University of Virginia
Department of Computer Science

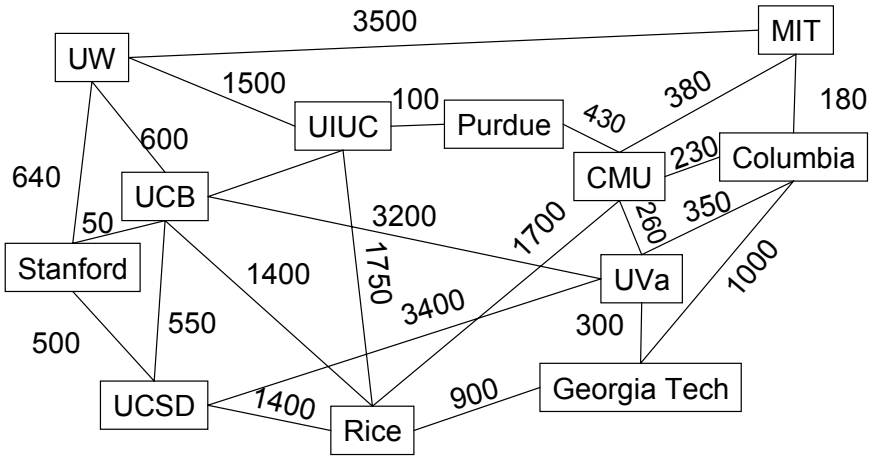
Prospective Graduate Students Pre-Qualifying Exam
1 April 2005

There was an unfortunate misunderstanding when the Dean's office informed the Computer Science department that we could admit 25 new graduate students this year. The CS admissions committee naturally interpreted the limit number as hexadecimal, and admitted thirty-seven new graduate students. Apparently, the Dean's office intended the number to be interpreted as decimal, so we admitted 12 more students than permitted. As a result, we are administering this exam to the admitted students to determine which students should be unadmitted.

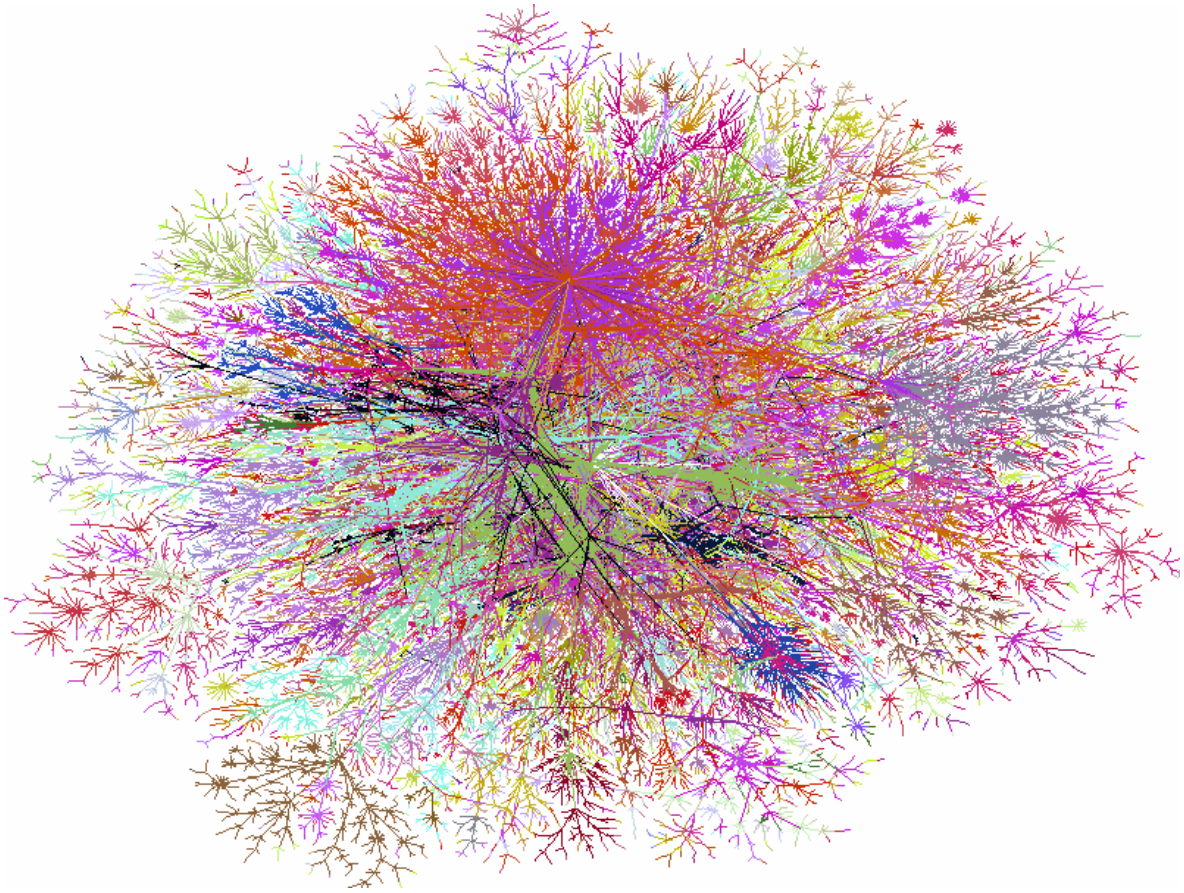
This exam has two questions in each of our three qualifying areas: theory, architecture and systems. Please answer all questions to the best of your ability and submit your answers before 11:59PM on Friday, April 1st 2005. If more than 25 students answer all questions correctly, Pete Gillen has offered to conduct a basketball shoot-around tomorrow morning to determine which of the remaining students should be unadmitted. In the event that you are unadmitted, we are no longer able to pay your travel expenses for the visit day. Please send a reimbursement check (or the equivalent in whisky) to Louminary Sofa, Apartment of Commuter Science, University of East Virginia, 151 Reengineer's Way, 204 Olsson Hall, Charlottansville, VA 22901.

