Why Get an M.Eng. in CS or Anything Else?

Prof. Charlie Van Loan
CS M.Eng. Program Director
Some Questions to Answer

- Do I need a fifth year?
- Is Entrepreneurship part of the deal?
- Is the MEng a stepping stone towards a PhD?
- What about the new 4-semester MS in CS?
- What about NYC programs at Cornell Tech?
- How do I put together a strong application?
- Should I have majored in CS?
In a Nutshell...

- There is a 2-semester CS MEng in Ithaca.
- There is a 3-semester “Medical Track” that involves work at the Cornell Medical Center in NYC.
- There is a 4-semester CS MS in Ithaca.
In a Nutshell at Cornell Tech...

- There is a 1-year CS MEng.
- There is 2-year MS in Connective Media.
- Additional 2-year MS programs are coming soon.

The Roosevelt Island Campus
In a Nutshell at Cornell Tech...

- There is a 1-year CS MEng.
- There is a 2-year MS in Connective Media.
- Additional 2-year MS programs are coming soon.
In this Presentation I will ...

- Focus on the one-year MEng.
- Discuss the difference between the Ithaca and NYC programs. (Entrepreneurship)
- Emphasize breadth of education and its importance to career development.
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- Emphasize breadth of education and its importance to career development.

Although CS-driven, what I say is relevant if you are considering ANY Masters Program in Engineering.
It’s a Crowded Space

The Bachelors

The M.Eng.

The PhD
It's a Crowded Space

The Bachelors

The M.Eng.

The PhD

Go Work

The M.B.A.
Two Bits of History

- Up until the 1960s, most undergrad degrees in Engineering were 5 years in length.

- Cornell’s first Master’s degree was awarded to David Starr Jordan. He became the first President of Stanford University (1891-1913).
What is an M.Eng. Degree?

An MEng in X is a professional degree program that emphasizes the practical application of ideas from X.
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True but...
• Being professionally strong means more than just being technically strong.
• The MEng is an occasion to refine your communication skills and your ability to work with others.
What is an M.Eng. Degree?

An MEng in X is a professional degree program that emphasizes the practical application of ideas from X.

True but...

- Practical applications sometimes require theoretical foundations.
- Pay attention to your mathematical, statistical, and logical talents.
M.Eng. Mindsets

The Entrepreneurial Mindset...

Being able (a) to identify CS problems of interest to society and (b) to develop solutions that have economic value.

Think: Start-Up Company
M.Eng. Mindsets

The Algorithmic Mindset...

Being able (a) to identify CS problems of interest to scientists and engineers and (b) to develop efficient algorithms for their solution.

Think: Being the CS person in a lab.
M.Eng. Mindsets

The Intrapreneurial Mindset...

Being able (a) to identify CS problems of interest to your company and (b) to develop solutions that have economic value.

Think: Working in development for a big company
M.Eng. Mindsets

The Social Entrepreneurial Mindset...

Being able (a) to identify CS problems of interest to society and (b) to develop solutions that have social value.

Think: Laptops for education in poverty areas.
The Dropout Mindset is OK Too!
Not polar opposites!

What it takes to apply technology is very similar to what it takes to discover something new.
1. The entrepreneur’s job is to identify a problem worth solving.
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1’. A PhD student’s job is to define a research problem worth solving.
2. Problem complexity is changing faster than technology.
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2’. Research problems are changing faster than field-specific education and can no longer be solved by homogeneous teams of look-alike experts.
3. Great entrepreneurs are able to describe a problem clearly, precisely, and with an economic description that talks about a customer and a price.
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3’. Great researchers are able to describe the “nut they cracked” in terms that can be understood by the public.
4. As an entrepreneur you need humility to know what you do not know because customers think differently, often in ways that have nothing to do with science, logic, or evidence.
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4’. As a researcher, you need humility to know what you do not know because colleagues outside your area often think in ways that are orthogonal to the traditions of your field.
Entrepreneurism & Basic Research

The Message of Ben Franklin
Properly practiced, there is no difference between

“Curiosity-Driven” Research

and

“Product-Driven” Research.
The CS M.Eng.

Now for a Few Details...
Who is it for?

- CS Majors who are hungry for more.
- Ugrads who major in X and (sort of) minored in CS.
Who is it for?

- **CS Majors who are hungry for more.**
  Need five years to be fully prepared for the work force.

