)	Biology 3 (B3)
Physics 1 (P1)	Physics 2 (P2)	Physics 3 (P3)

Source: [unclear]

	Physic	Chemistry	Maths	Biology
1 1 1	1	2	0	0
2 2 2	2	2	1	0
3 3 3	2	2	1	2
4 4 4	0	1	1	2

Suppose Matrix,  $M$

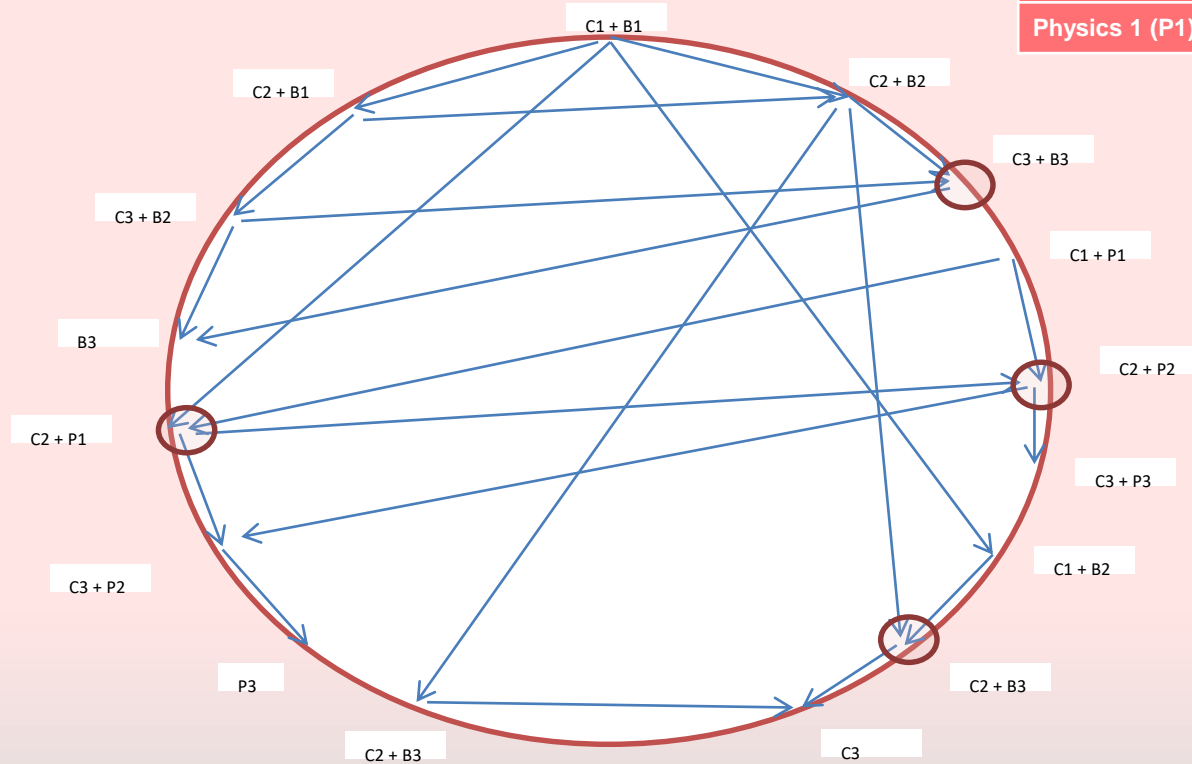
$$\vec{P}_j = \sum_{i=1}^n \delta_{ij} [M_{ij} - M_{ij} > 0] = d (M_{ij} - M_{ij})$$

$$d = \begin{cases} 1, & M_{ij} - M_{ij} > 0 \\ 0, & M_{ij} - M_{ij} < 0 \end{cases}$$

