

# **‘Undergraduate’s Dilemma’**

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# **1      Introduction**

## **a.      Description and Rationale**

Since 2008, Singapore has been facing a severe talent crunch, with more firms moving into the country. It is undoubtedly very important to address this issue as our human resources are vital to our economy, given that we lack other natural resources. It is not a question of whether we have enough people, but whether the university graduates are specialising in the university courses and areas that are in demand. Not only is it important to firms and Singapore's society that there is a sufficient supply of talents in a particular field or area of study, in order to fulfill these parties' needs, but it is also important to graduates, who are likely to choose a course in which can mould them into becoming useful and valuable contributors to our society, and at the same time provide a steady income. These considerations create an impact on decisions made, and will affect enrolment and employment rates one way or another. Hence, this project aims to analyse the supply and demand in the workforce for various university courses at the present through analysing and applying Python programming on recent years' table data provided by local universities, such as the National University of Singapore (NUS), Nanyang Technological University (NTU), Singapore Management University (SMU), and Singapore University of Technology and Design (SUTD). We will also analyse and process data published on official government datasets for an overall illustration of university course trends in Singapore.

## **b. Objectives**

1. To find out the more popular courses among local university students at the present, by analysing table data retrieved from university and other official websites, through Python programming.
2. To find out university courses and areas of specialisation in high demand today, and hence the relevance of the more popular courses.
3. To find courses in most need of an increase in student enrolment, to cater to the current and future employment demands in the workforce.

## **c. Research Questions**

1. What are the local university courses that have the most supply of graduates? How do they differ as society progresses - such as technology?
2. How relevant is the supply of graduates to the job market today? What are the courses that are in demand with regards to the development of the country?
3. Which courses need a higher supply of graduates, and how might this change in the future?

#### **d. Fields of Mathematics**

- Statistics
- Graph Theory
- Combinatorics

#### **e. Terminology**

<b>Term</b>	<b>Definition</b>
Course	An area of study pursued by a university student
Graduates	Former students from a university whom have achieved a degree in the last 6 months and are actively looking for paid work
Undergraduates	University students who have yet to take a first degree

## **2 Literature Review**

### **a. Popular University Courses over Time**

To understand the supply of graduates from a certain course, we need to understand the courses that are in high demand, and how that has changed over time. Davie (2017), representing The Straits Times, writes that in 2017, the demand for Law courses at the National University of Singapore, one of the most popular courses previously, has dropped by 17 %, while the demand for Computing courses went up by a significant 35 %. This is unlike in 2014, which, at that point of time, the demand for Law courses had increased by a third. This shows that there can be a change in trend over time. On the other hand, courses such as medicine are consistently in high demand. This project aims to understand the current supply of graduates from certain courses, and also use available data to recognise how the supply has been adapting to meet the demand so far, and to predict courses that may need an increase in supply of graduates to meet the possible higher demands of the workforce in the future.

### **b. Courses and Areas that Lack Supply**

A recent article published on *Today* ("S'pore faces talent crunch as tech giants scale up", 2021) writes about the high demand for the skills of those with computer engineering degrees, citing the experience of a Singapore-based software engineer, who receives multiple job offers daily. Singapore aims to grow into a regional technological hub, generating an influx in the demand for software engineers. With such a high demand, it is beneficial for undergraduates to pick up a computer engineering course. This project aims to raise awareness about such courses

that are in high demand, in the present and in the future, attempting to prevent large gaps between the demand and supply of graduates from certain courses.

### **c. Redundancy in Influx of Graduates in Certain Courses**

By understanding the impact of the mismatch between the courses supplied and courses demanded by employers, we must look at the employment rate of graduates in recent years. Mui (2018), representing The Business Times, writes that only 78.4 % of graduates from the National University of Singapore (NUS), Nanyang Technological University (NTU), and the Singapore Management University (SMU) found full time employment in 2017, the lowest in 10 years since 2007. When we look at the figures from autonomous universities, the divide in employment rates between the courses is more than obvious; only 50 % to 60 % of graduates in Humanities and certain Science courses found full time employment, while all or almost all graduates in courses that are in high demand, such as Computing, Accountancy and Nursing found full time employment. This large gap in employment between the courses taken by graduates is the effect of mismatching between the supply of graduates of certain courses and the demands of employers for graduates of other courses, which this project aims to minimise.

### **d. Factors Influencing Future Changes**

In order to predict future changes more accurately, we must take into account various factors that have an effect on the demand. For example, as Singapore starts to face rising problems such as an ageing population, this would likely give rise to the demand for talents specialising in areas related to healthcare, such as eye care specialists, of which most probably

would be of much significance and importance in the future. Ansah (2015), an NUS medical school graduate, while conducting a program in Health Services and Systems Research, writes that with Singapore's ageing population, this might lead to an increase in eye diseases and demand for eye care. The four main scenarios that were created were business-as-usual scenario, current policy scenario, new model of care scenario and moderated workload scenario. In all of these scenarios, the projected increases in the number of ophthalmologists are 117%, 175%, 150% and 192% respectively. This possible large increase in the demand for ophthalmologists due to ageing population in Singapore highlights the relevance of certain factors that will affect future demands of other courses, which this project aims to analyse and tackle.

