FINAL EXAMINATION

Networked Life
CIS 112
Prof Michael Kearns

May 7, 2008

This is a closed-book examination. You should have no materials on your desk other than this exam and a pen or pencil.

YOUR NAME: ________________________

Problem 1 _______/10

Problem 2 _______/10

Problem 3 _______/10

Problem 4 _______/15

Problem 5 _______/10

Problem 6 _______/10

Problem 7 _______/10

Problem 8 _______/15

Problem 9 _______/10

TOTAL: _______/100

Problem 1 (10 Points) For each item on the left, write the index of the item on the right which matches best.

a. kings and pawns ____	1. market for lemons
b. Gladwell ____	2. a model for network clustering
c. maximum social welfare ____	3. money
d. IDS ____	4. mixed strategy equilibrium

e. Poisson distribution ____

f. Caveman & Solaria ____

g. 1/3 for selfish routing ____

h. they always “tip” ____

i. IP ____

j. iterated dominance ____

k. Travers & Milgram ____

l. every game has one ____

m. result of top-down design ____

n. information asymmetry ____

o. alpha = 2 ____

p. encodes all pair-wise exchange rates ____

q. trivial for centralized computation ____

r. early exit routing ____

s. rock paper scissors ____

t. frequency of English words ____

5. “knife’s edge” result

6. full / no investment at equilibrium

7. exponential decay from the mean

8. independent set

9. best effort packet delivery

10. telephony network

11. price of anarchy

12. the most M.K. pays out

13. peering agreements

14. six degrees of separation

15. has no pure strategy equilibrium

16. monotone graph properties

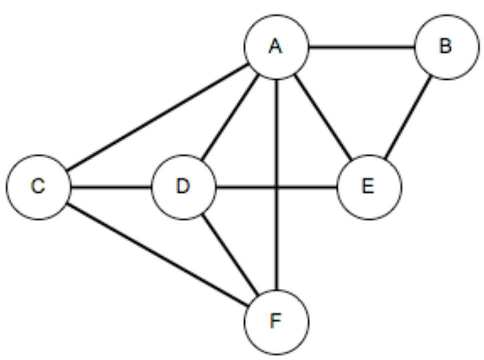
17. power law distributed

18. fads as epidemics

19. beauty contest game

20. consensus

Problem 2 (10 points)



For the network above:

a) What is the value of the worst case diameter?

b) What is the maximum degree?

c) What is the minimum degree?

d) Which node has the smallest clustering coefficient and what is its value?

e) Determine whether there exists a perfect matching and if so, list the corresponding pairs of vertices.

Problem 3 (10 points) Give a real-world example, other than those discussed in class or the readings, of a "rich get richer" phenomenon, in which parties already possessing a larger amount of some resource are differentially advantaged in obtaining more of it. Discuss what you think might be the resulting distribution of this resource across the population.

Any reasonable example here OTHER than preferential attachment for network formation and degree distribution. Their example should clearly have the property that those with more "stuff" are arguably more likely to get even more; they should ideally say something to support this, or it should be self-evident. Presumably these processes should lead to heavy-tailed distribution (not necessarily power law).

Problem 4 (15 points) During the course we examined both stochastic (or randomized) models of network formation, and game-theoretic ones. Briefly discuss the main commonalities and differences between these two broad classes of models, illustrating your discussion with at least one example of both a stochastic and a game-theoretic formation model. What do we mean for each of these models when we say that it generates networks with a particular property (for instance, small diameter)?

Commonalities: both describe distributed, decentralized NW formation w/o any master plan or centralized authority; edge "decisions" are made by individual vertices (in the sense that we can view the vertices as choosing edges, either randomly or game-theoretically). This is a partial list, any reasonable common property is acceptable.

Differences: the obvious one (random vs rational edge choice); in stochastic models the edges chosen are unconstrained by global behavior, while in GT models there is the global equilibrium constraint; again a partial list

Example: be sure they use legitimate examples of mathematical NW formation models discussed in class

Generating properties: for stochastic models, we mean that a NW chosen at random according to the model will have the property with high probability; for GT models, we mean that all Nash equilibria of the formation game have the property.

Problem 5 (10 points) Give a real-world example, other than those discussed in class or the readings, of an "unhappy equilibrium": a situation in which most or all of a large population is unhappy, but no individual can unilaterally improve things for themselves.

Any plausible example here that is well-argued is acceptable OTHER than those discussed in class or Schelling (you'll have to check his examples).

Problem 6 (10 points) Describe and discuss two games (in the formal sense of game theory) in which it is known that human subject behavior deviates from equilibrium predictions, and discuss the nature of this deviation.