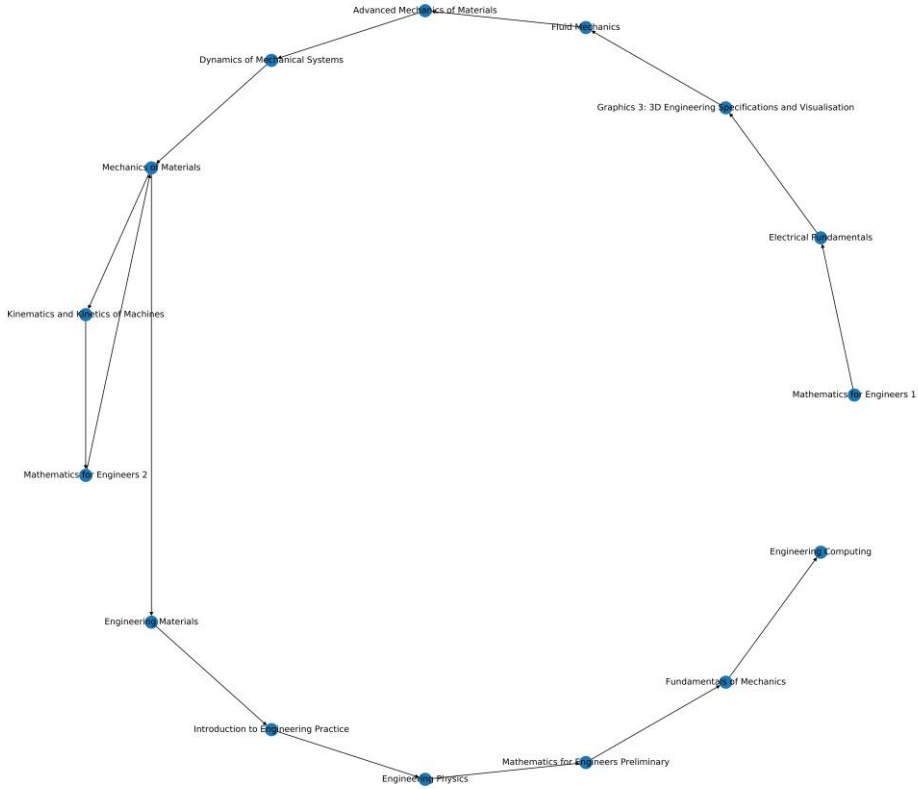
	P	C	M	B
P	0	1	2	2
C	2	0	2	1
M				
B				

$$P_{ij} = p(i,j) = \frac{P_{ij}}{\sum_{k=1}^n \delta_{ik} [M_{ik} > 0]}$$

	P	C	M	B
P	0	0.25	0.75	0.5
C	0.5	0	0.5	0.25
M				
B				

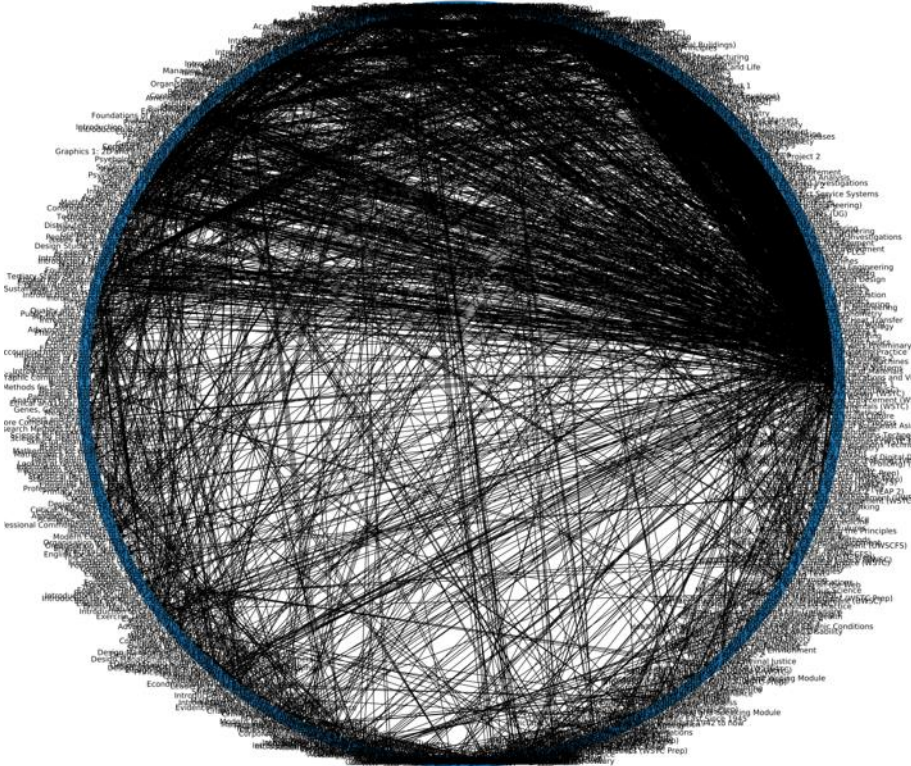


# Data Analysis and Pilot Finding



1 Student from Engineering

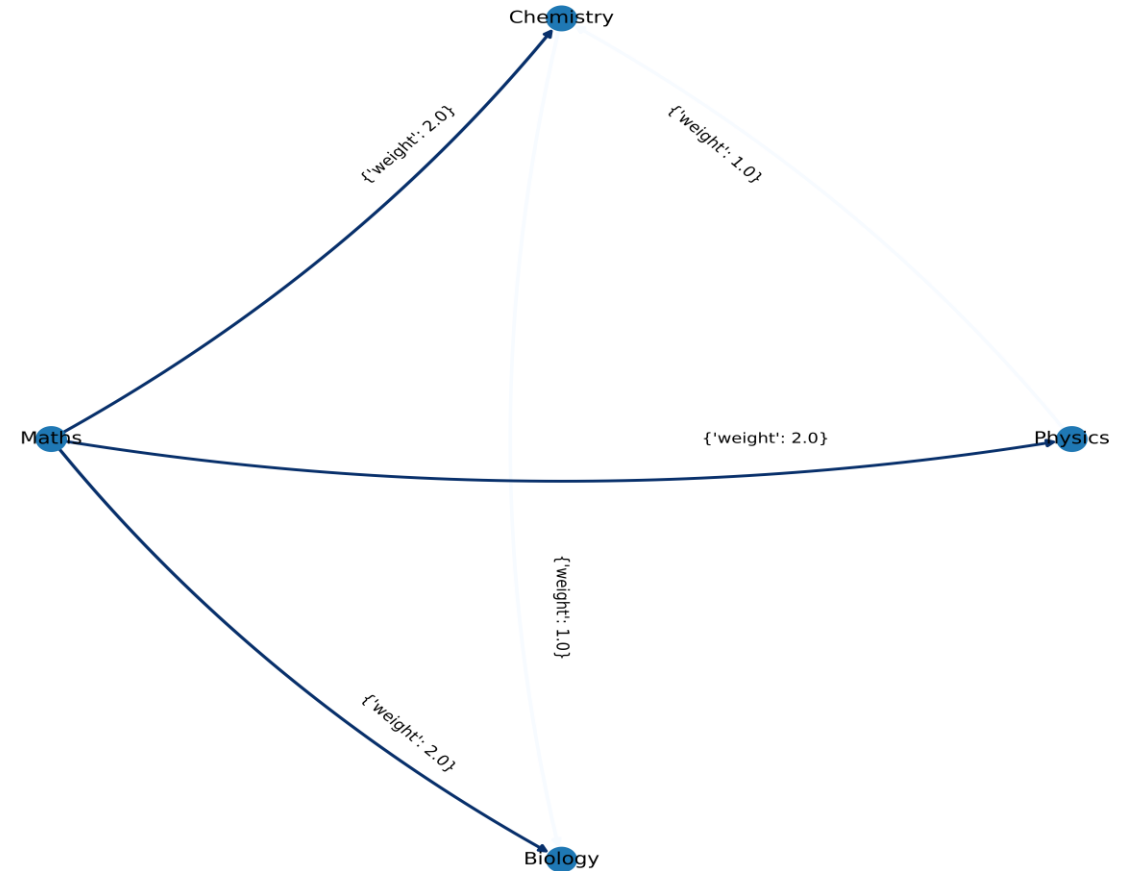
Time elapsed (hh:mm:ss.ms) 0:03:27.702398



