CCCSS meeting
October 31, 2014

Transferring Courses and Students
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Based on slides & info from Jerry Richter

These slides available at http://www.cs.rutgers.edu/~lou
Outline

• Teaching Computer Science
• What we look for in transfer courses
• Current Status of the transfer program
• What transfer students find at Rutgers
Computing changes quickly

• 10 years ago
  – No iPhones or Android phones
  – Facebook not available to the public

• 20 years ago
  – No Java language
  – No Wikipedia
  – No Google Search

• Speed of change is only increasing
What can we teach that won’t change?

• Basic Principles
  – Binary Search is $O(\log(n))$, linear is $O(n)$

• Ways of thinking
  – Recursion

• How to learn on your own
  – [How can we teach this?]
Outline

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Courses that teach general concepts

• E.g., Designing interactive web pages
  – Not Flash or javaScript

• E.g., Camera Models or Focal planes
  – Not Maya 3D
What about programming languages?

• Students need to practice
  > Need to use some specific language
  > Need to learn some specific language
What about programming languages?

• It is ok to use specifics as examples
  – teach specific => general
  – As long as you eventually generalize

• Programming / Language so big that it takes several semesters to get to general
What about programming languages?

- We teach mostly the generic aspects of Java
  - To switch my slides Java -> C++, 90% need only syntax change
  - E.g., we try to say as little as possible about packages
What specific topics do we look for

- For “Intro to CS” (198 :111)
  - Java [variables, types, ifs, loops, subroutines, arrays]
  - Sorting [insertion or selection, merge or quick]
  - Recursion
  - Asymptotic Complexity / Big-O

- We do not look for much on objects
  - In 111 we do inheritance and polymorphism in one lecture
What specific topics do we look for

• For “Data Structures” (198 :112)
  – Linked lists,
  – Stacks, queues
  – Trees, Binary trees, [Balanced] binary search trees
  – Hash tables, Heaps
  – Graphs and graph algorithms
  – Sorting algorithms
  – Asymptotic analysis of time and space requirements throughout
What specific topics do we look for

• For “Intro to Discrete Structures I” (198 :205)
  – Crucial:
    • Propositional Logic, Truth Tables, Boolean Circuits
    • First-Order Logic, Predicates, Quantifiers
    • Mathematical Induction, Program Correctness
  – Less so:
    • Basic Set Notation
    • Relations: Closures of relations. Orders, Equivalence Relations, Functions
    • Finite-State Machines
What specific topics do we look for

• For “Computer Architecture” (198 :211)
  – Data representation and computer arithmetic
  – Assembly language programming
  – Boolean algebra
  – Basic digital logic design
  – Instruction sets
  – Processors: Pipelining
  – Memory hierarchy: registers, RAM, cache, disk
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Rutgers CS courses for which transfer credit can be earned at NJ County Colleges

Non-major course
   110: Introduction to Computers & Applications (17/19)

Courses which count toward the major
   111: Introduction to Computer Science (8)
   112: Data Structures (5)
   205: Discrete Structures I (10)
   211: Computer Architecture (5)
What NJ county college courses should a prospective Rutgers CS major take?

Answer…

those transferring as math 151, 152, 250 and CS 111, 112, 205, 211, to the extent such courses are available
## County College courses for prospective Rutgers CS majors

<table>
<thead>
<tr>
<th></th>
<th>Math 151</th>
<th>Math 152</th>
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Contribution to total growth in science and engineering occupations, 2010-2020

- Computer Occupations: 62%
- Engineers: 13%
- Drafters, Engineering Technicians, and Mapping Technicians: 4%
- Architects, Surveyors, and Cartographers: 4%
- Mathematical Science Occupations: 1%
- Life Scientists: 5%
- Physical Scientists: 3%
- Life, Physical, and Social Science Technicians: 3%
- Social Scientists and Related Workers: 5%
Science and engineering workforce projections, 2010-2020

- **New jobs**
- **Job openings, new + replacements**

<table>
<thead>
<tr>
<th>Year</th>
<th>Jobs</th>
<th>Openings</th>
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<tbody>
<tr>
<td>15-1100</td>
<td>800K</td>
<td>1.4M</td>
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<tr>
<td>17-2000</td>
<td>400K</td>
<td>500K</td>
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<tr>
<td>19-1000</td>
<td>200K</td>
<td>300K</td>
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<tr>
<td>19-2000</td>
<td>100K</td>
<td>150K</td>
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<td>19-3000</td>
<td>50K</td>
<td>75K</td>
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</tbody>
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**Computer Occupations**
### Best Paying College Majors
**National Association of Colleges and Employers**  
**January 2013**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Major</th>
<th>Average Starting Salary</th>
<th>Forecast Job Growth through 2020</th>
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<tbody>
<tr>
<td>1</td>
<td>Computer Engineering</td>
<td>$70,400</td>
<td>30%</td>
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<tr>
<td>2</td>
<td>Chemical Engineering</td>
<td>66,400</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Computer Science</td>
<td>64,400</td>
<td>19</td>
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<tr>
<td>4</td>
<td>Aerospace Engineering</td>
<td>64,000</td>
<td>5</td>
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<tr>
<td>5</td>
<td>Mechanical Engineering</td>
<td>62,900</td>
<td>9</td>
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<tr>
<td>6</td>
<td>Electrical Engineering</td>
<td>62,300</td>
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<tr>
<td>7</td>
<td>Civil Engineering</td>
<td>57,600</td>
<td>19</td>
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<tr>
<td>8</td>
<td>Finance</td>
<td>57,300</td>
<td>?</td>
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<tr>
<td>9</td>
<td>Construction Science/Mgmt.</td>
<td>56,600</td>
<td>17</td>
</tr>
<tr>
<td>10</td>
<td>Information Sciences</td>
<td>56,100</td>
<td>19</td>
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</table>
What is the Computer Science Department like?

