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Deputy Head (Undergraduate Teaching)
Division of Mathematical Sciences
School of Physical & Mathematical Sciences

These slides are available at the division homepage:
http://www.spms.ntu.edu.sg/mas/
Three main programmes to discuss

- MATH - Mathematical Sciences
- MAEC - Mathematics and Economics combined degree
- MAFI - Mathematics with a Minor in Finance
Why choose mathematics?

Why study with us at MAS, the division of mathematical sciences at NTU?
Why study mathematics?

- Many of the most exciting 21st century industries are BUILT on mathematics
  - The algorithms that power the internet
  - The math that powers mobile communication
  - Financial Engineering
  - Big Data Analytics
  - Modelling and Computation
  - Statistics in business, economics, government, medicine, insurance and actuarial fields, ...
  - And future industries we can’t even imagine yet.
Why study mathematics?

- **Flexibility**: A degree in mathematics gives you the flexibility and technical strength to aim at many different careers.

- **Resilience**: A good mathematician will be able to adjust their career later on as they and the world change.

- **Employability**: Employers of all sorts value mathematicians for their analytical minds and for their confidence with numbers and with technology.

- **Maths is fascinating, fun, and powerful**
“I’m passionate about mathematics, but if I study math all I can become is a teacher.”

*True or False?*

*So false.*
What do MAS alumni do next?

24% Financial services and Insurance related fields
20% Education
5% Manufacturing
2% Scientific R&D
3% I.T.
10% Miscellaneous other:
  • Healthcare
  • Admin services
  • Trade
  • Accounting services
  • ....
12% Business and management consultancy, including logistics and supply chain management.
24% Public administration and Defense.

(Concerns ‘Economically active graduates’. Based on NTU’s official graduate employment survey, 2008-2012)
Some companies who have employed our alumni

Banking, Finance
- Standard Chartered
- Singapore Airlines
- HSBC
- UOB
- Credit Suisse
- RBS
- Crédit Agricole
- Commerzbank
- Citi
- DBS
- Ernst & Young
- OCBC Bank
- Chartis
- Cito
- UBS

Government, public administration and defense
- PetroChina Company Limited
- World Scientific
- Singapore Airlines
- PSA
- Resort World Sentosa
- Marina Bay Sands
- ExxonMobil
- General Insurance Association
- P&G
- AON
- Nielsen
- CCG Veritas
- Savant Degrees
- Great Eastern
- DSO

Industry, Business
- Central Provident Fund Board
- DPM Information Group
- Infocus International
- Spring Singapore
- National Environment Agency
- Ministry of Trade and Industry Singapore
- Ministry of Finance Singapore
- Ministry of Health Singapore
- Ministry of Manpower Singapore
- Ministry of Manpower Singapore
- National Cancer Centre Singapore
- SingHealth
- Economic Development Board Singapore
- Competition Commission Singapore
## 2014 MOE Graduate Employment Survey

- Figures are for 6 months after final exams.
- Excludes students going on to further study.

<table>
<thead>
<tr>
<th>Degree</th>
<th>Overall Employment rate (%)</th>
<th>Full time Permanent Employment rate (%)</th>
<th>Gross Monthly Salary ($$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>NTU, Mathematics &amp; Economics</td>
<td>88.4</td>
<td>87.0</td>
<td>3,155</td>
</tr>
<tr>
<td>NTU, Mathematical Sciences</td>
<td>91.3</td>
<td>79.7</td>
<td>3,022</td>
</tr>
</tbody>
</table>
Employment rates over the last 3 surveys.

**MAEC:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall Employment Rate</th>
<th>Full-time Employment Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>87.5%</td>
<td>82.1%</td>
</tr>
<tr>
<td>2013</td>
<td>92.2%</td>
<td>89.6%</td>
</tr>
<tr>
<td>2014</td>
<td>88.4%</td>
<td>87.0%</td>
</tr>
</tbody>
</table>
Employment rates over the last 3 surveys.

MATH:

- Overall employment rate:
  - 2012: 94.4%
  - 2013: 86.0%
  - 2014: 91.3%

- Full-time employment rate:
  - 2012: 83.3%
  - 2013: 83.7%
  - 2014: 79.7%
What do MAS alumni do next?

Usually ~10% of our alumni go on to further study, in fields such as:

- All parts of mathematics
- Economics
- Financial Engineering
- Computer science and engineering
- Actuarial studies
- ...