Engineering dataset

# Data Analysis/Pilot findings

- ✓ Evaluated number of records which failed
- ✓ Hence developed mathematical formulae to process the big data
- ✓ Define the students pathways
- ✓ Data consolidation for big data for > 4 yrs
- ✓ Pilot run with test dataset
- ✓ Kicked off with a small test data analysis

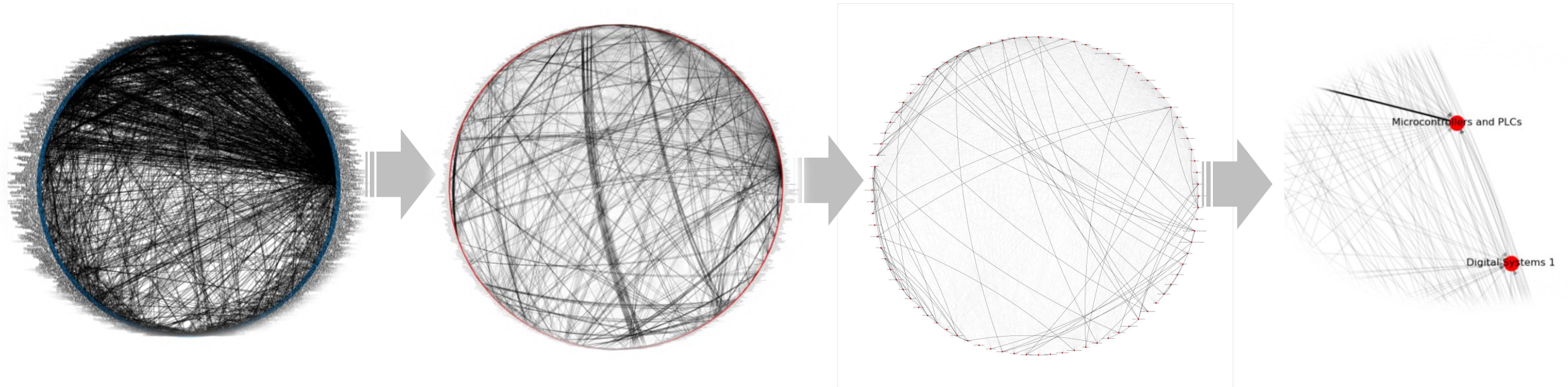


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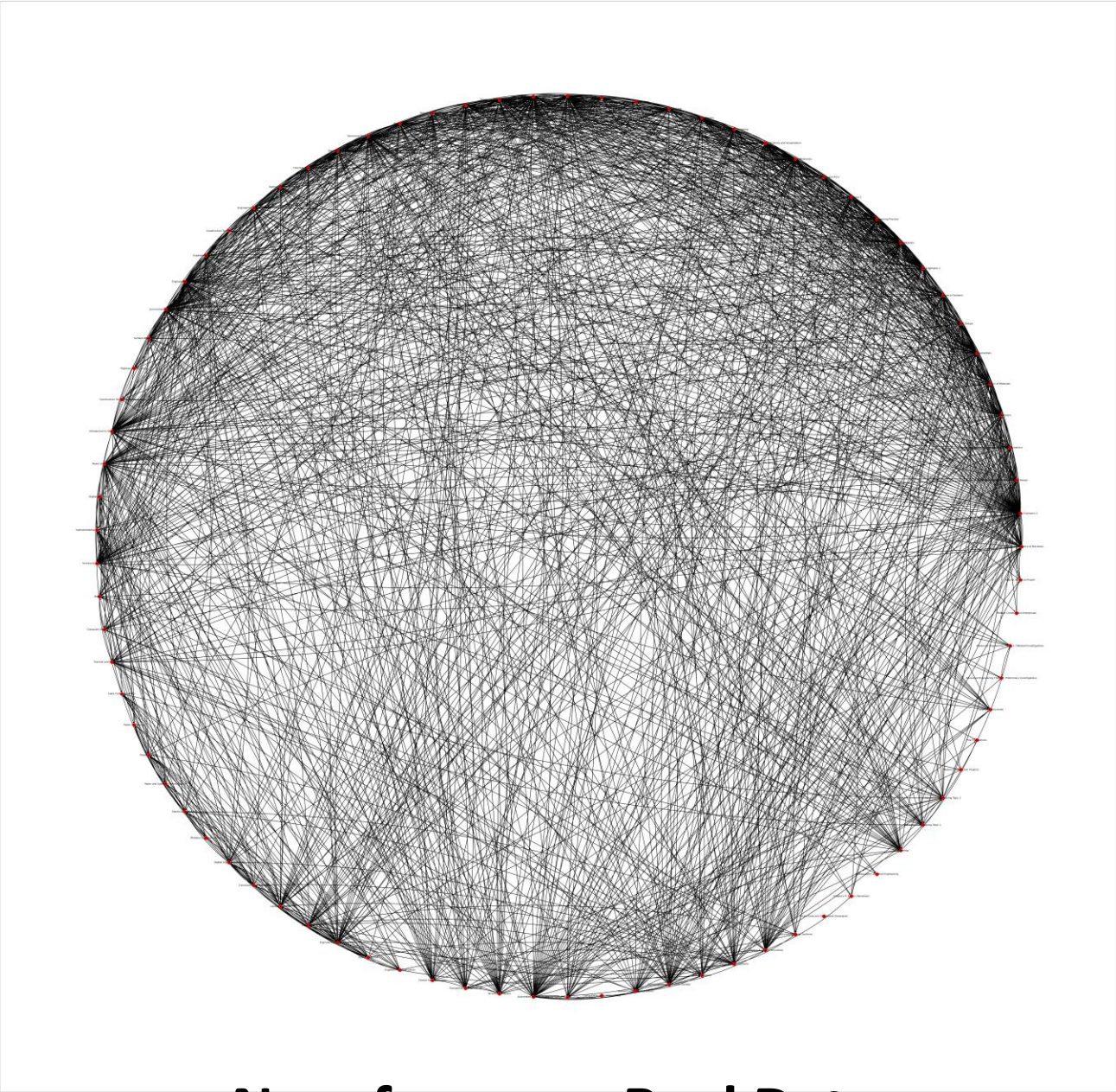
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From complex diagrams to better interpretation through algorithms & Python