### **3 Study and Methodology**

#### **a. Methodology**

1. To read up on relevant materials regarding the demand and supply of popular university courses offered.
2. To research related methods to reduce the gap of demand and supply, such as providing opportunities to disadvantaged youths or lowering the salary of jobs with high demand.
3. To obtain data on undergraduate enrolment and graduate employment from various sources, such as local university websites and official government datasets.
4. To convert data in .pdf form obtained into .csv form for analysis.
5. To scrape data through Python and R programming and analyse the trends, such as enrolment and employment rates of certain courses among local universities.
6. To express the trends visually by plotting graphs using suitable graphing tools, such as Tableau and Microsoft Excel.
7. To compare the enrolment and employment trends in recent years, and hence project the demand and supply of graduates in selected courses, and find the courses that need an increase in supply to meet employers' demands.

## **b. Results and Findings**

### **i. Research Question 1**

What are the local university courses that have the most supply of graduates?

How do they differ as society progresses - such as technology?

#### **Methodology:**

1. Process and clean enrolment data obtained from government and university websites.
2. Find trends in enrolment across years.
3. Present trends graphically.
4. Identify factors which correlate to the increase or decrease in enrolment.

Data on university enrolment used for this project was obtained mainly from [www.data.gov.sg](http://www.data.gov.sg) and [www.nus.sg](http://www.nus.sg). The enrolment data provided by [www.data.gov.sg](http://www.data.gov.sg) is sorted by university and by year. The enrolment data obtained from [www.nus.sg](http://www.nus.sg) is sorted by course, confined to the National University of Singapore. The data of the Arts and Social Sciences, Computing and Science courses were chosen to be analysed as they had the highest enrolment amongst all available courses offered.

## Arts and Social Sciences

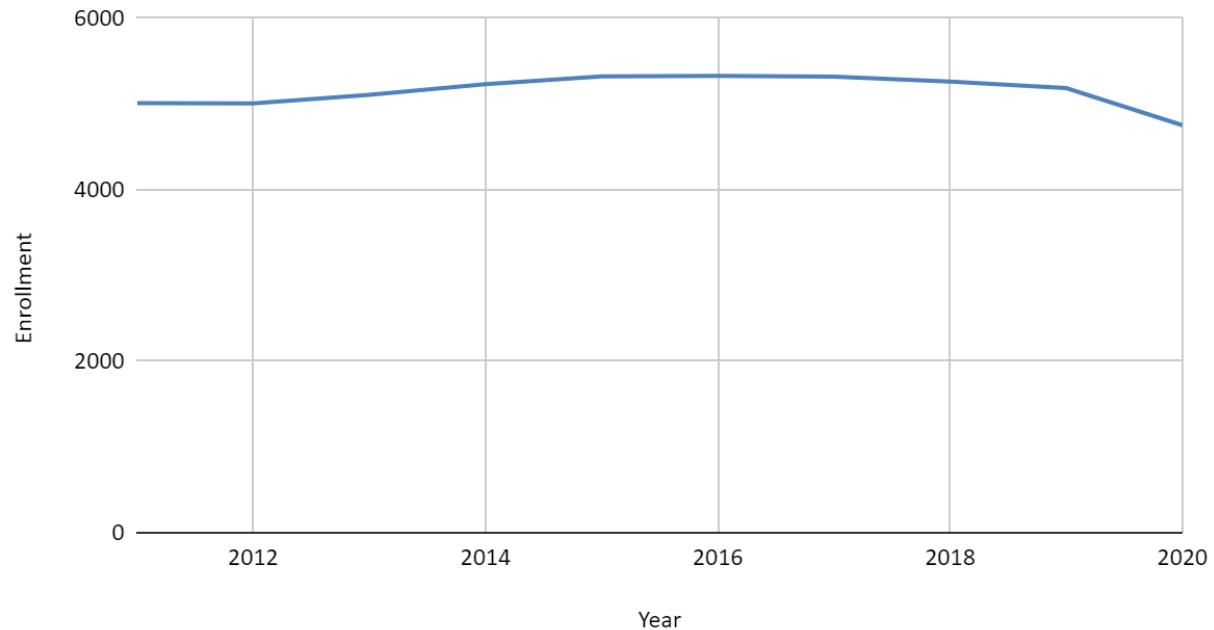


Fig. 1 - Arts and Social Sciences Enrolment from 2011 to 2020

From Fig. 1, it can be observed that from 2011 to 2019, the overall enrolment for the Arts and Social Sciences has remained exceptionally constant, between 5000 and 5500, with the slightest increase of 3.51 % (5010 - 5186). However, from 2019 to 2020, the enrolment rate experienced a notable decrease, dipping below the 5000 threshold (4753), the lowest in 10 years.

