



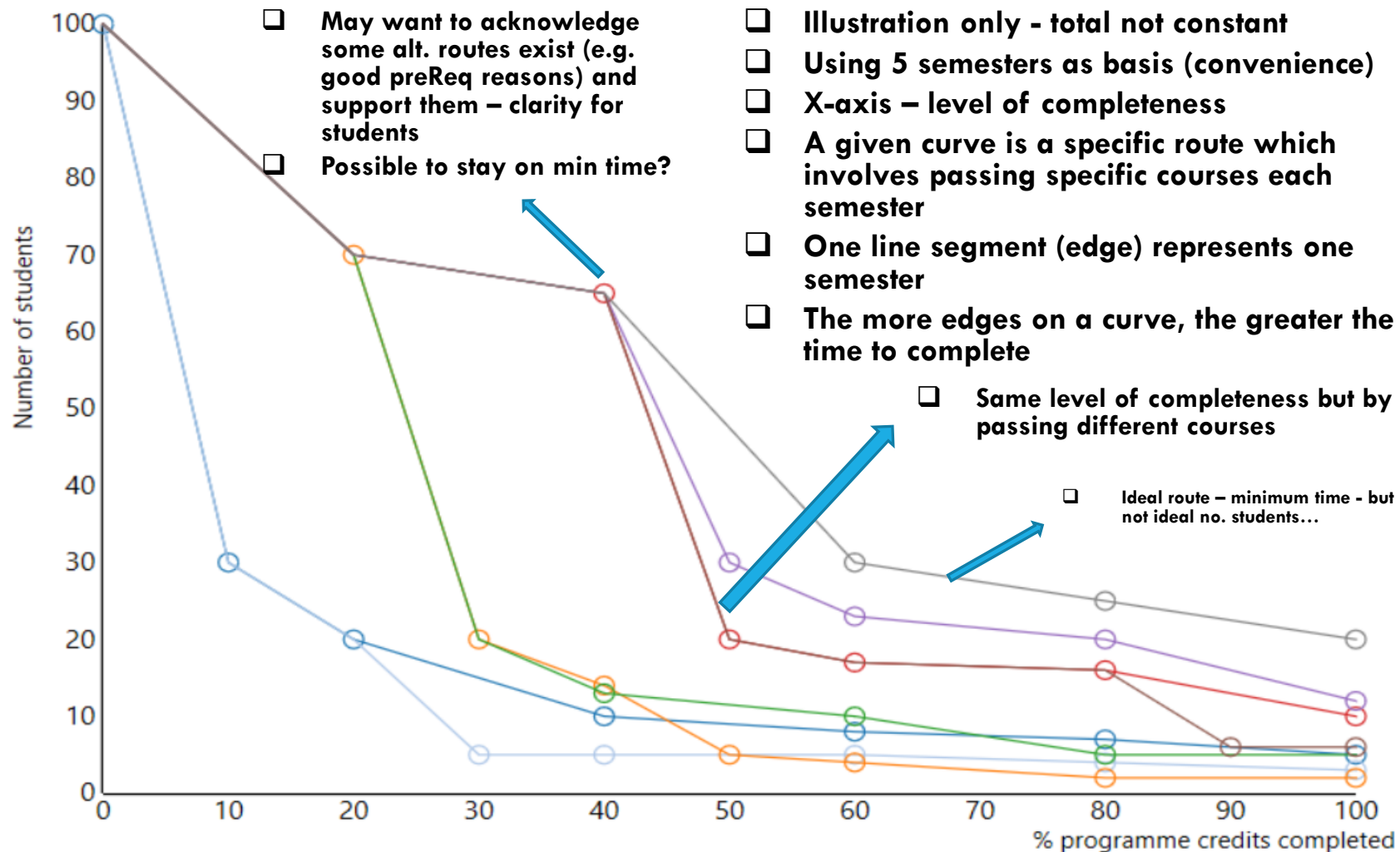
# APPLICATION OF ARTIFICIAL INTELLIGENCE TO FACILITATE PROGRAMME MANAGEMENT

An Autoscholar Advisor  
component  
R Rawatlal, R Dhunpath,  
UKZN, June 2016


# 1. PROGRESSION


- ❖ Original: Determine consistent way to identify programme “bottlenecks”
- ❖ Not same as pass/fail rate – failing a course may or may not inhibit overall progression
- ❖ Identify specific courses with high failure AND which inhibit programme progression
- ❖ Progression map – complicated by number of routes – variety of combinations of passing courses, presence of electives, and course equivalents
- ❖ Application
  - ❖ Independent awareness of gatekeeper courses
  - ❖ Examine curriculum design – is the passage is students according to the plan?
  - ❖ Track whether programme managers are acting on bottlenecks
- ❖ Machine learning – student success