Filtered the data to only incorporate cohort specific units  
A threshold applied to highlight the links



Engineering  
Undergraduate Course

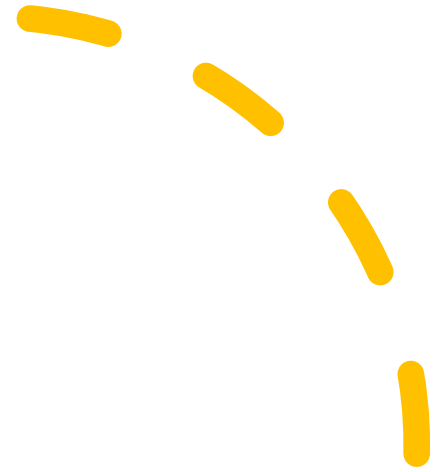
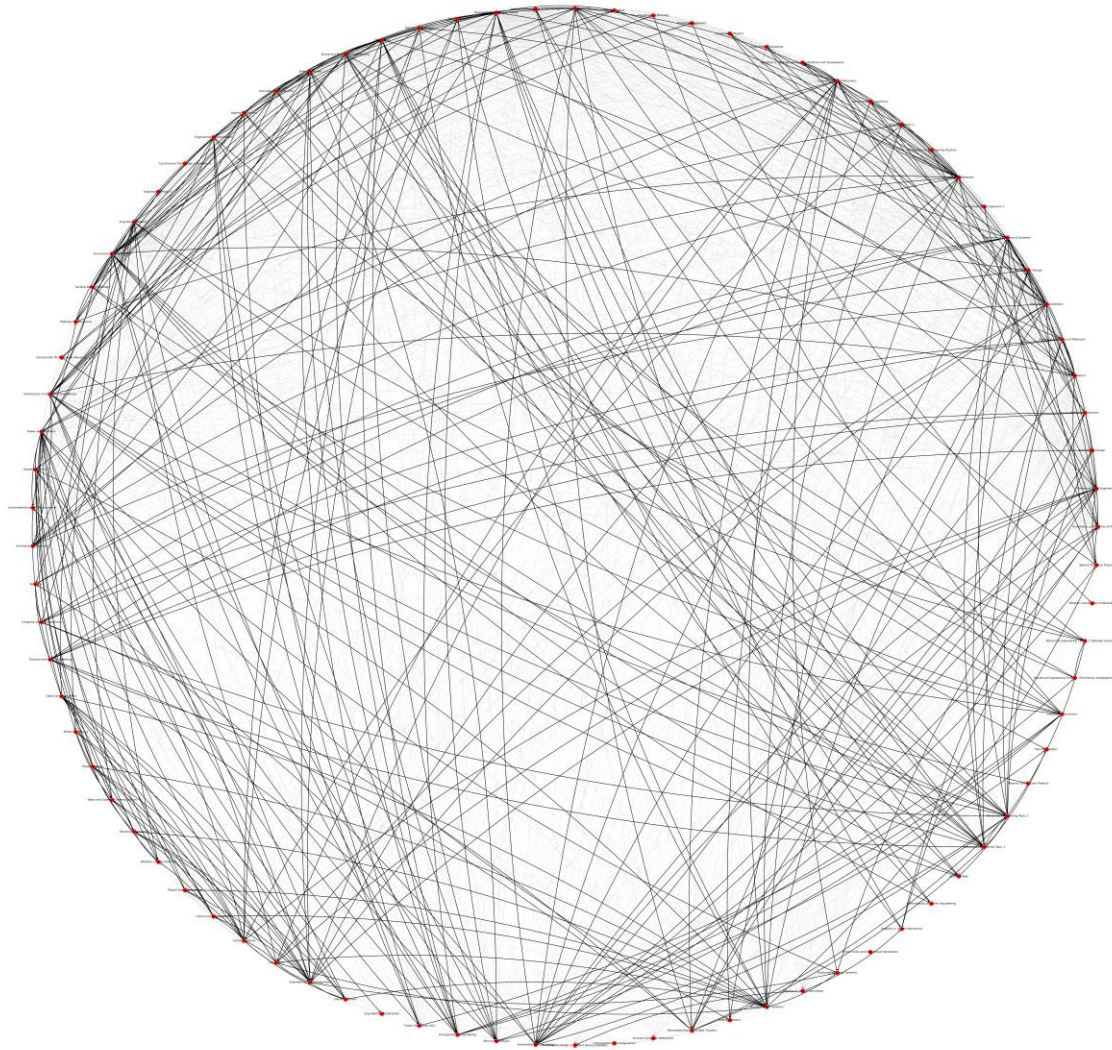
2014-2019