## Computing

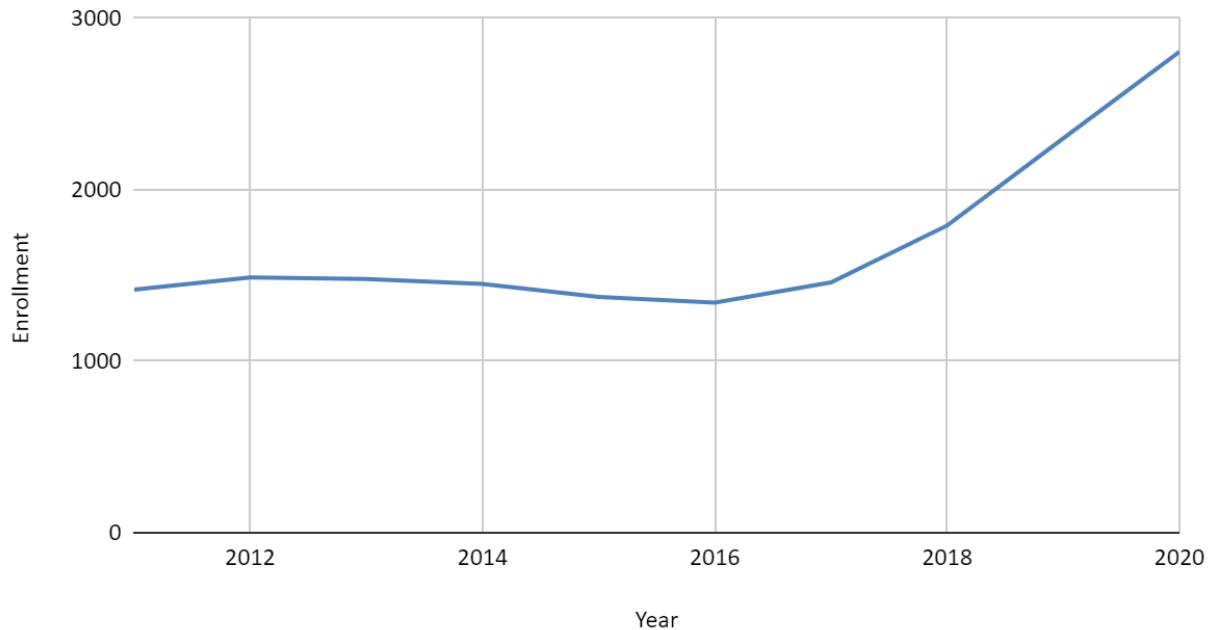


Fig. 2 - Computing Enrolment from 2011 to 2020

From Fig. 2, it can be observed that from 2011 to 2016, the enrolment for Computing remained stable at around 1400, before making a considerable increase of 109 % from 2016 to 2020 (1342 - 2804).

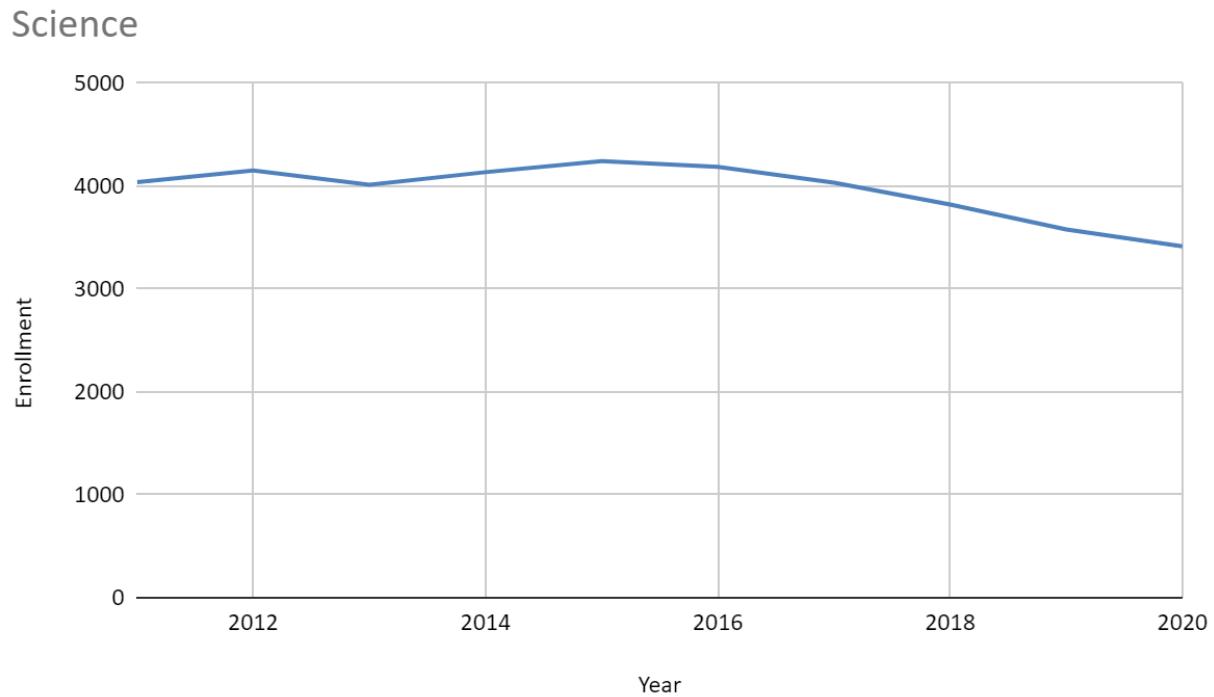


Fig. 3 - Science Enrolment from 2011 to 2020

From Fig. 3, it can be observed that from 2011 to 2015, the enrolment for Science was relatively stable at a level above 4000. From 2015 to 2020, that number suffered a fall of 19.5 %, eventually bottoming out at 3415 in 2020.