# 1. SCOPE CTD – PROGRESSION MAPPING (RR)





## 2. AUTOSCHOLAR ADVISOR

 Progression Advisor

 UG progression

 UG Advisor

 PG progression

 Programme

SELECT PROGRAMME, COHORT

select programme in college

Select school

1. SCHOOL OF AGRI, EARTH & ...  
COLLEGE OF AGR, ENG & SCIENCE  
2181

2. SCHOOL OF CHEMISTRY & ...  
COLLEGE OF AGR, ENG & SCIENCE  
2182

3. SCHOOL OF ENGINEERING  
COLLEGE OF AGR, ENG & SCIENCE  
2183

4. SCHOOL OF LIFE SCIENCES  
COLLEGE OF AGR, ENG & SCIENCE  
2184

5. SCHOOL OF MATHS,STATS ...  
COLLEGE OF AGR, ENG & SCIENCE  
2185

Select programme in school

Bachelor of Agricultural Management (BAGM) [34]

Bachelor of Agricultural Management Honours (BAGMH) [1]

Bachelor of Agriculture (Agricultural Extension and Rural Resource Management) (BAGRAE) [54]

Bachelor of Agriculture Honours (BAGR-H) [15]

Bachelor of Science in Agriculture (Animal and Poultry Science) (BSAAPS) [94]

Bachelor of Science in Agriculture (Agribusiness) (BSC-AB) [51]

Bachelor of Science in Agriculture (Agricultural Economics) (BSC-AE) [77]

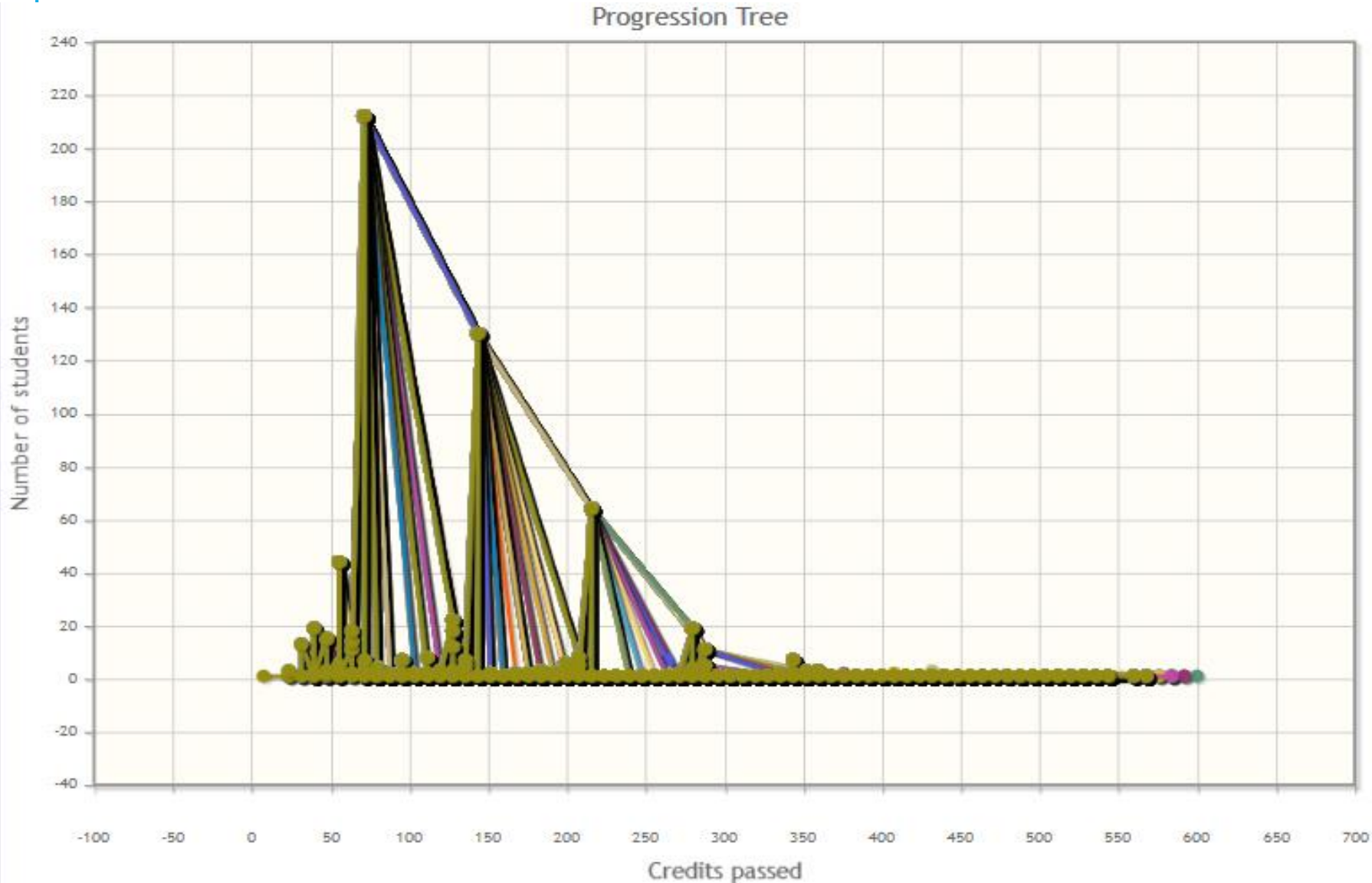
Bachelor of Science in Agriculture (BSC-AG) [114]