Theory

1. Traveling Prospective Grad Student Problem. Ally Hacker has been admitted to several computer science PhD programs and is planning a trip to visit all of the schools she might want to attend. A map of the programs that have admitted Ally is below. The lines on the edges indicate the mileage between each school. Determine the best possible route for Ally to visit all worthwhile schools. Provide an algorithm for Ally can use do determine which graduate school to attend that has worst case execution time $O(n)$ where n is the number of schools that have admitted Ally.



2. Graph Coloring. The graph below is a map of the Internet in 1998 made by Bill Cheswick and Hal Burch. Is this graph 3-colorable? Prove or disprove.



Architecture

3. Branch Prediction and Caching. When Jefferson designed the lawn pavilions, he used all the different styles of columns so computer architecture classes could observe the different design decisions just by walking down the lawn. Explain the performance tradeoffs an architect should consider when deciding between a direct mapped Doric column, a 4-way associative Ionic column, and a fully associative Corinthian column.

4. Instruction Sets. What will the following byte sequence (written in hexadecimal notation) produce when executed on an Intel Xeon MP 2.8GHX (BX80532KC2800F) processor?

```
EB FE ED DE AD BE EF F0 0D D0 0D 88
```

Systems

5. Cryptography. Consider the following the standard C program written by Mark Schnitzus.

```
main(l,i,I)char**i;{l/=!(l>(I=atoi(*++i))
   ||fork()&&main(l+1,i-1)||I%l);
   return printf("%d\n",l);}
```

a. What output will it produce when executed with parameter 35?

b. On a machine with *infinite resources*, what output would it produce when executed with the parameter below (this is one number split into multiple lines)? (Note: $100,000 bonus for correct answer.)

```
135066410865995223349603216278805969938881475605667027524485143851526510604859533833940287150571909441798207282164471551373680419703964191743046496589274256239341020864383202110372958725762358509643110564073501508187510676594629205563685529475213500852879416377328533906109750544334999811150056977236890927563
```

6. Programming Languages.

a. Describe or make up a naming myth for each of the following languages (sometimes an incorrect creative answer is better than a correct dull answer): APL, BLISS, Forth, JOVIAL, Scheme, SNOBOL.

b. For each system, identify the language in which it was programmed: AWACS (air defense), Multics, WorldWideWeb (first Web server & browser), X-Windows.

END OF EXAM