Students = 980

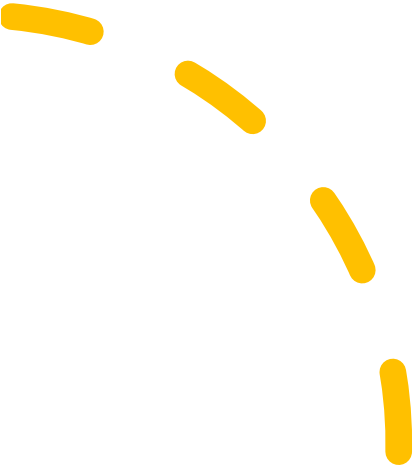
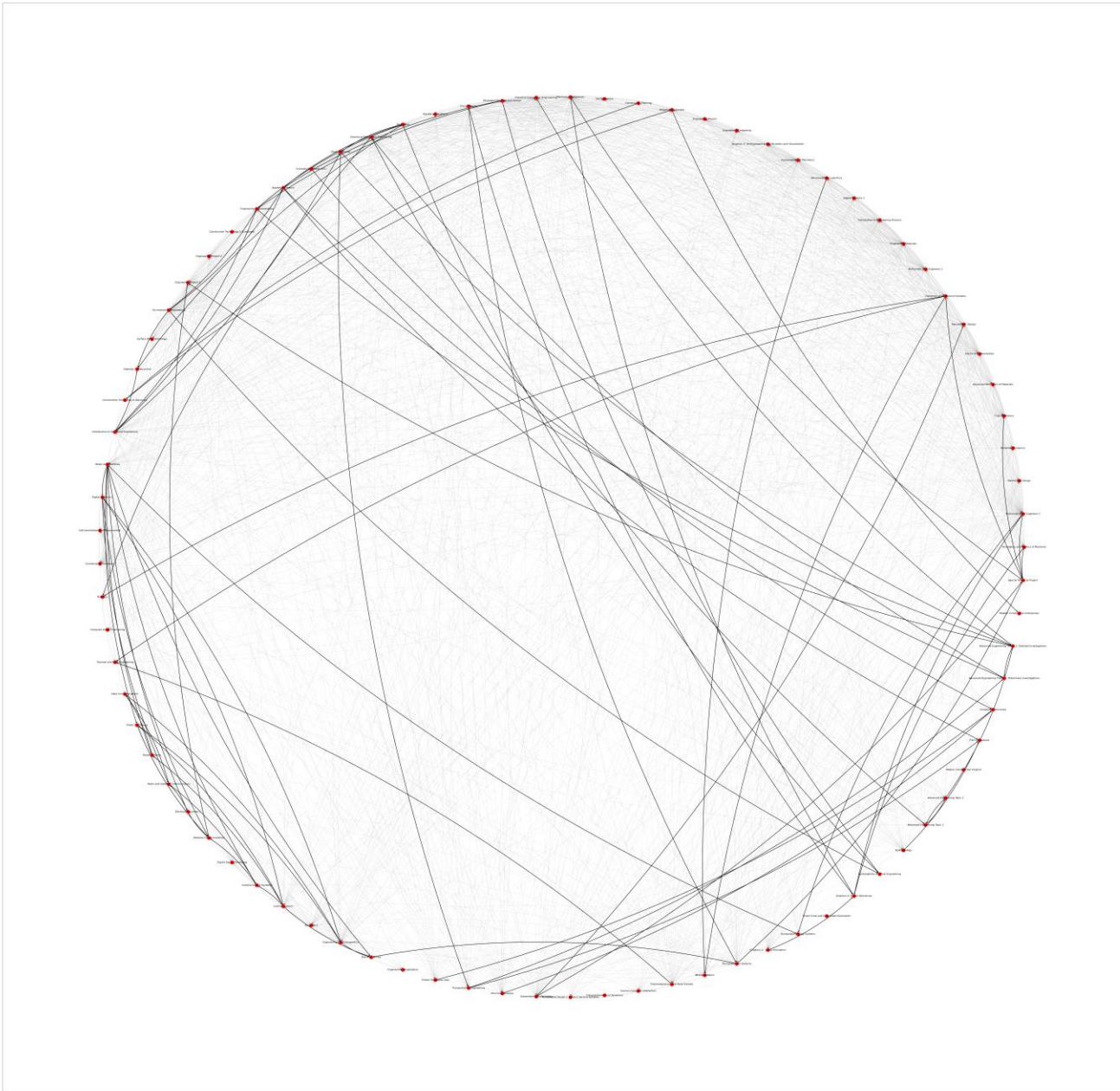
Data Points = 11,379