- **Ugrads who major in X and (sort of) minored in CS.**
  X + CS is a powerful combination for students interested in a career in X or graduate study in X.
# What a CS Minor Looks Like

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Required</th>
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<tbody>
<tr>
<td>CS 2800</td>
<td>Discrete Math</td>
<td></td>
</tr>
<tr>
<td>CS 2110</td>
<td>Object-Oriented Prog.</td>
<td>Required</td>
</tr>
<tr>
<td>CS 3410</td>
<td>Computer Systems</td>
<td></td>
</tr>
<tr>
<td>CS 4220</td>
<td>Scientific Computing</td>
<td></td>
</tr>
<tr>
<td>CS 4320</td>
<td>Databases</td>
<td></td>
</tr>
<tr>
<td>CS 4700</td>
<td>Artificial Intelligence</td>
<td></td>
</tr>
<tr>
<td>CS 4620</td>
<td>Computer Graphics</td>
<td></td>
</tr>
<tr>
<td>CS 4780</td>
<td>Machine learning</td>
<td></td>
</tr>
<tr>
<td>CS 4830</td>
<td>Cryptography</td>
<td>(many more options)</td>
</tr>
</tbody>
</table>

*3 courses of your choosing*
CS MEng Req’ts--Briefly

A total of at least 30 credit hours that includes a 3-6 credit hour project and at least 15 credit hours of CS coursework.

Roughly six courses and a project.

All courses at the 4000-level and 5000-level. No specific course is required.
CS Courses for MEng Students

Parallel Computing
Software Engineering
Large-Scale Information Systems
Scripting Languages
Defending Computer Networks
Open Source Software Engineering
Heuristic Methods for Optimization
Cloud Computing
Computer Security
Physically-Based Animation

Computer Networking
Building Large-Scale Information Systems
Mobile Systems
Signal and Image Processing
Physical Computing
Images and Video
Technology Product Development
Psychological and Social Aspects of Connected Media
Big Data/Complex Event Proc.
The Key Attribute: Flexibility

You have the freedom to structure your course selection and project so that what you learn resonates with your career aspirations.
What You Can Emerge With…

- A broader set of CS-related skills.
- A deeper knowledge of an application area.
- An ability to work with others.
- A set of entrepreneurial skills.
- An ability to communicate technical ideas in everyday language.
Impact of Nearby Degrees

The CS Undergraduate Program

The CS PhD Program

The 5th year idea.
Background building.

The CS MEng Program

Research snapshots.
How research works.
The Cornell Environment

The University is particularly famous for

1. The way it achieves the aims of liberal education.
2. The way it promotes interdisciplinary research.

Breadth is the common denominator, and it can be an attribute of YOUR MEng if you choose.
Using Cornell

Many non-CS courses that you can take to strengthen your MEng record.

- Johnson Graduate School of Management
- Science and Technology Studies
- Information Science
- Statistical Science
- Electrical and Computer Engineering
- Operations Research
- Mathematics
<table>
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<tbody>
<tr>
<td>NCC 5500</td>
<td>Financial Accounting</td>
</tr>
<tr>
<td>NCC 5530</td>
<td>Marketing Management</td>
</tr>
<tr>
<td>NCC 5560</td>
<td>Managerial Finance</td>
</tr>
<tr>
<td>NBA 5070</td>
<td>Entrepreneurship for Scientists and Engineers</td>
</tr>
<tr>
<td>NBA 5640</td>
<td>Entrepreneurship and Business Ownership</td>
</tr>
<tr>
<td>NBA 6010</td>
<td>Electronic Commerce</td>
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Science & Technology Studies

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<tbody>
<tr>
<td>STS 4071</td>
<td>Law, Science, and Public Values</td>
</tr>
<tr>
<td>STS 6241</td>
<td>Science, Technology, and International Security</td>
</tr>
<tr>
<td>STS 6261</td>
<td>Seminar in the History of Technology</td>
</tr>
<tr>
<td>STS 6321</td>
<td>Inside Technology</td>
</tr>
<tr>
<td>STS 6661</td>
<td>Public Engagement in Science</td>
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Statistical Science

STSCI 4740  Data Mining and Machine Learning
STSCI 5010 - Applied Statistical Analysis
STSCI 5060 - Database Management and SAS High Performance Computing with DBMS
STSCI 5080 - Probability Models and Inference
Information Science

INFO 4400  Human-Computer Interaction Design
INFO 4500  Language and Technology
INFO 5150  Culture, Law, and Politics of the Internet
INFO 6140  Cognitive Psychology
INFO 6648  Speech Synthesis by Rule
<table>
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<tr>
<td>ECE 5220</td>
<td>Nonlinear System Analysis and Computations</td>
</tr>
<tr>
<td>ECE 5470</td>
<td>Computer Vision</td>
</tr>
<tr>
<td>ECE 5480</td>
<td>Digital Image Processing</td>
</tr>
<tr>
<td>ECE 5660</td>
<td>Fundamentals of Networks</td>
</tr>
<tr>
<td>ECE 5670</td>
<td>Digital Communications</td>
</tr>
<tr>
<td>ECE 5750</td>
<td>Advanced Microprocessor Architecture</td>
</tr>
<tr>
<td>ECE 5780</td>
<td>Computer Analysis of Biomed Images</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>------------</td>
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</tr>
<tr>
<td>OR&amp;IE 4350</td>
<td>Introduction to Game Theory</td>
</tr>
<tr>
<td>OR&amp;IE 4370</td>
<td>Computational Optimization</td>
</tr>
<tr>
<td>OR&amp;IE 5140</td>
<td>Applied Systems Engineering</td>
</tr>
<tr>
<td>OR&amp;IE 6500</td>
<td>Applied Stochastic Processes</td>
</tr>
</tbody>
</table>
Mathematics

