Networked Life
CSE 112
Prof. Michael Kearns
Final Examination
May 6, 2005

The final exam is closed-book; you should have no materials present other than the exam and a pen or pencil.

NAME: ___________________________________

PENN ID: __________________________________

Exam Score:

Problem 1:__________/10
Problem 2:__________/10
Problem 3:__________/12
Problem 4:__________/10
Problem 5:__________/12
Problem 6:__________/10
Problem 7:__________/12
Problem 8:__________/12
Problem 9:__________/12

TOTAL:____________/100

1. (10 points, 1 point each) For each item on the left, write down the number of the item on the right that it is most closely associated with.

a) Stanford Prison Experiment: _____	1. central limit theorem
b) alpha model: _____	2. friends of friends
c) contagion: _____	3. dynamics of transmission
d) social capacity: _____	4. Zipf's Law
e) convergence to expectation: _____	5. power of context
f) North American city sizes: _____	6. Caveman and Solaria
g) threshold for monotone graph properties: _____	7. the magic number 150
h) clustering coefficient: _____	8. threshold for participation
i) mixed strategy: _____	9. randomization
j) volleyball: _____	10. formalization of tipping

2. (10 points) As precisely and as generally as you can, define the notion of the "Price of Anarchy" in economic and game-theoretic settings. Give an example from class materials in which the Price of Anarchy was relatively high, and another example in which it was relatively low. Briefly discuss the Price of Anarchy as applied to the Prisoner's Dilemma.

3. (12 points) On the following page is the output of an invocation of the traceroute program discussed in class.

a) (2 points) What is the IP address of the destination?

b) (10 points) In two or three paragraphs in the space below, discuss the technological, organizational, economic and geographic inferences one can draw from this output. You should refer to specific parties appearing in the output to illustrate your discussion.