Bachelor of Science in Dietetics (BSCDT) [115]

Bachelor of Science Honours (Crop Science) (BSCHCR) [2]

Bachelor of Science Honours (Horticultural Science) (BSCHHS) [11]

### 3. OUTCOMES: PROGRESSION MAPPING (RR)



Unexpected high level of complexity

Not suitable for identifying bottlenecks



# 3. OUTCOMES: STUDENT SUCCESS SIMPLER

- Every student was on minimum time up to some point
- Basis of calculation is tree – can sort for max credits passed
- Becomes tracker of minimum time students
- Shift the attention to success orientation: What are the stumble points for otherwise successful students?
- Becomes possible to determine academic programme / curriculum structure

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### 3. OUTCOMES: STUDENT SUCCESS SIMPLER

Progression Advisor

UG progression UG Advisor PG progression Programme

SELECT PROGRAMME, COHORT

PROGRESSION OBSTRUCTIONS

Top 5 areas inhibiting progression

Show 10 entries Search:

Year	Semester	Num straight through	Course Code	Number failed	% of total in semester
1	1	389	MATH131	105	27
1	1	389	ENCH1EA	60	15
1	1	389	MATH132	51	13
2	2	89	ENCH2TD	50	56
2	1	159	ENCH2MB	38	24
1	2	239	MATH142	36	15
1	2	239	PHYS162	33	14
1	2	239	MATH141	31	13
2	2	89	ENCH2CP	29	33
2	2	89	ENCH2IT	27	30

Showing 1 to 10 of 53 entries

Previous 1 2 3 4 5 6 Next

Major bottlenecks identified

Can sort by % or number

Transparency and exposure – avail to upper management and staff

Routes to be used for planning

# 4. DEDUCING CURRICULUM STRUCTURE

Time to graduate? Need curriculum structure

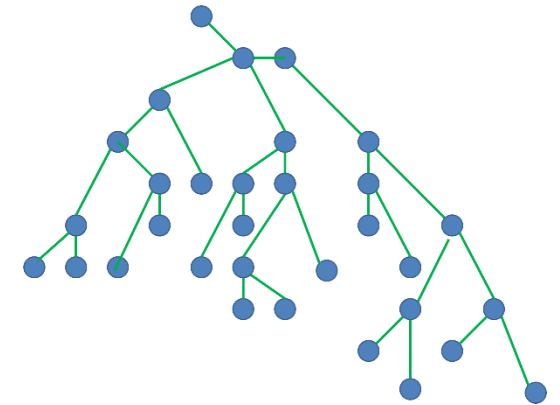
Such data structures not typically stored in systems