<table>
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<tbody>
<tr>
<td>MATH 4240</td>
<td>Wavelets and Fourier Series</td>
</tr>
<tr>
<td>MATH 4330</td>
<td>Honors Linear Algebra</td>
</tr>
<tr>
<td>MATH 4340</td>
<td>Honors Introduction to Algebra</td>
</tr>
<tr>
<td>MATH 4370</td>
<td>Computational Algebra</td>
</tr>
<tr>
<td>MATH 4410</td>
<td>Introduction to Combinatorics I</td>
</tr>
<tr>
<td>MATH 4420</td>
<td>Introduction to Combinatorics II</td>
</tr>
<tr>
<td>MATH 4550</td>
<td>Applicable Geometry</td>
</tr>
</tbody>
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The MEng Project

- Typically an application of computer science techniques to practice.
- All projects must be supervised by a Computer Science faculty member or researcher.
- Illustrate the path from theory to practice, from classroom to product, etc.
Some Project Formats

- Participate in a faculty member’s research group
- Build upon a project started within an advanced course, perhaps in collaboration with other students from that course
- A few faculty members advertise one-on-one project openings—this might either be a smaller project or a test-run for a larger initiative
- Work as a member of one of the College’s large team efforts—there are an increasing number of these relatively high-profile projects
Some Project Formats

- A team project designed to explore an idea for a startup (often from business courses)
- Systems built on behalf of non-CS groups with challenging problems
- Projects brought to Cornell from company or military or government settings, with appropriate permissions
- Ideas of your own, but for this you still need a faculty supervisor.
The Health and Medicine Track

• **Semester 1.** In Ithaca doing courses.

• **Semester 2.** At the Weill Medical Center in NYC, get stipend, work on project.

• **Semester 3.** In Ithaca doing courses.
The (New) 4-Semester MS

Key Attributes:

- 34 credits including thesis research
- Advanced CS Coursework
- Outside Minor
- Serve as TA and receive full tuition and stipend.

Limited size at the start: about 5 students.
Sample Schedules...

Term 1: 3 CS                      (4+4+3)
Term 2: 1 CS, 1 nonCS            (4+3)
Term 3: 1 CS, 1 nonCS            (4+3)
Term 4: 1 CS, Thesis Research    (3+6)

Term 1: 2 CS, 1 nonCS            (4+4+3)
Term 2: 1 CS, 1 nonCS            (4+3)
Term 3: 1 CS, Thesis Research    (4+3)
Term 4: Thesis Research          (9)
The MS: Who is it for?

- Students who wish to deepen their knowledge of computer science through advanced coursework, research, writing, and teaching.

- Students who are self-motivated, have expository skills, enjoy the research environment, and like working with undergraduates in introductory courses.

- Students who might like to teach CS at a 4-year college.

- Students who like research but are anxious about the PhD timeline.
The MS: Admissions Criteria

• Must have been a CS major or have a CS minor.

• Must have served as ugrad grader/ta.

• 3 letters of recommendation + essay
The Cornell Tech CS M.Eng.

Same as the Ithaca CS MEng except that the entrepreneurial aspect is very explicit:

- Faculty have entrepreneurial experience.
- Tight coupling to the NYC tech scene.
- Industrial mentors for the project.
- Courses that are interdisciplinary.
- A weekly seminar on the “entrepreneurial life”
MS in Connective Media

A new 2-year program at Cornell Tech that is part of the Technion-Cornell Innovation Institute. Three semesters of courses followed by a one-semester project.

• Digital media data analytics
• Human-centered design.
• Mobile technologies.
• Social networks.
Coursework that is systematic and shows that you can handle the requirements of the grad program to which you are applying.
Building a Strong Application

Letters of Recommendation

Should speak to your independence, originality, communication skills, and ability to work with others.
The Statement of Purpose

Should show that you understand what the grad program is all about and justifies your application in terms of past experiences.
Relevant Experiences For Cornell Tech

• Been part of a startup.
• Belonged to a student organization/club related to entrepreneurship.
• Made intrapreneurial contributions to some project.
• Would like to apply CS to a real world problem.
• Worked in the non-profit/ gov’t sector and would like to return with a stronger CS background.
Hope to See You Here
Or Here!