traceroute output for Problem 3:

```
C:\Documents and Settings\Administrator>tracert cs.berkeley.edu

Tracing route to cs.berkeley.edu [169.229.60.161]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  subnet-50-router.seas.upenn.edu [158.130.50.1]
  2     1 ms     1 ms     1 ms  INTERNAL-BORDER-ROUTER.CIS.upenn.edu [158.130.21
.2]
  3     2 ms     1 ms     1 ms  EXTERNAL-BORDER-ROUTER2.CIS.upenn.edu [158.130.2
1.14]
  4     2 ms     2 ms     2 ms  ISC-GW-FE.CIS.upenn.edu [158.130.20.4]
  5     3 ms     3 ms     2 ms  EXTERNAL-GE2.ROUTER.UPENN.EDU [165.123.217.1]
  6     2 ms     2 ms     3 ms  local.upenn.magpi.net [198.32.42.249]
  7     3 ms     2 ms     2 ms  phl-02-01.backbone.magpi.net [216.27.100.221]
  8     5 ms     5 ms     5 ms  remote.oc48.abilene.magpi.net [216.27.100.22]
  9    31 ms    25 ms    25 ms  chinng-nycmng.abilene.ucaid.edu [198.32.8.82]
 10    29 ms    29 ms    48 ms  iplsng-chinng.abilene.ucaid.edu [198.32.8.77]
 11    43 ms    40 ms    38 ms  kscyng-iplsng.abilene.ucaid.edu [198.32.8.81]
 12    55 ms    53 ms    48 ms  dnvrng-kscyng.abilene.ucaid.edu [198.32.8.13]
 13    73 ms    73 ms    73 ms  snvang-dnvrng.abilene.ucaid.edu [198.32.8.1]
 14    82 ms    81 ms   104 ms  losang-snvang.abilene.ucaid.edu [198.32.8.94]
 15    81 ms    81 ms    81 ms  hpr-lax-gsr1--abilene-LA-10ge.cenic.net [137.164
.25.2]
 16    91 ms    90 ms    90 ms  sac-hpr--lax-hpr-10ge.cenic.net [137.164.25.11]

 17    92 ms    92 ms    92 ms  oak-hpr--sac-hpr-10ge.cenic.net [137.164.25.16]

 18    93 ms    92 ms    96 ms  hpr-ucb-ge--oak-hpr.cenic.net [137.164.27.130]
 19   115 ms   114 ms    94 ms  vlan190.inr-202-doecev.Berkeley.EDU [128.32.0.39
]
 20    93 ms    92 ms    93 ms  doecev-soda-br-6-4.EECS.Berkeley.EDU [128.32.255
.170]
 21    95 ms    94 ms    94 ms  sbd2a.EECS.Berkeley.EDU [169.229.59.226]
 22   116 ms    94 ms    94 ms  soda-cr-1-2-cory-cr-1-1.EECS.Berkeley.EDU [169.2
29.59.234]
 23    94 ms    95 ms    94 ms  mx1.EECS.Berkeley.EDU [169.229.60.161]

Trace complete.
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4. (10 points) The 1999 AltaVista web crawl study discussed in class and the readings identified five components of the web graph according to their different connectivity properties. For each of these five components, give its name, briefly describe what constitutes a web page being a member of that component, and give an example of either a specific web page or a type of web page that you might expect to find in that component.

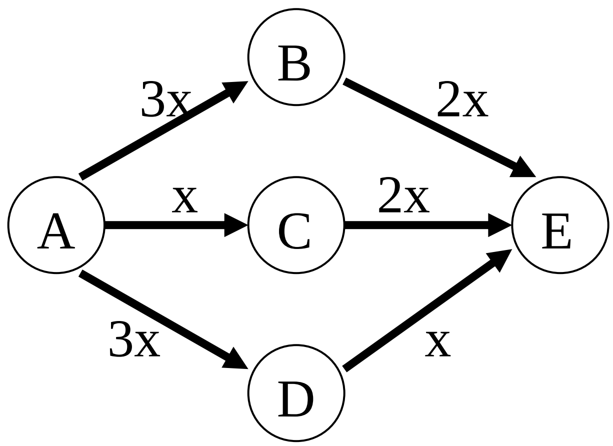
5. (12 points) For each of the current problems or challenges regarding the use or management of the Internet, briefly describe a potential solution that can be viewed as having an economic or financial flavor, and that can be administered in a relatively distributed, decentralized fashion.

a) (4 points) e-mail spam

b) (4 points) free-riding in peer-to-peer file sharing

c) (4 points) lack of quality-of-service guarantees for high-bandwidth, real-time applications

6. (10 points) Consider the network diagram below, and suppose that a large volume of traffic (say, Internet packets or drivers on freeways) would like to travel from vertex A to vertex E. Each directed edge in the network is annotated by the latency or delay that traffic will suffer on that edge if a fraction x of the total volume is traveling that edge. Assume that each packet or driver is selfish, meaning that it will always travel a route from A to E that minimizes its own total latency, given the behavior of the rest of the traffic population.



a) (5 points) For the three possible paths A-B-E, A-C-E, A-D-E, write down the order of these paths according to how much of the total volume of traffic they carry at equilibrium, from the most to the least traffic. For the path carrying the least traffic in this ordering, will it carry *any* traffic at equilibrium?

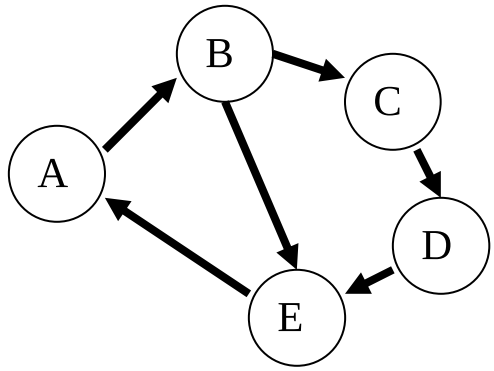
b) (5 points) Suppose that we add a directed edge from C to D, thus creating a new path A-C-D-E. Suppose that this new edge from C to D is a "teleport" edge, meaning it has zero latency no matter how much traffic it carries. As in part a), order the four paths according to how much traffic they carry at equilibrium, from the most to least traffic. For the path carrying the least traffic in this ordering, will it carry *any* traffic at equilibrium?

7. (12 points) One of the major themes of the course was the distinction between the "dynamics of transmission" and the "dynamics of rationality".

a) (6 points) Briefly describe what is meant by the dynamics of *transmission*, and give at least two examples (either from course materials or from the real world). You should make sure your answer is clearly distinguished from your answer to part b).

b) (6 points) Briefly describe what is meant by the dynamics of *rationality*, and give at least two examples (either from course materials or from the real world). You should make sure your answer is clearly distinguished from your answer to part a).

8. (12 points) Consider the following directed network diagram:



a) (3 points) Which vertex do you think has the highest PageRank in this network? Briefly justify your answer in terms of the properties of the algorithm. (You do not need to numerically calculate anything.)

b) (3 points) Which vertex has the highest hub weight in this network? Briefly justify your answer in terms of the properties of the algorithm. (You do not need to numerically calculate anything.)

c) (3 points) If your answers to a) and b) above were different, discuss what it is about the PageRank and Hubs and Authorities algorithms that causes them to choose different vertices.

9. (12 points) This question examines concepts in behavioral game theory.

a) (3 points) Briefly describe the Ultimatum Game, and describe its Nash equilibrium

b) (3 points) Briefly describe the behavioral findings on the Ultimatum Game, and discuss the systematic ways in which they differ from Nash equilibrium.

c) (3 points) Briefly describe some known factors or settings in which the systematic results of part b) are violated.

d) (3 points) Briefly describe the theory of inequality aversion, and how it modifies the classic concepts of game theory.