Tree sorting by credits passed – deduce curriculum

Two schools of thought

- Include curriculum editor – catch 10% error
- This IS the curriculum
- Notion of Designed / Operational / Experienced curriculum

With curriculum object defined, large amount of additional analysis and planning becomes possible - Experienced



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  ► 0_2ICHEM171_MATH141_MATH142_PHYS102; # 3; o-cr: 136; s-or: 64; drop: 2
  ▼ 0_2ICHEM171_ENCH1EB_MATH141_MATH142; # 22; o-cr: 128; s-or: 56; drop: 4
    ► 1_1ICHEM241_ENCH2MB_ENCH2OM_ENEL2CM_ENEL2EE_ENME1DR_MATH238; # 4; o-cr: 200; s-or: 72; drop: 0
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# 5. CURRICULUM STRUCTURE – STUDENT ADVICE

2	80	240	Green	Continue. (Passed 80 > 70% of 72 Cr)	You have passed a full load of credits. Keep it up!
3	48	288	Orange	RISK (Passed 288 > 75% of 288)	You need to pass at least 50 credits next semester to get back in the green.
4	64	352	Green	Continue rehabilitated (Passed 64 credits)	Although you have been rehabilitated, you must continue to work hard to pass courses. Ensure that you pass at least 72 credits next semester.
5	48	400	Orange	RISK (Passed 400 > 75% of 432)	You need to pass at least 50 credits next semester to get back in the green.
				Continue	Although you have been rehabilitated, you must continue to

1. CHEM161	16	1, 1	2011, 1	75	1	0	0
2. ENCH1EA	8	1, 1	2011, 1	60	1	0	0
3. ENCH1TC	8	1, 1	2011, 1	70	1	0	0
4. MATH131	16	1, 1	2011, 1	69	1	0	0
5. MATH132	16	1, 1	2011, 1	53	1	0	0
6. PHYS161	8	1, 1	2011, 1	57	1	0	0
7. CHEM171	16	1, 2	2011, 2	52	1	0	0
8. ENCH1EB	8	1, 2	2011, 2	55	1	0	0
9. MATH141	16	1, 2	2011, 2	57	1	0	0
10. MATH142	16	1, 2	2011, 2	50	1	0	0
11. PHYS162	16	1, 2	2011, 2	59	1	0	0
12. CHEM241	8	2, 1	2013, 1	60	1	2	1
13. ENCH2MB	8	2, 1	2012, 1	50	1	1	0
14. ENCH2OM	8	2, 1	2012, 1	50	1	1	0
15. ENEL2CM	8	2, 1	2012, 1	70	1	1	0
16. ENEL2EE	16	2, 1	2012, 1	54	1	1	0
17. ENME1DR	8	2, 1	2012, 1	78	1	1	0
18. MATH238	16	2, 1	2012, 1	50	1	1	0
19. CHEM251	8	2, 2	2013, 2	60	1	2	1
20. ENCH2CP	8	2, 2	2012, 2	50	1	1	0
21. ENCH2EF	16	2, 2	2012, 2	57	1	1	0
22. ENCH2IT	8	2, 2	2012, 2	74	1	1	0
23. ENCH2MS	8	2, 2	2012, 2	50	1	1	0
24. ENCH2WS	0	2, 2	-	-	0	-1	
25. MATH248	16	2, 2	2013, 2	50	1	2	1
26. CHEM261	8	3, 1	2013, 1	57	1	2	0
26. CHEM261	8	3, 1	2013, 1	57	1	2	0
27. ENCH3FM	8	3, 1	2014, 1	71	1	3	1
28. ENCH3HE	16	3, 1	-	-	0	-1	
29. ENCH3MP	8	3, 1	2016, 1	50	1	5	3
30. ENCH3SL	8	3, 1	2013, 1	75	1	2	0
31. MATH354	8	3, 1	2014, 1	50	1	3	1
32. STAT370	8	3, 1	2014, 1	58	1	3	1
33. ENCH2TD	8	3, 2	2013, 2	58	1	2	0
34. ENCH3CP	8	3, 2	2013, 2	73	1	2	0
35. ENCH3MT	16	3, 2	-	-	0	-1	
36. ENCH3PO	16	3, 2	-	-	0	-1	
37. ENCH3RT	16	3, 2	2014, 2	52	1	3	1
38. ENCH3TH	8	4, 1	-	-	0	-1	
39. ENCH4DC	16	4, 1	-	-	0	-1	
40. ENCH4ML	8	4, 1	2014, 1	58	1	3	0
41. ENCH4MT	8	4, 1	-	-	0	-1	
42. ENCH4RT	8	4, 1	-	-	0	-1	
43. ENCH3EC	8	4, 2	-	-	0	-1	
44. ENCH4PE	8	4, 2	-	-	0	-1	
45. ENEL4EB	8	4, 2	2014, 2	55	1	3	0
46. MGNT102	16	4, 2	-	-	0	-1	
47. ENCH4LA	16	5, 1	-	-	0	-1	
48. ENCH4PP	8	5, 1	-	-	0	-1	
49. ENCH4BG	8	5, 2	-	-	0	-1	
50. ENCH4DP	32	5, 2	-	-	0	-1	
51. ENCH4VW	0	5, 2	2015, 2	null	1	4	0