**Now for some Real Data**

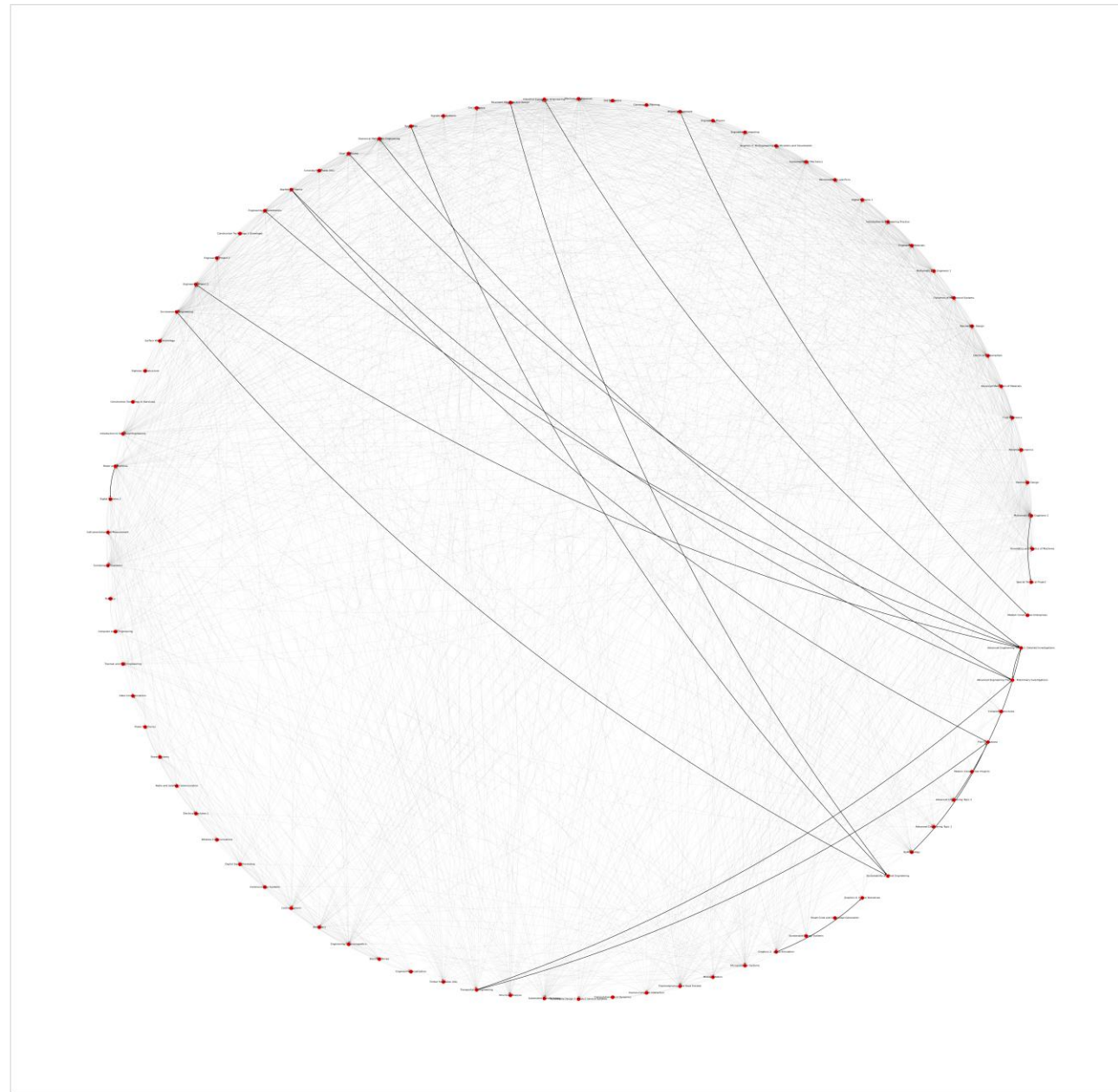
Threshold  $\geq 25\%$



Threshold  $\geq 50\%$

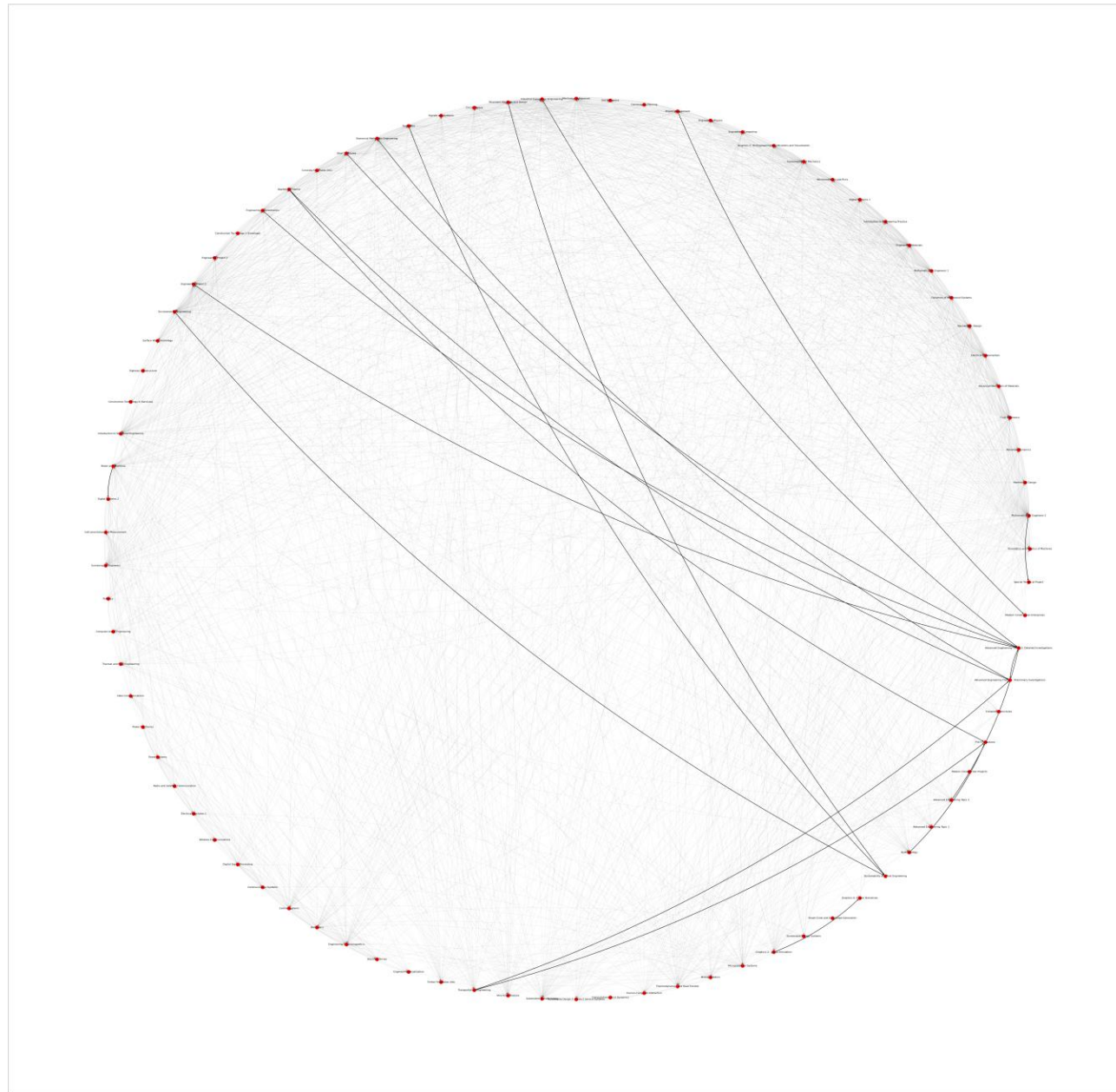


Threshold  $\geq 75\%$

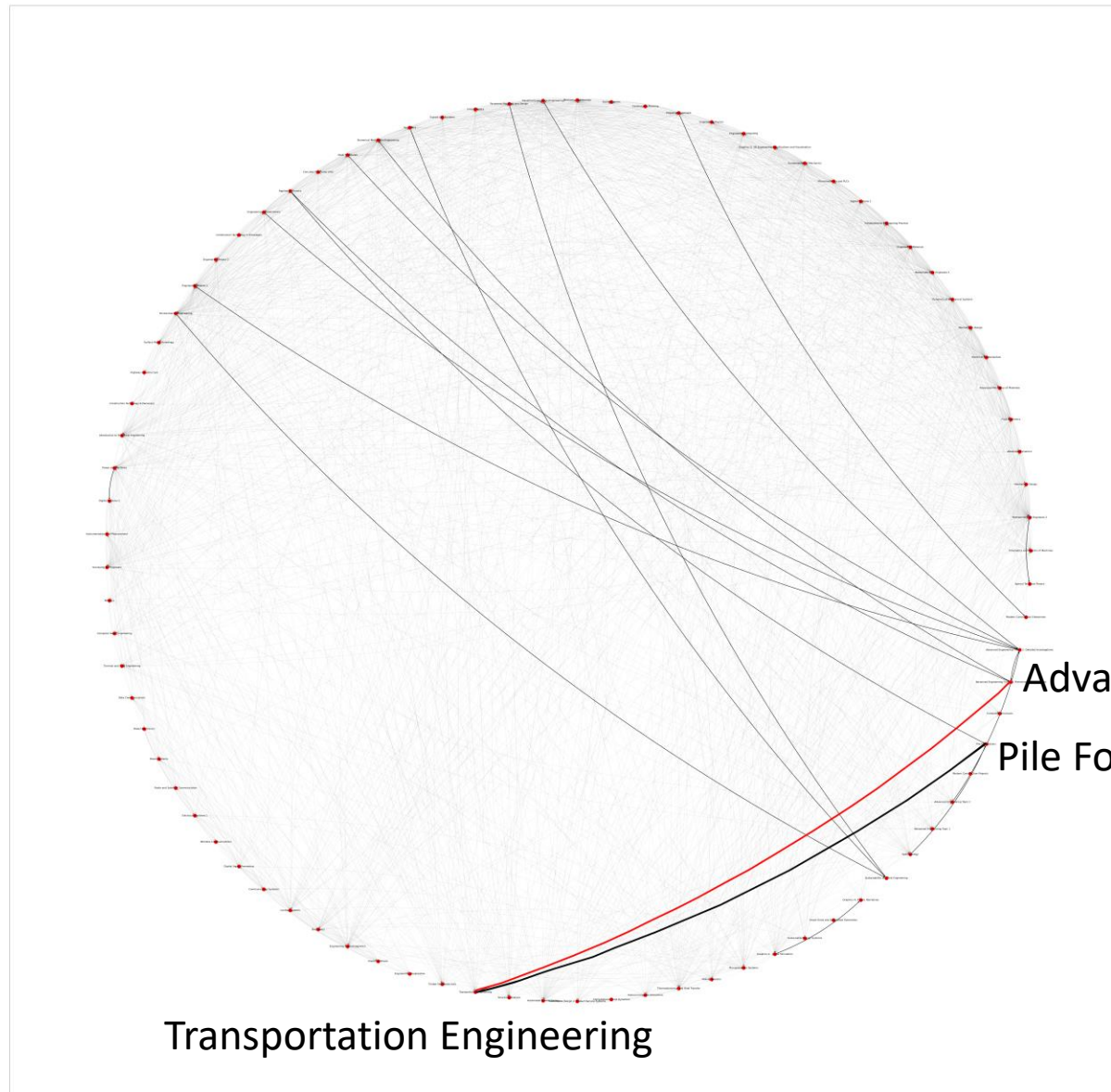




Threshold  $\geq 90\%$



Pathways (highlighted)  
Threshold  $\geq 90\%$



Advanced Engineering Thesis 1

Pile Foundations

Transportation Engineering



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## Milestones Reached

- Successfully managed a project remotely during COVID.
- We have overcome the challenges how to structure & manage large data sets