## Total Enrollment - NUS

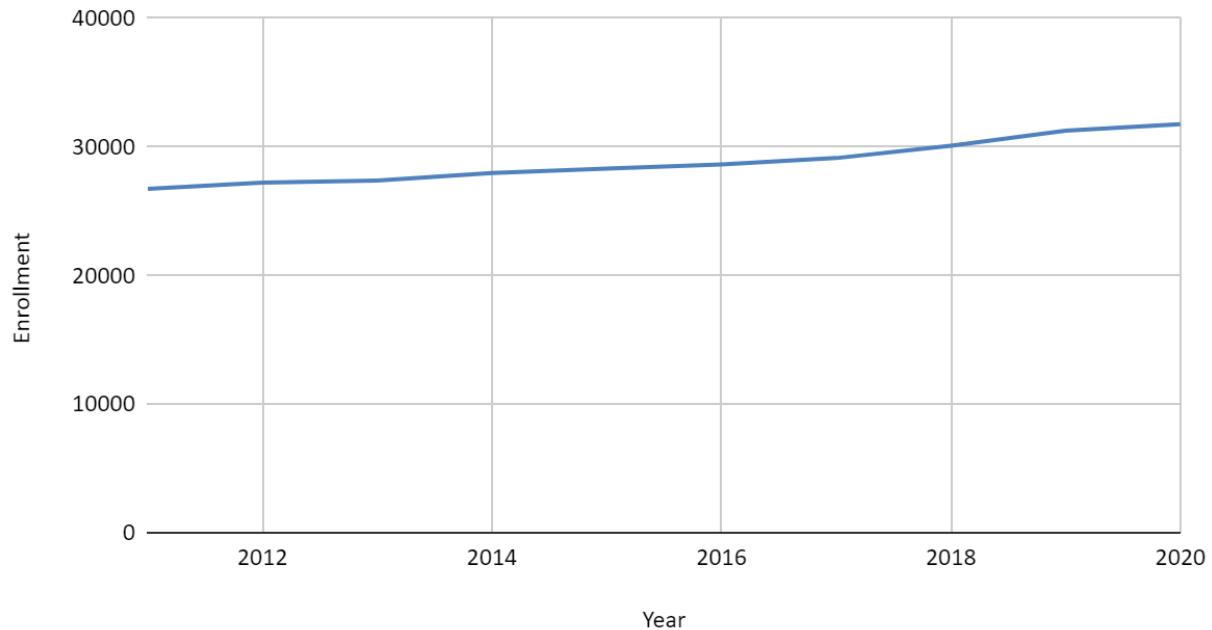


Fig. 4 - Total Enrolment for NUS from 2011 to 2020

In conclusion, Fig. 4 shows that from 2011 to 2020, the total enrolment for NUS gradually increased by 18.8 % (26742 - 31760). This can be due to the drastic increase in enrolment for Computing and Computer Science courses. In today's digitizing and ever-changing world, there is an increased need for more computer scientists because of increased reliance on technology, be it replacing humans with A.I. systems for businesses, coming up with new 5G stand alone networks, or the switching to online lessons in education, computer scientists aim to prepare our world in this Information or Digital Age, as well as provide people with a better quality of life. Thus, this might explain why more university students are enrolling in Computing courses. Thus, Computing is one of the current courses that are becoming increasingly popular.

## ii. Research Question 2

How relevant is the supply of graduates to the job market today? What are the courses that are in demand with regards to the development of the country?

### Methodology:

1. Process and clean graduate employment data from government websites.
2. Find trends in number and percentage of graduates employed across local universities.
3. Present trends graphically.
4. Identify factors which correlate to the high employment of graduates in certain courses.