# 6.1 DEDUCING CURRICULUM – STUDENT ADVICE

## STUDENT RECORDS

## STUDENT ADVICE

Core credit weighted average: 58.4.  
Estimated year of study: 3.

Extra time taken to complete courses: CHEM241[1], CHEM251[1], MATH248[1], ENCH3FM[1], ENCH3MP[3], MATH354[1], STAT370[1], ENCH3RT[1]

Extra time: 0.04 years.

Your study is subsidised by the government. By taking this extra time to complete, you have cost both the State and the University an additional **2000 ZAR**.

This is also an estimated loss of earnings to you of 9600 ZAR.

More importantly, this is the loss of time that a graduate with the skills that you are studying toward could have been contributing to society.

Please avoid further losses by passing all your courses within the minimum possible time.

1.	CHEM161	16	1, 1	2011, 1	75	1	0	0
2.	ENCH1EA	8	1, 1	2011, 1	60	1	0	0

## 6.2 EXTENSION 5 — MACHINE LEARNING

With curriculum object, can develop student model of success

Predictive model — performance and bio data — predict likelihood of success

From biodata and other metrics consider admissions policy

In programme, given profile of results, determine whether additional support etc. required

Can perform curriculum design and evaluate likely throughput



## 6.5 MACHINE LEARNING – CROSS CORRELATING COURSES

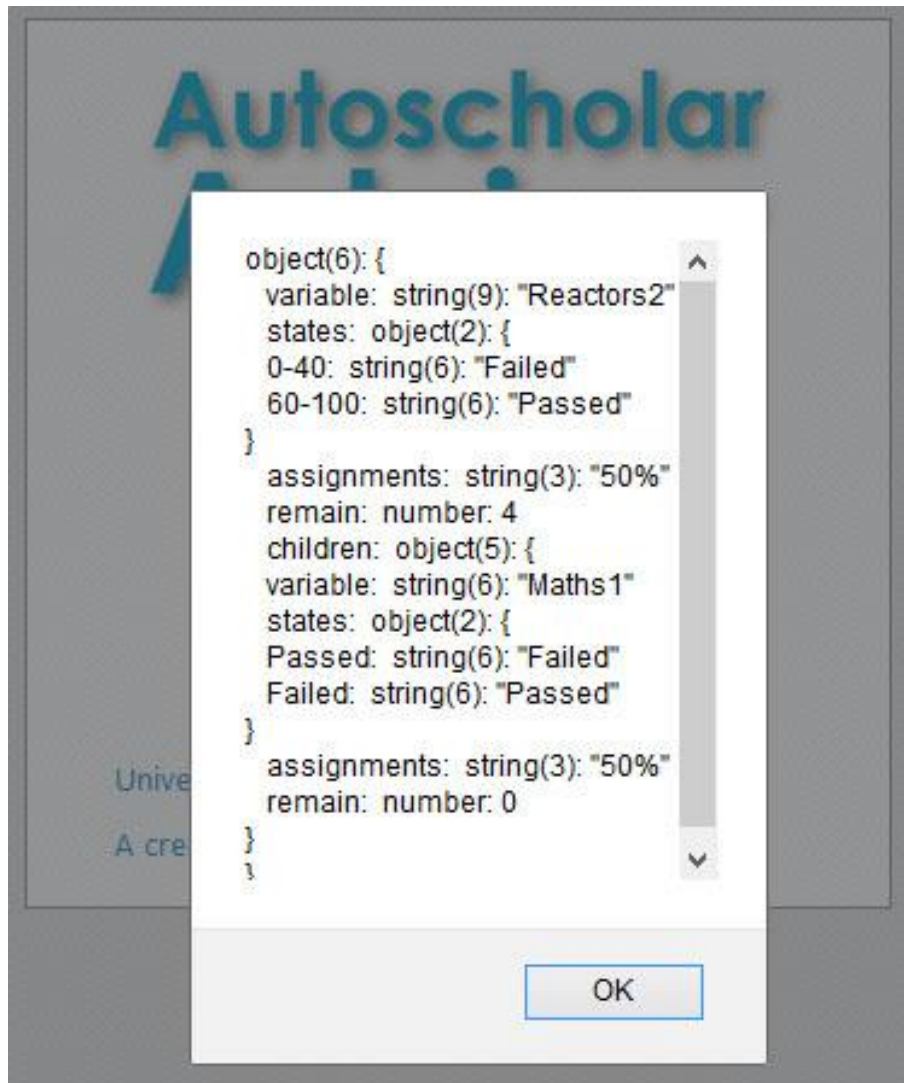
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CHEM161	0.05	0.52	0.44	0.27	0.33	0.33	0.37	0.49	0.41	0.22	0.24	0.51
ENCH1EA	0.34	0.38	0.44	0.24	0.25	0.26	0.34	0.12	0.3	0.31	0.19	0.34
ENCH1TC	0.25	0.15	0.39	0.19	0.23	0.19	0.35	0.49	0.05	0.45	0.23	0.28
MATH131	0.24	0.25	0.3	0.15	0.17	0.22	0.2	-0.51	-0.05	0.14	0.1	0.32
MATH132	0.42	0.39	0.49	0.33	0.46	0.26	0.51	0.35	0.25	0.33	0.32	0.4
PHYS161	0.49	0.38	0.41	0.42	0.49	0.4	0.52	0.39	0.31	0.22	0.49	0.38
CHEM171	0.43	0.11	0.47	0.33	0.36	0.09	0.41	0.4	0.18	0.17	0.22	0.53
ENCH1EB	0.28	0.45	0.5	0.27	0.22	0.44	0.46	-0.08	0.3	0.28	0.26	0.32
MATH141	0.27	0.36	0.48	0.28	0.35	0.46	0.38	-0.12	0.49	0.4	-0.06	0.42
MATH142	0.49	0.47	0.4	0.43	0.57	0.25	0.53	0.5	0.3	0.42	0.46	0.42
PHYS162	0.51	0.46	0.5	0.47	0.56	0.25	0.51	0.46	0.43	0.39	0.42	0.49