I am expecting Ultimatum Game, Beauty Contest Game (the one we did in class where the target is 2/3 the average), and possibly the behavioral experiments in networked trade. All are acceptable. In ultimatum and NW trade, inequality aversion is a main deviation, but there are others described in the slides/reading (you will have to check) that are acceptable. For Beauty Contest, the main finding is the limited number of rounds of iterated reasoning people perform.

Problem 7 (10 points) The image on the following page is reproduced from the lecture on behavioral network games in which players are incentivized to agree with the color of their neighbors (consensus).

(a) Describe the underlying network structure that accompanies this image.

Chain of 6 6-cliques. It's OK if they don't mention the possibility of some random rewiring (or if they do). See class slides.

(b) As precisely as you can, describe what the image is showing (i.e. what are the x and y coordinates and the meaning of the colors).

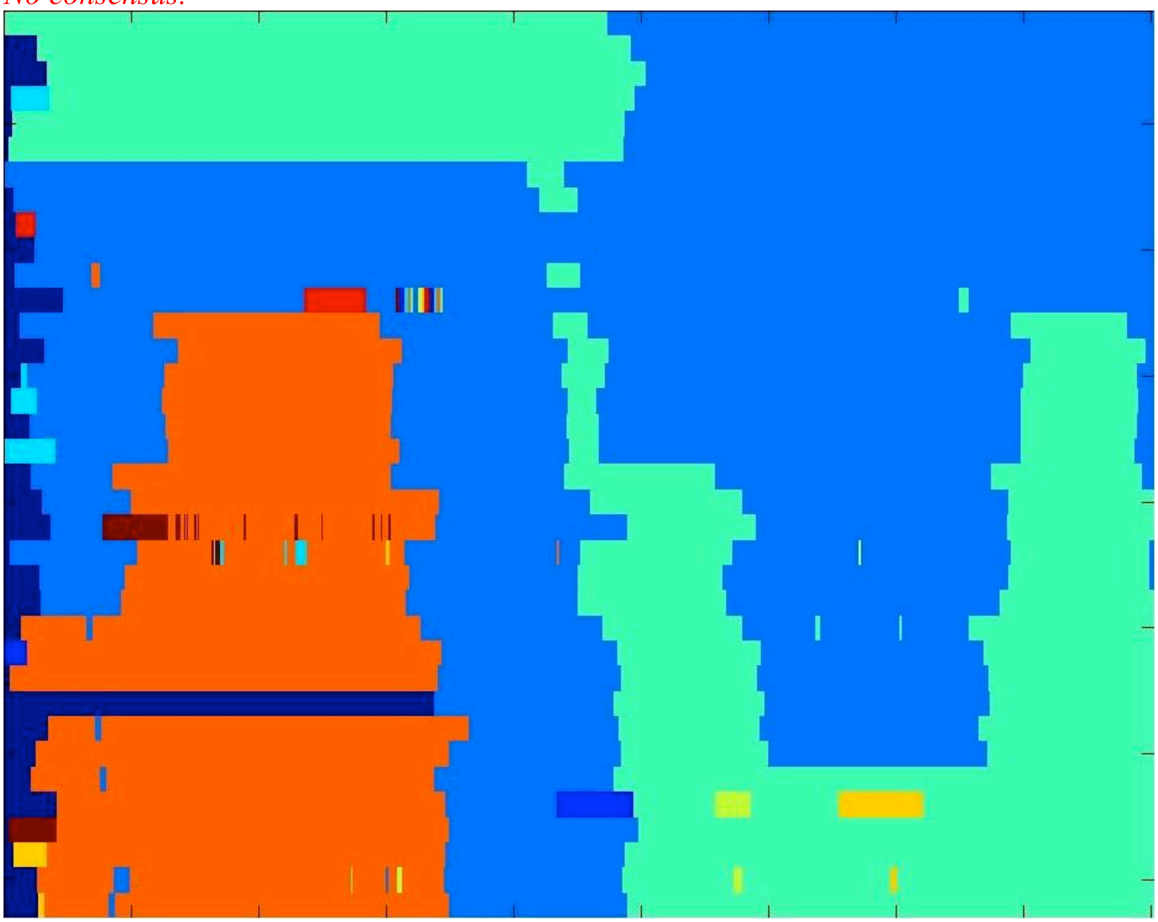
For a single experiment: x-axis is time in the experiment, y-axis has one row for each of 36 players, value shown is color of that player at that time. See class slides.

(c) Discuss interesting instances of both collective and individual dynamics represented in the image.

There are many and they were discussed in class; obvious individual signaling and stubbornness; collective block structure induced by NW structure; and the obvious oscillation between two colors that results in no consensus.

(d) What was the final outcome of this experiment?

No consensus.



Problem 8 (15 points) The two plots labeled (1) and (2) on the following page are reproduced from the lectures and paper on behavioral experiments in networked trade.