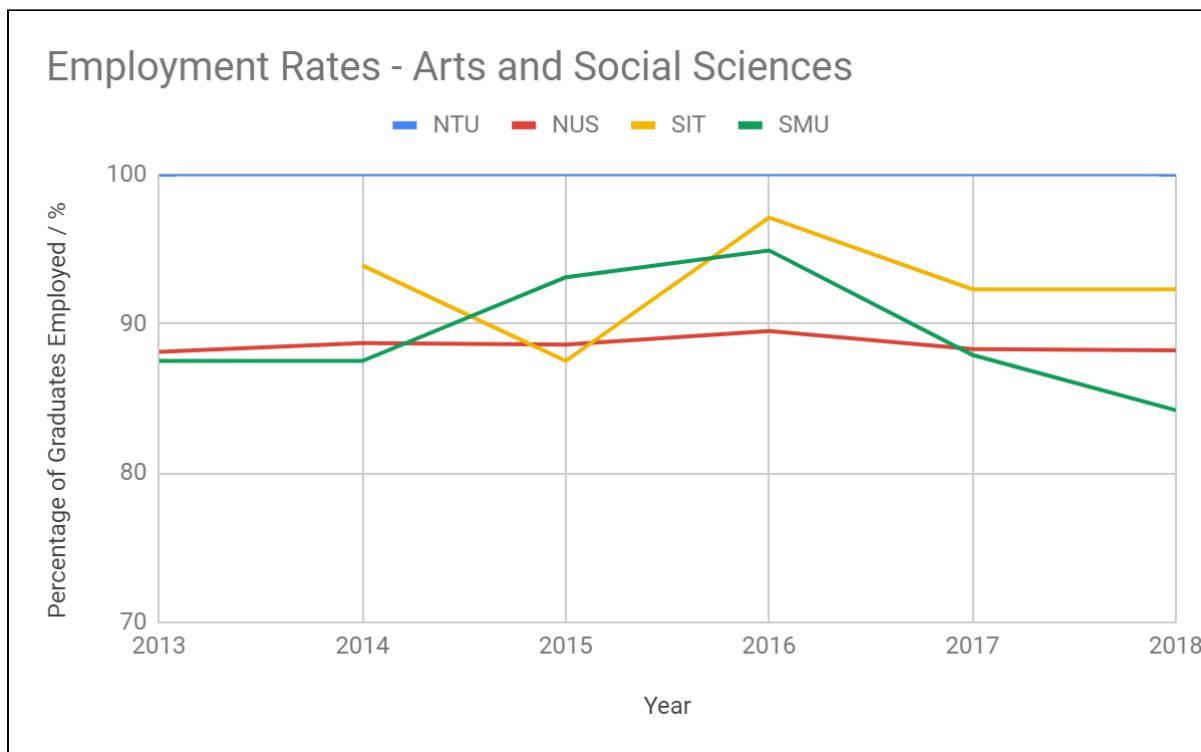


Fig. 5 - Arts and Social Sciences Employment Rates from 2013 to 2018

From Fig. 5, it can be seen that for the Arts and Social Sciences course, the employment rates have generally remained high over the years. Furthermore, comparing the statistics of the 4 universities, it can be observed that the employment rates based on NTU graduates have remained at 100 %. All NTU students enrolled in Arts and Social Sciences have been employed. For NUS, employment rates have also generally remained constant, around 88 %. As for SIT and SMU, although the rates seem to fluctuate, the employment rate has been kept high. Thus, we can conclude that the demand for students specialising in Arts and Social Sciences have also remained high. This explains the need for an increase in the supply of graduates.

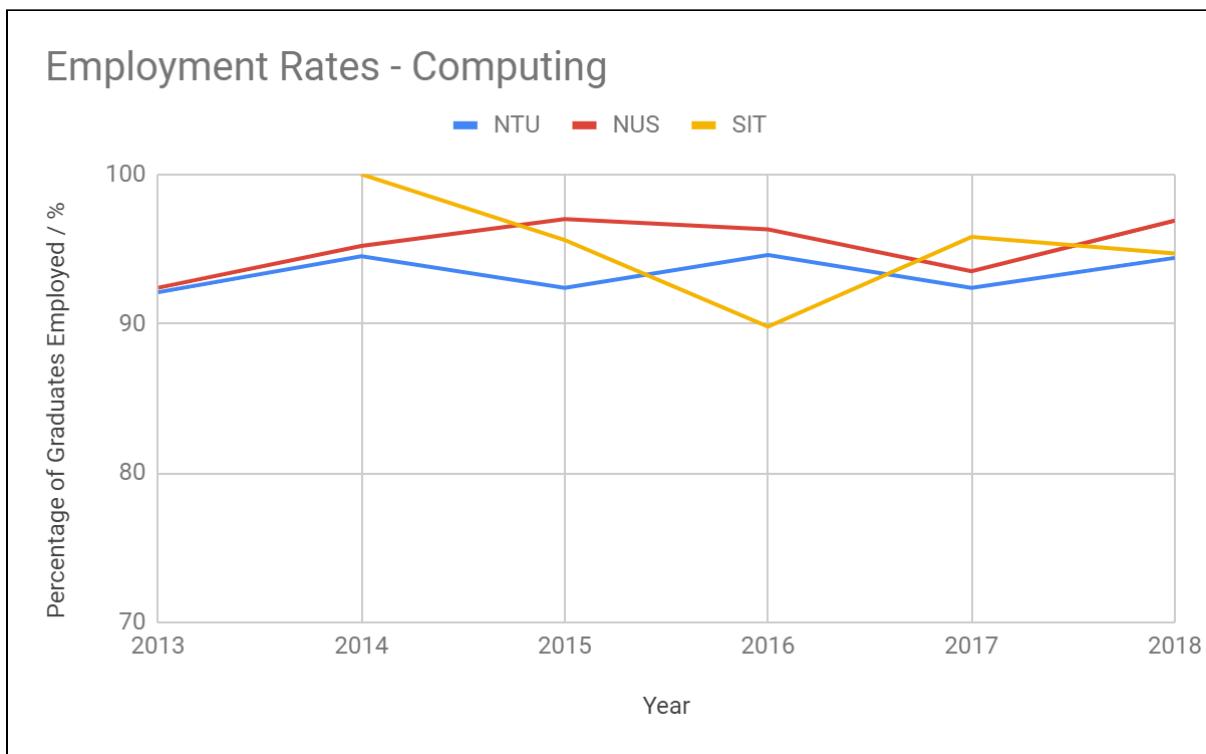


Fig. 6 - Computing Employment Rates from 2013 to 2018

From Fig. 6, it can be seen that for Computing courses, the employment rates for all three universities are very high, at around 95 %. This shows that the demand for Computer Science is

very high and that Computing is one of the more popular courses today, thus the number of students enrolling in Computing courses has been increasing over the years.