- We have developed our own programming tool kit for student unit enrolment analysis
- We now have an understanding of how complex student unit enrolment pathways can be.
- We are well on our way to developing a useable tool for staff to predict student unit enrolment loads ahead of semesters.

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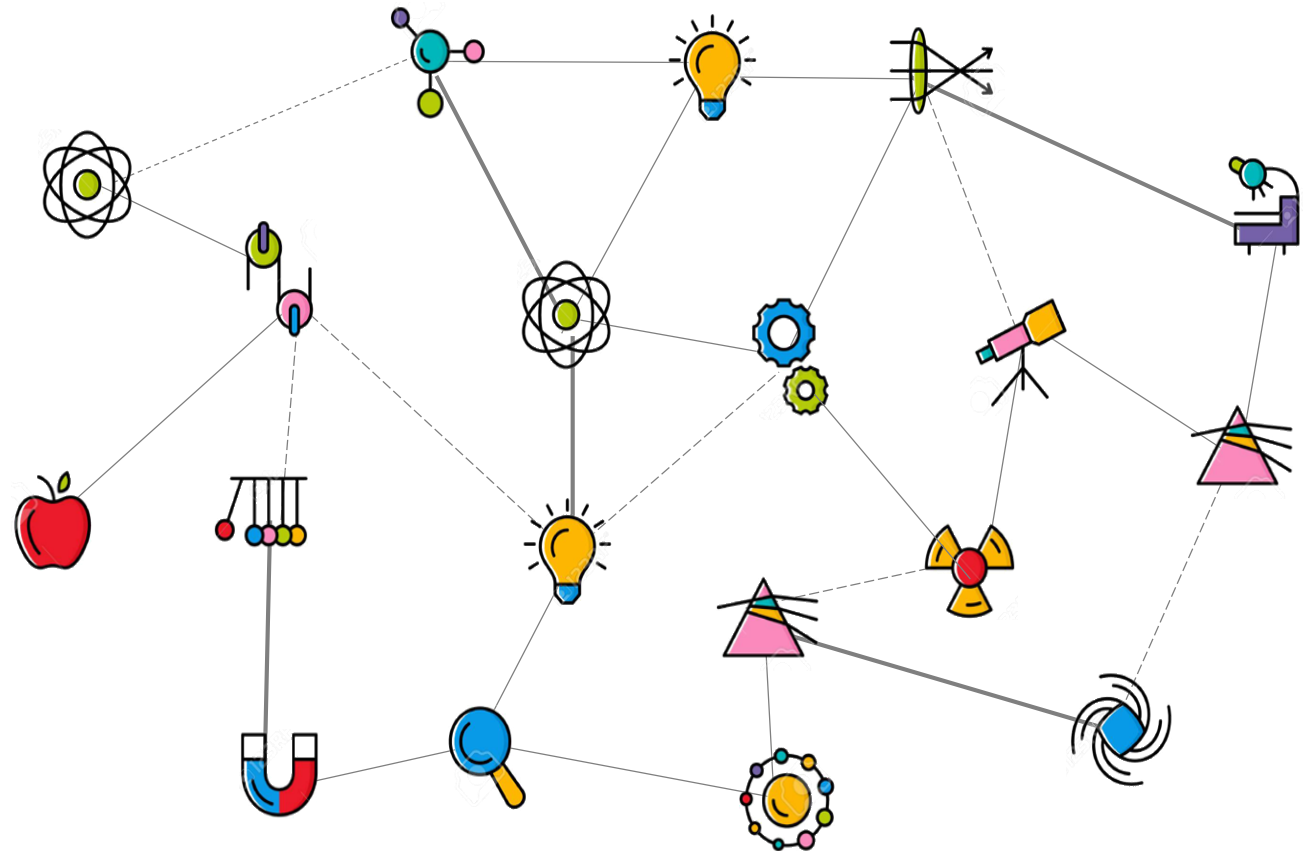


## Future Work

Graph Neural Network Approaches

Continue to develop the programming tool kit

Create a usable tool for support staff to predict student unit enrolment loads.



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### **Project Team**

**Chris Wang – Senior Technical Officer - TSS (MARCS)**

**Vivek Dafre - Data Analyst -TSS**

### **Data Support**

**Tony Lazzara** (Executive Director, Business Intelligence and Performance),

**Sharath Purighalla** (Senior Manager Analytics & Data Strategy)

**Chitra Suriyarachchi**(Manager, Enterprise Data)

**Nectar** – for high performance computing resources

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**PROFESSIONAL STAFF CONFERENCE**  
Tuesday 1 September 2020, via Zoom





WESTERN SYDNEY  
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