## 6.5 MACHINE LEARNING – CASE STUDY

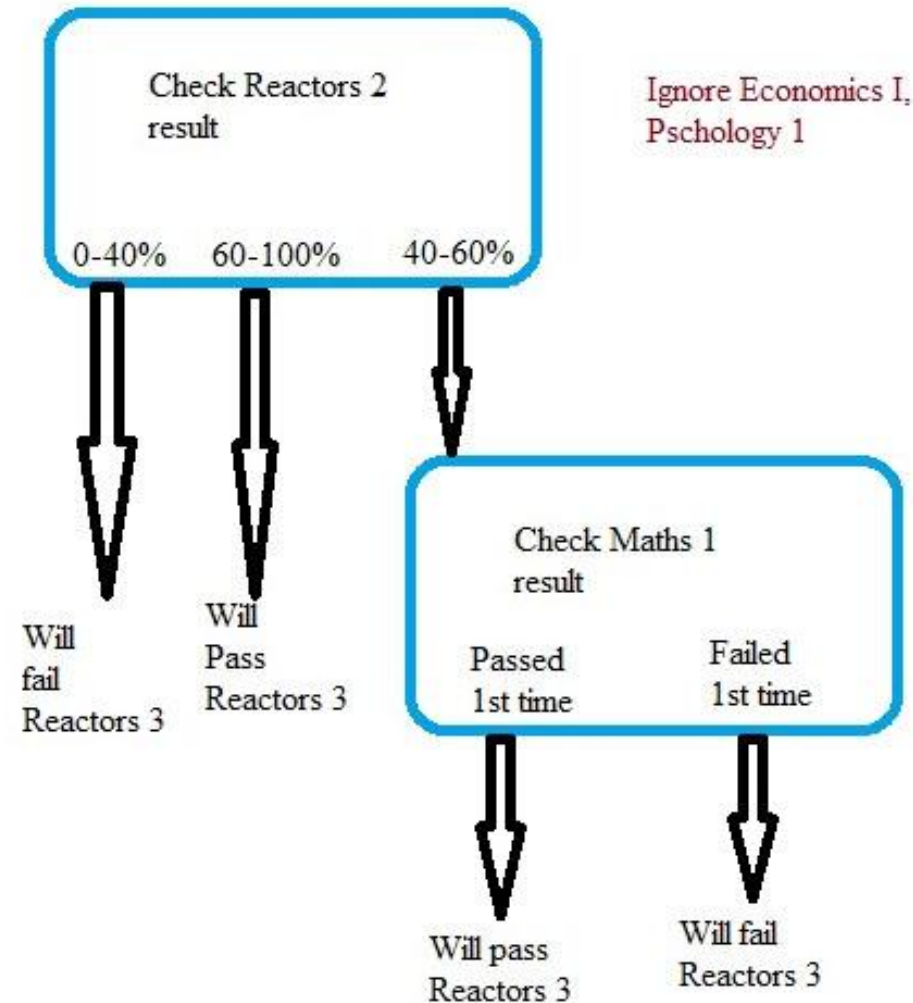
Reactors 3	Reactors 2	Maths1	Economics 1	Psychology 1
Failed	40-60	Passed	0-40	40-55
Failed	0-40	Passed	60-80	40-55
Passed	40-60	Failed	60-80	40-55
Passed	60-100	Failed	40-60	70-85
Passed	40-60	Failed	40-60	55-70
Failed	0-40	Failed	0-40	70-85
Failed	0-40	Failed	40-60	70-85
Failed	40-60	Passed	60-80	55-70



## 6.5 MACHINE LEARNING – MACHINE LOGIC



Logic Summary for Machine Derived Reactors 3 success predictor



## 7. WHAT TO DO WITH IT?

- Data-driven curriculum (re-)design
- Provide customised student advice – but requires careful treatment
- Monitoring of programme revision follow-through
- Discipline specific advice
- Robot system gives summative status – not predictive

# CONCLUSION

- ❖ Progression tree can identify major gatekeepers in curriculum
- ❖ Progression tree generation leads to deducing the 'Experienced' curriculum
- ❖ With curriculum known can provide advice:
  - ❖ Students – rate of progression
  - ❖ Programme advisors – course cross-correlation
- ❖ May also apply Machine Learning to curriculum – develop predictive models
- ❖ What can we do with the Machine Learning results
  - ❖ Student advising – but handle with care
  - ❖ Programme advising – curriculum (re-)design
  - ❖ Cannot ignore situation where we know so much

# ACKNOWLEDGEMENTS

Implementation of the Autoscholar at UKZN would not have been possible without the support of the following people

- ❖ Rubby Dhanpath, UTLO
- ❖ Bala Pillay, CAES
- ❖ Deogratius Jaganyi, CAES
- ❖ Vic Borden, Indiana University
- ❖ Lennard Wood, II
- ❖ Naveena Moodley, II
- ❖ Riaz Essay, ICS
- ❖ Heli Guy, ICS
- ❖ Logini Govender, Corp Relations

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