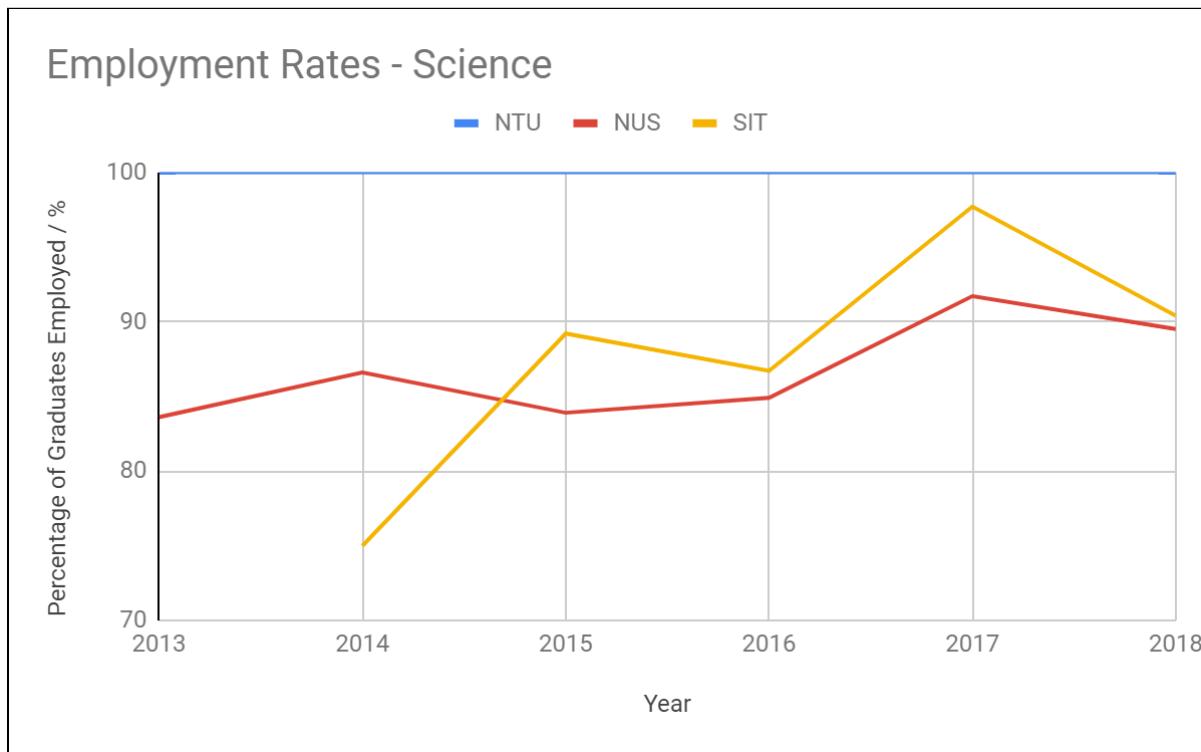


Fig. 7 - Science Employment Rates from 2013 to 2018

From Fig. 7, it can be seen that there is a general increase in the employment rate for graduates who take Science from 2013 to 2018. However, from 2017 to 2018, there has been a gradual decline for NUS and SIT whereas for NTU, it remained at 100%. Thus, this explains the slight decrease in the number taking Science courses at NUS.

In conclusion, we can say that the employment rates are significant in determining the enrolment rates in the respective popular courses. For the three most popular courses, Art and Social Sciences, Computing and Science, we can conclude that as society progresses, more

people tend to rely on technology. Hence, computer scientists are essential in ensuring our country's technological advancements. With greater exposure to technology from a young age, an increasing number of people are also more interested in the area of Computing and this may suggest why the number of people taking computing courses is increasing. As for Arts and Social Sciences, we believe that the slight increase is because more people taking this course are getting employed nowadays, indicating that there are multiple pathways of success available and people do not need to always strive to be in Computing or Science courses. This might also explain why the number of students taking Science courses is decreasing.

### **iii. Research Question 3**

Which courses need a higher supply of graduates, and how might this change in the future?

#### **Methodology:**

1. Process and clean graduate employment data from government websites used in Research Question 2 to find the number of graduates employed from percentages.
2. Process undergraduate enrolment data from university websites used in Research Question 1 to match graduating year for comparison.
3. Present employment and enrolment trends graphically on the same axis.
4. Compare employment data to enrolment data.
5. Identify courses that need increased enrolment.
6. Project employment trends.