Hua Zhunyou  
MAEC Class of 2013  
Masters student in Financial Engineering, Cornell University

Keshav Kini  
MATH Class of 2010  
Majored in Pure Math  
PhD student in Computer Science, Uni. Of Texas

Dou Liyu  
MAEC Class of 2011  
PhD student in Economics, Princeton

Li Enlin  
MATH Class of 2014  
Majored in Pure Mathematics  
Studying Medicine at Duke-NUS Graduate Medical School

Danny Nguyen  
MATH Class of 2011  
Majored in Pure Math  
PhD student in Pure Mathematics, UCLA
A few real applications of mathematics coming from areas we are leaders in
Mathematics in Economics, Banking & Finance

\[ \frac{\partial C}{\partial t} + (\frac{\partial C}{\partial S}) r S + \frac{1}{2}(\frac{\partial^2 C}{\partial S^2}) q^2 S^2 = rC \]

Mathematics of Finance
Nobel Prize (Economics) 1997.

Professor James Simons
Co-inventor of “Chern-Simons Theory”, a highly abstract topic in differential geometry.
Founder of the hedge fund Renaissance Technologies.
His estimated net worth: US $12.5 billion.
Mathematics in Economics, Banking & Finance

Assoc. Prof. Nicolas Privault
Faculty with MAS, Head of finance related programmes
PhD from the University of Paris 1994
Teaches undergraduates courses in probability and statistics for MAS and also for the Nanyang Business School Masters in Financial Engineering.

Prof. Privault has authored many popular textbooks on financial mathematics:
Mathematics in Business

The mathematics being used by business is becoming increasingly sophisticated.

Two examples we focus on in MAS are:

- Optimization of business processes and logistics
- Business Analytics.

What is “optimization”? 
What is the shortest path from red to green?

Solution by Dijkstra’s algorithm
A few more examples of online algorithms powered by deep mathematics:

- Internet search algorithms
- Online ad auctions
- Online shop instantaneous product recommendations
- Internet dating
- …
The Travelling Salesman Problem:
Given a set of points in the plane, what is the shortest possible way of visiting them all and ending up back where you started?

An optimal TSP tour through 13,000 cities in the USA.

In Business language: “Logistics and supply chain management”
Several MAS faculty are leaders in these fields. Eg:

- Professor Andrew Lim
  - PhD in Computer Science from University of Minnesota
  - Research: Analysis and process optimization, large scale optimization, business analytics.
  - The school’s Director of Business Analytics programmes
  - Teaches: MH3400 Algorithms for the Real World

- Associate Professor Chua Chek Beng
  - PhD from Cornell University
  - Research: Theory of Optimization

- Nanyang Associate Professor Chen Ning
  - PhD from the University of Washington
  - Has his own startup company providing online job-matching services.
  - Teaches: MH4320 Computational Economics.
Mathematics in Business: Business analytics

What is “business analytics”?

• The I.T. revolution means modern businesses easily acquire massive data sets about their customers and how they buy and use their products.

• “Business analytics” is all about exploiting these massive data sets to help make business decisions, to customize user experience, and to optimize business processes.

• This field combines many different types of math: statistics, optimization, algorithms, technology, and programming...
An example of analytics: instantaneous customer recommendations
Mathematics in Business: Business analytics

We are launching in March 2015:
Masters in Business Analytics
Mathematics in E-commerce

hypertext transfer protocol secure
Mathematics in E-commerce

invented the most commonly used cryptography scheme. It is based on the following mathematical idea:

*Multiplying is easy…*

\[2^2 \times 3^3 \times 5^5 \times 7^7 = 11117830500\]

*…but factoring is hard.*
MAS has one of the strongest groups in cryptography and the mathematics of telecommunications anywhere on the planet…

Prof. Ling San, Dean of the College of Science.

Assoc Prof. Wang Huaxiong, Head of MAS.

Prof. Xing Chaoping

Prof. Chee Yeow Meng, Chair of the School of Physical and Mathematical Sciences.

Nanyang Assistant Profs. Oggier and Wu
Not a traditional pure math department.

“Mathematical Sciences” emphasizes not only mathematics but also how it is applied and relevant in other contexts.
Faculty from 12 countries, so far.