(a) Precisely describe what each circle represents, and the meaning of the x and y coordinates in each diagram. Be sure to clearly describe both plots (1) and (2).

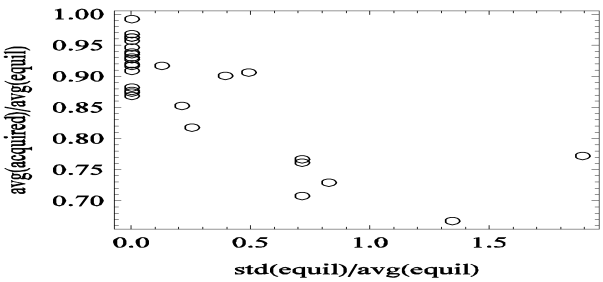
See detailed discussion in accompanying paper.

(b) Describe the overall phenomenon or finding being illustrated by each diagram.

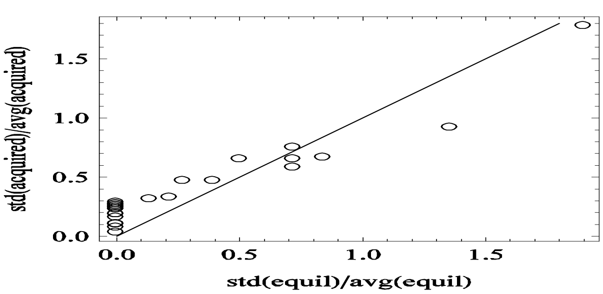
See paper.

(c) Discuss how these findings agree and/or disagree with equilibrium theory.

See paper.


avg(acquired)/avg(equil)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.0
0.5
1.0
1.5
std(equil)/avg(equil)

(1)


std(acquired)/avg(acquired)
1.5
1.0
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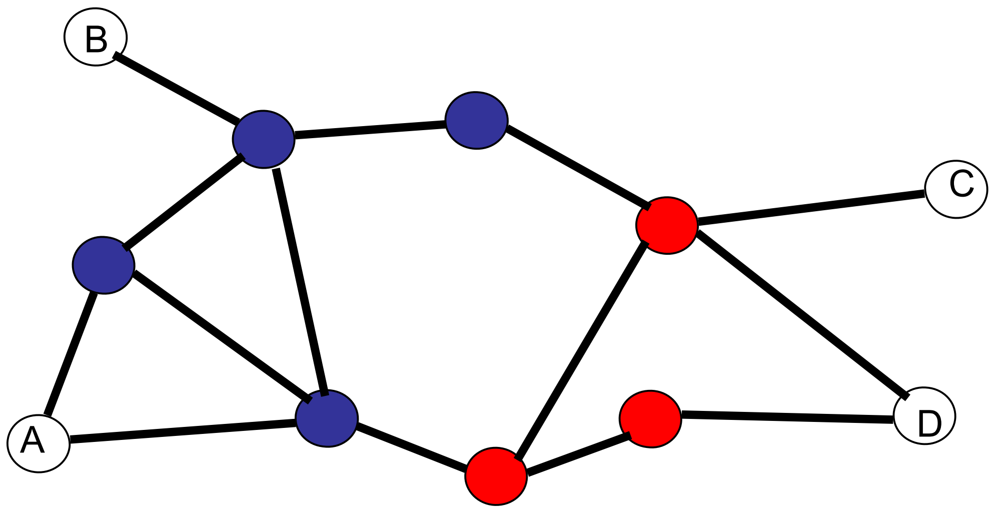
0.5
1.0
1.5
std(equil)/avg(equil)

(2)



Problem 9 (10 points) The network diagram above shows 4 Internet end-users: A, B, C and D. Users A and B have their Internet service provided by Provider Blue, who operates the routers shown in blue, while users C and D have their Internet service provided by Provider Red, who operates the red routers. Providers Red and Blue operate independently, and each has the incentive to get traffic destined for parties on the other network off of their own network as quickly as possible (that is, with the fewest hops).

Will the combined routing behavior of Providers A and B guarantee that all traffic between all pairs of end users will always travel on a *globally* shortest path? Answer yes or no. If your answer is no, give a specific counterexample to global optimality.

No. The counterexample I had in mind was traffic sent from D to A: the globally shortest route just follows along the bottom (two red hops, one blue hop, length 4), while under early-exit routing, it first goes to the upper red router, resulting in a path length of 5. There may be other examples; you'll have to check them carefully. Also note that the counterexamples may NOT be symmetric --- e.g. traffic from A to D above DOES achieve the global optimal under early-exit routing. They should be docked points if they exhibit confusion about this (though it is fine as long as their example is unidirectional and they don't mention it).