## Arts and Social Sciences

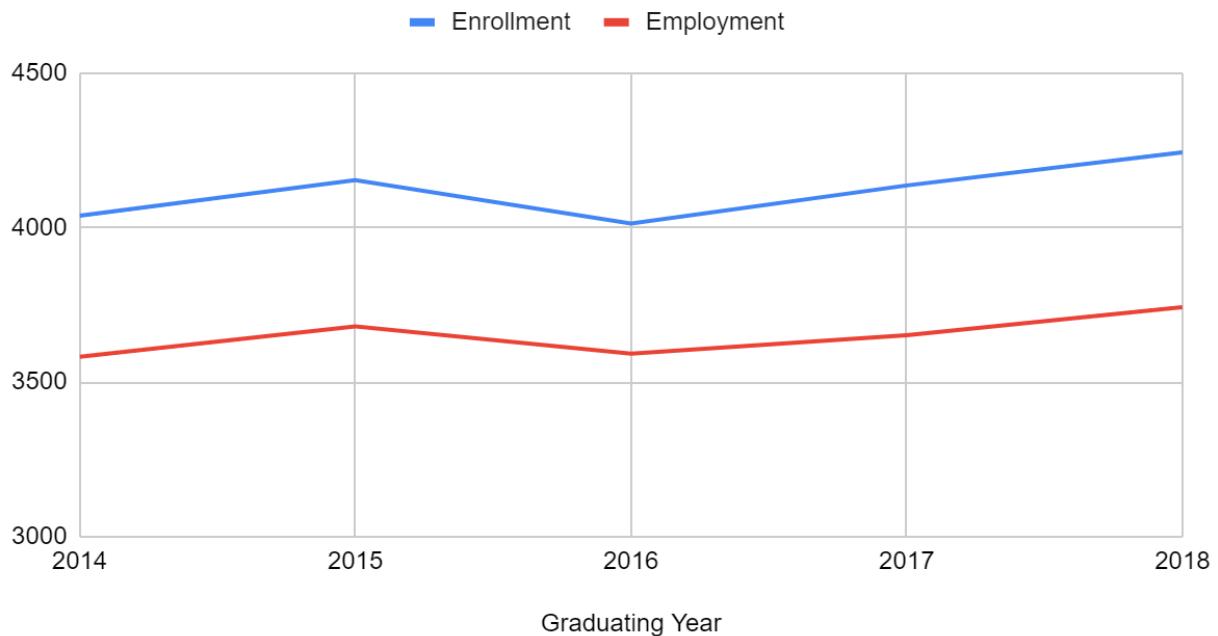


Fig. 8 - Arts and Social Science Employment and Enrolment from 2013 to 2018

From Fig. 8, it can be seen that both the employment and enrolment rates have remained stagnant with only a slight increase (100-200) over the years 2014 to 2018. This shows the supply and demand for the Arts and Social Sciences has been rather constant in recent years. The consistent difference between employment and enrolment rates portrays the existing gap between supply and demand in the market. However, instead of having a lack of supply, higher enrolment rates depict a scenario where there is supply surplus, more than sufficient to meet the demand.