Typical age is around 40, many at the peak of their respective fields.
Overview of the Division of Mathematical Sciences

Schools
- Chemistry
- SPMS
- Physics
- Earth sciences

Divisions
- Chemistry
- Math
- Physics
- Earth sciences

Programmes
- B.Sc. (Hons) + M.Sc. or MFE
- Math with minor in finance
- Mathematical sciences
- Mathematics and economics

Specializations
- Applied math
- Business analytics
- Pure math
- Statistics

Integrated programme: two degrees in 4 years (by invitation only) (Joint with HSS)
A typical study programme

Level 4
Projects / Internships

Level 3
Specialization
- Seminars and special talks
- Overseas Exchange
- Research projects
- Supervised Independent study

Level 2

Level 1
Common foundations:
- Calculus, Linear algebra, Computing,
- Probability and Statistics, Discrete mathematics, Logic, Communication,
- Broadening electives
What is special about our programmes?

1. Many different initiatives to prepare students for careers in business, finance, banking, etc.

- *Mathematics and Economics (MAEC)* combined major.

### Mathematics and Economics (MAEC)

- Jointly offered with the College of Humanities, Arts and Social Sciences.
- A challenging 4 year *combined* degree to the honors level.
- Students study the most important parts of a normal degree in Mathematics, as well as the most important parts of a normal degree in Economics.
- In early years the emphasis is on mathematical foundations and analytical tools. In later years the emphasis is on economic theories and descriptive tools.
MAEC was introduced in 2006, and now has a strong international reputation.

For example, here are a few of our MAEC Alumni:

**Cheng Tianyin**
- MAEC Class of 2009
- MSc from the London School of Economics in Econometrics and Mathematical Economics with **Distinction**.
- Has held many positions as a quantitative and risk analyst in various investment funds.
- Currently an Associate Director at Standard and Poor’s Dow Jones Indices.

**Dou Liyu**
- MAEC Class of 2011
- MSc from the LSE in Econometrics and Mathematical Economics with **Distinction**.
- Was awarded the **Ely Devon Prize from LSE for Best Overall Student Performance**.
- Currently pursuing his PhD in Economics at Princeton.

**Hu Zhongchen**
- MAEC Class of 2013
- MSc in Economics and Finance from the LSE.
- Was awarded the **LSE’s Antoine-Grimaud Prize for Best Overall Student Performance**.
Previous education: Temasek JC
Now risk analyst at OCBC

"Taking NTU Maths and Economics (MAEC) course have been a rewarding experience for me. Mathematics trained me to think logically and critically while Economics taught me to think in a macro perspective. Lately, I have also seen direct applications of mathematics at my workplace with the calculation of risks. Also the economics training allows me to understand the intuition behind some of the parameters. Lastly, I had the opportunity to interact internationally when travelling abroad for student exchange and the ample availability of mathematics and economics subjects did not limit me to the universities that I can choose. I am glad I chose MAEC in SPMS, for it prepares me for the working world in a wholesome manner."
What is special about our programmes?

1. Many different initiatives to prepare students for careers in business, finance, banking, etc.

   • *Mathematics and Economics (MAEC)* combined major.
   • *Mathematics with a minor in Finance (MAFI).*

<table>
<thead>
<tr>
<th>Mathematics with a Minor in Finance (MAFI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• With the help of the Nanyang Business School (NBS).</td>
</tr>
<tr>
<td>• Students take a number of core and elective Finance courses taught by NBS.</td>
</tr>
<tr>
<td>• MAS students are the only students in NTU allowed to take this minor. This reflects the deep connections between mathematics and finance, and between MAS and NBS.</td>
</tr>
<tr>
<td>• To stay in the programme students need to meet a performance requirement in 1st year.</td>
</tr>
</tbody>
</table>
What is special about our programmes?

1. Many different initiatives to prepare students for careers in business, finance, banking, etc.
   
   - *Mathematics and Economics (MAEC)* combined major.
   - *Mathematics with a minor in Finance (MAFI)*.
   - *Business analytics* track. With the help of the Nanyang Business School and the School of Computer Engineering.
   - *Statistics* track in our general degree.

   “I keep saying that the sexy job in the next ten years will be statisticians. And I’m not kidding!”

Wong Qi Ling, MAS Statistics track 2012

Previous education: Meridian JC
Now FCIP analyst at Standard Chartered Bank

"Studying Mathematics with a major in Statistics had trained me to think more logically. I can now better understand the figures obtained which aids me in my analysis. My 4 years in SPMS has landed me with great friends, great experience and is definitely a rewarding journey!"
What is special about our programmes?

2. Mathematics and technology

From The Straits Times, November 25th 2014:

Prime Minister Lee Hsien Loong

1st Class Honours in Mathematics from the University of Cambridge
What is special about our programmes?