Big

– About 40 full time faculty members
– 259 declared undergrad majors (A.Y. 2012/2013)
– 131 u.g. majors graduated (A.Y. 2012/2013)
What is the Computer Science Department like?

And growing
Enrollments in Rutgers CS Major Courses
Size is

A problem

<table>
<thead>
<tr>
<th>Level</th>
<th>2010 / 11</th>
<th>2012 / 13</th>
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<tbody>
<tr>
<td>1xx</td>
<td>70</td>
<td>138</td>
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<td>2xx</td>
<td>44</td>
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<td>3xx</td>
<td>40</td>
<td>63</td>
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<tr>
<td>4xx</td>
<td>25</td>
<td>32</td>
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Size is

An advantage
• Active student groups
  – USACS, Women in CS
  – Clubs on developing games, mobile apps
• Resources and Activities
  – The CAVE
  – HackerSpace
  – HackRU hackathon

See [www.cs.rutgers.edu/~lou](http://www.cs.rutgers.edu/~lou) for urls
May 2013 computer science graduates

- 135 bachelors degree recipients
- 81% BS, 19% BA
- 30 completed additional majors in…

  - Mathematics (14)
  - Physics (4)
  - Economics (4)
  - Electrical & Computer Engineering (4)
  - Information Technology (2)
  - Linguistics (2)
  - History
  - Molecular Biology & Biochemistry
  - Visual Arts
Required CS and math courses (BA and BS)

Math 151: Calc 1
  “ 152: Calc 2
  “ 250: Linear Algebra

CS 111: Introduction to Computer Science
  “ 112: Data Structures
  “ 205: Discrete Structures I
  “ 206: Discrete Structures II
  “ 211: Computer Architecture
  “ 344: Design and Analysis of Computer Algorithms
Electives

• Software Methodology
• Systems Programming
• Principles of Programming Languages
• Numerical Analysis and Computing
• Intro to Imaging and Multimedia
• Principles of Information and Data Management
• Internet Technology
• Computer Architecture II
• Compilers
• Operating Systems Design
• Distributed Systems: Concepts and Design
• Computer Security
More Electives

• Intro to Computer Graphics
• Software Engineering
• Database Systems Implementation
• Formal Languages and Automata
• Topics Courses (vary)
  – Cryptography
  – Data mining
  – Probabilistic Algorithms
• Independent Study
• Selected Courses offered by Mathematics or Electrical and Computer Engineering
Computer Science elective tracks
Advisory, not requirements

1. Computer Security
This track studies the principles behind and the design, implementation, and maintenance of secure computing systems.

**Required:** 214, 314, 416, 419
**Chose at least one from:** 336, 352, 411, 415, 417, 431, 436
**Recommended:** 415, 452, ECE 424 or Math 348
2. Software Engineering and Information Management
This track studies the principles, tools, and techniques used in specifying, designing and implementing modern application software, including ones for managing and processing information.

Required: 213, 336, 431
Choose at least one from: 352, 417
Choose at least one from: 214, 314, 352, 415, 416, 417, 419, 437
Recommended: 214, 437
Computer Science elective tracks

3. Computer and Software Systems
This track studies the major components that comprise today's computing platform (i.e., the components that together present the current programming interface seen by most application developers). These include computer architecture, operating systems, languages and compilers, and database

Choose at least one from: 213, 214
Choose at least three from: 314, 336, 352, 411, 415, 416, 417, 419, 437
Computer Science elective tracks

4. Graphics and Vision
This track studies the mathematical foundations and practical implementations of computer graphics and computer vision technologies and applications.

Required: 323, 334, 428
Recommended: 214, 314, 523
Computer Science elective tracks

5. Artificial Intelligence and Cognitive Science

**Required:** 314, 440, 336

**Choose at least two from:** the Philosophy, Linguistics, Statistics, and Math 355 and Math 461 courses from the designated list of courses in Computer Science and Related Disciplines.
Computer Science elective tracks

6. Computing Concepts and Themes
This track studies the theoretical foundations underlying computing and explores a variety of computing disciplines (e.g., vision, data management, and artificial intelligence)

Required: 323, 452
Choose at least two from: 314, 334, 336, 352, 440
CS 493/494: Independent Study

Enrolled 24 students in AY 2012-2013

Projects …

- speech synthesis using AI
- data mining
- control of autonomous underwater vehicles
- intelligent mobile apps
- sensor networks
- private cloud computing infrastructure
- battery powered computing environments
- encryption for queries
- viewing of medical records
- modeling of uncertainty in language
- music composition on online social networks
CS 395: Internship in CS

Counts toward CS major requirements

CS majors have done internships at Johnson & Johnson, Merck, SEI, AT&T, Citicorp, Google, others
What jobs for Rutgers CS grads?

- Financial
- Pharmaceutical
- Telecom
- Search engines
- Small companies, start-ups
Some students go to graduate school

- Berkeley, Princeton, Cornell, …
Computer science vs. related Rutgers programs

**Computer engineering…**
- greater emphasis on hardware vs. software
- many more required courses than for CS
- few general elective choices for students
- some CE students pursue dual degree in CS,
  made easier by ‘double-counting’ possibilities
Computer science vs. related Rutgers programs

Information technology and informatics program
(School of Communication and Information)

- use and management of information technologies within organizations
- little emphasis on CS principles (e.g., no required math)
- little overlap with CS (or CE)