## Computing

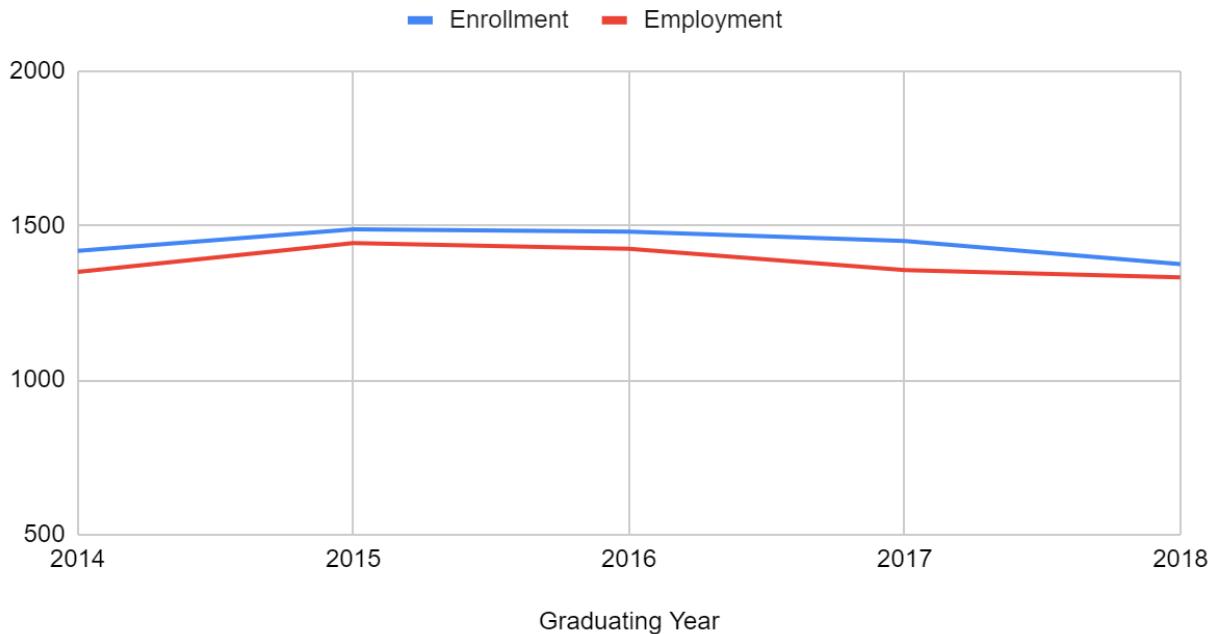


Fig. 9 - Computing Employment and Enrolment from 2013 to 2018

From Fig. 9, it can be seen that both the employment and enrolment rates have increased slightly (~100) from 2014 to 2015, but there was a slight decrease (~100) in the rates after 2015. This shows that the supply and demand for Computing has been quite constant over the years despite the slight decreases. The gap between the employment and enrolment rates has also been constant and relatively small. Therefore, although the supply is more than sufficient to meet the demands for Computing graduates now, there might still be a chance that the demand for Computing graduates will increase over the years. Thus, more Computing graduates may be required in the future.

## Science

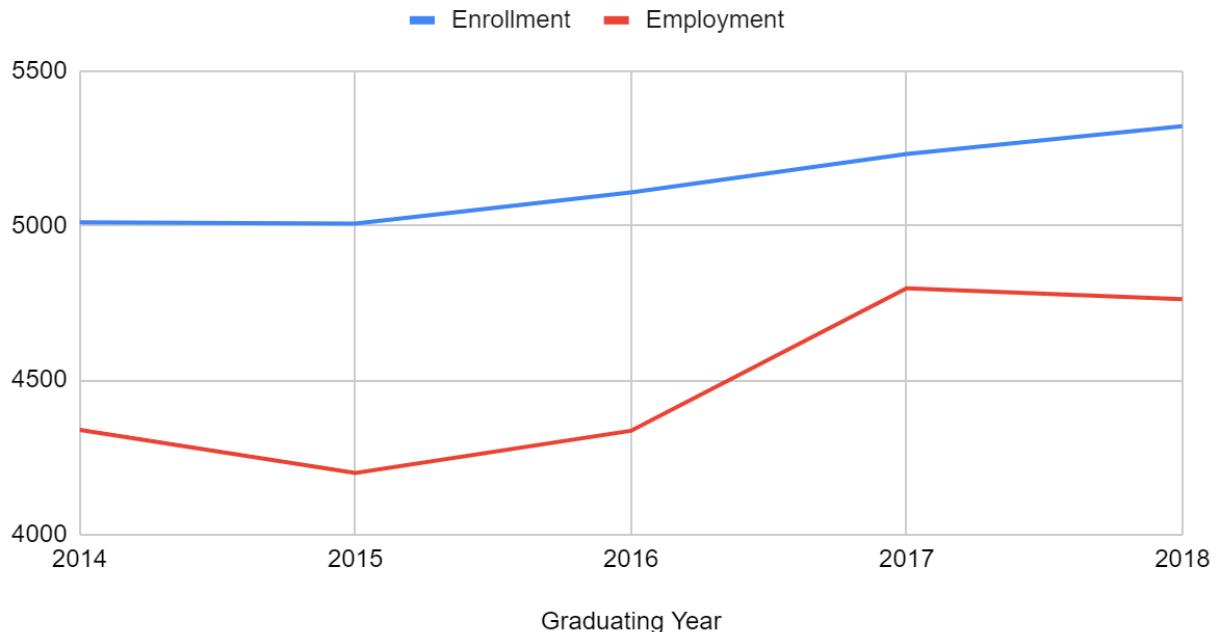


Fig. 10 - Science Employment and Enrolment from 2014 to 2018

From Fig. 10, it can be seen that throughout the years 2014 to 2018, the enrolment rates have remained consistently higher than the employment rates. While the enrolment rates have been increasing at a steady rate (~300), the employment rates have been increasing at a faster rate (~500). However, the increase in percentage of employment rates have been rather unsteady, with slight dips from 2014 to 2015, and 2017 to 2018. Although there exists uncertainties in the future trends for the employment rates, it can be said that the gap between employment and enrolment rates have proved quite constant (500 - 700) with slight narrowing, where the employment has been lower than the enrolment. Hence, the supply is more than sufficient to meet current demands for Science.

Across the popular courses offered, data provided on employment and enrolment rates across the years has shown that there is generally no special need for a higher supply of graduates to meet demands. It can be noted that it is the case that there has been a gap maintained between employment and enrolment rates for the Arts and Social Sciences, and is projected to remain as such in the near future as well, where the supply overall has been able to meet the demands in the workforce.

However, Science and Computing follows a different trend as compared to Arts and Social Sciences.

For Sciences, although there was a wide gap from 2014 to 2016, it has then started to narrow. This shows that the gap might continue to narrow and there might be a need for more Science graduates in the future to meet the demands of the workforce.

For Computing, there is a consistent narrow gap between the supply and demand that has been maintained from years 2014 to 2018. The narrow gap suggests that our society lacks graduates who specialise in Computing. This is especially true due to technological advances and the need for new innovations and ideas. In order to ensure that the workforce does not lack such talents, we have identified that in the area of Computing, society might require more of such graduates to cater to the increasing employment rates.

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