2. Mathematics and technology
   • Since our founding in 2005, a strong emphasis on the interactions between mathematics and technology all the way through our curricula.
   • For example, all students take a sequence of 3 computing courses at the start of their studies, “Algorithms and Computing”, alongside more traditional mathematics topics.
   • Many higher level courses taught by leaders in the field. E.g. “Algorithms for the Real World”, “Computational Economics”, “Cryptography”, and many more.
Previous education: international student (Malaysia).
Now - analytics specialist at PulseMetrics

“...NTU SPMS has provided me with strong mathematics foundation and the right skill sets that allowed me to achieve my dream to become an analytical thinker and eventually an analytics specialist at a business intelligence consultancy firm, PulseMetrics. ...”
What is special about our programmes?

3. A commitment to innovative teaching ideas

Two examples today:

• MS8300 It’s a discreetly discrete world
• PS9888 Makers and Tinkers
What is special about our programmes?

3. A commitment to innovative teaching ideas

MH8300: It’s a discreetly discrete world - Mathematics in real-life applications.

- The purpose of this course is to provide a broad introduction to various applications of mathematics in technology, such as cryptography, search algorithms, optimization, ...
- Based on the “flipped classroom” concept.
- Students learn material (e.g. on their SPMS iPads) from 10 minute recorded “chunks”, mixed in with problems and online quizzes.
- Accompanied by a lively online discussion forum.
- Every week a face-to-face tutorial, for more in depth explorations of the material.
What is special about our programmes?

3. A commitment to innovative teaching ideas

MH8300: “It’s a discreetly discrete world - Mathematics in real-life applications”

Student Feedback:

• “It allowed me to study at my own pace and comfort. I could rewind, pause or stop the video to suit my learning progress.”

• “Awesome, I can learn it through my spare time.”

• “The recorded lectures are clear and tutors are ready to help when questions arise.”

• “I liked the forum where we can see what other people asked and the replies to it.”
What is special about our programmes?

3. A commitment to innovative teaching ideas

**PS9888: Makers and Tinkers**

- **Idea:** Students form interdisciplinary teams (with students from other divisions in SPMS) to work on projects with an element of design, fabrication, experimentation, and play.

- **SPMS has spent >$1 million equipping a maker space with 3d printers, scanners, laser cutters, etc.**

- [www.facebook.com/makersofscience](http://www.facebook.com/makersofscience)
What is special about our programmes?

3. A commitment to innovative teaching ideas

*Many more fresh teaching ideas in the pipeline...*
Enrichment opportunities
URECA

In URECA, strong students get to do some actual research and earn some money while they are doing it.

URECA = Undergraduate Research Experience on CAMPUS.
Mathematics competitions

Math competition for students with attractive prizes.

Winners represent NTU at the International Mathematics Competition.

Search for “NTU math competitions”
Mathematics competitions

2009-2012:

NTU did **better** than Cambridge, Yale

**same as** Princeton, Ecole Polytechnique

**IMC 2012, Bulgaria:**

2nd, 1st, 1st, 3rd prize
Many schemes to nurture academically ambitious students

- **URECA**
- **Math competitions**
- “**Advanced Investigation**” groups running in parallel with the core courses (typically ~10 students)
- **Self-paced study** so ambitious students can clear core topics quickly
- **Supervised Independent Study**
- **Summer research opportunities**
- **Programming competitions**
- And more...
Exchange programmes

You get a chance to spend a semester overseas.

Serena Ho, USA

Terence Ng, Canada

Dai Chenyuan, France

Jeremy Quek, Finland
Vibrant undergraduate life

Other activities at Division of Mathematical Sciences include Career Fair, Math Magic Hour, Math Clinic, Pi Day, seminar ‘Why I care about’, MAS sharing session and many more.
NTU SPMS Poly OPENHOUSE
31 January 15, Sat | 10.00am to 2.30pm

FREE KRISPY KREME DONUTS & drinks for the first 400 Early Birds
Stand a chance to win an iPad Mini at our Lucky Draw!

MAKE YOUR OWN ICE CREAM in less than 60 seconds!

INSTAGRAM CONTEST take a photo at our photobooth, upload to instagram and the best photos will win movie vouchers!

TAKE PART IN OUR VERY OWN “SPMS RUNNING MAN” solve puzzles and win prizes!

PARTICIPATE IN OUR FACEBOOK SCIENCE TRIVIA QUIZ $10 Starbucks cards to be given away to 10 lucky winners!

FREE STICKY HANDMADE CANDIES when you show us that you’re a fan of our facebook page.

For more details or to register, visit: http://tinyurl.com/SPOH15
OR
Scan the QR code on the right →