Some Analysis of Coloring Experiments and Intro to Competitive Contagion Assignment

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Networked Life

NETS 112

Fall 2014

Coloring Assignment: Experimental Design

- 30 graphs total
- 10 each from the following generative models
  - Erdos-Renyi
  - Small Worlds (multi-hop cycle with rewirings)
  - Preferential Attachment
- Controlled to keep number of edges and vertices constant
- Also designed graphs to elicit different running times for heuristics

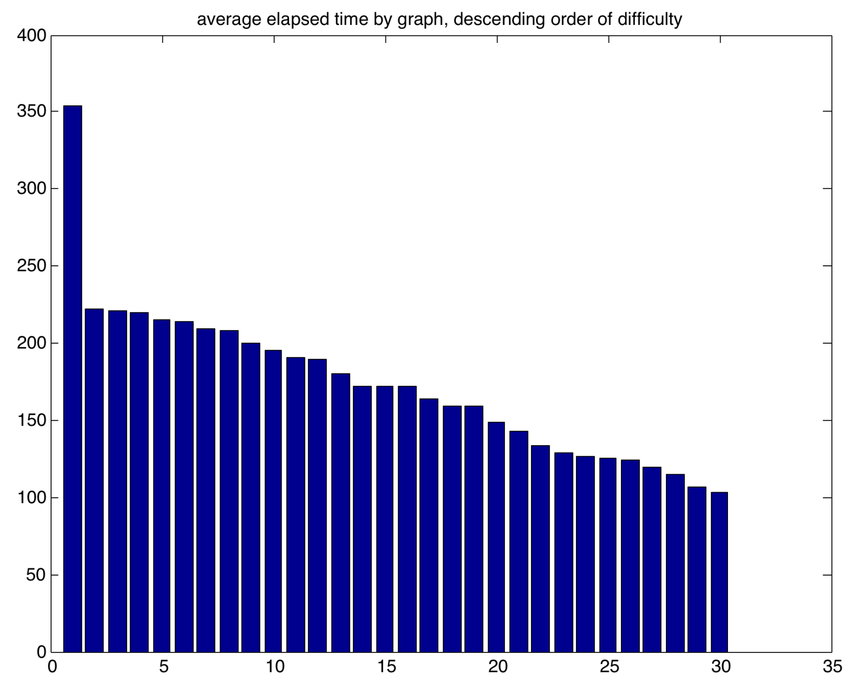
Are Some Families Harder Than Others?

1.1.2 Comparing graph families

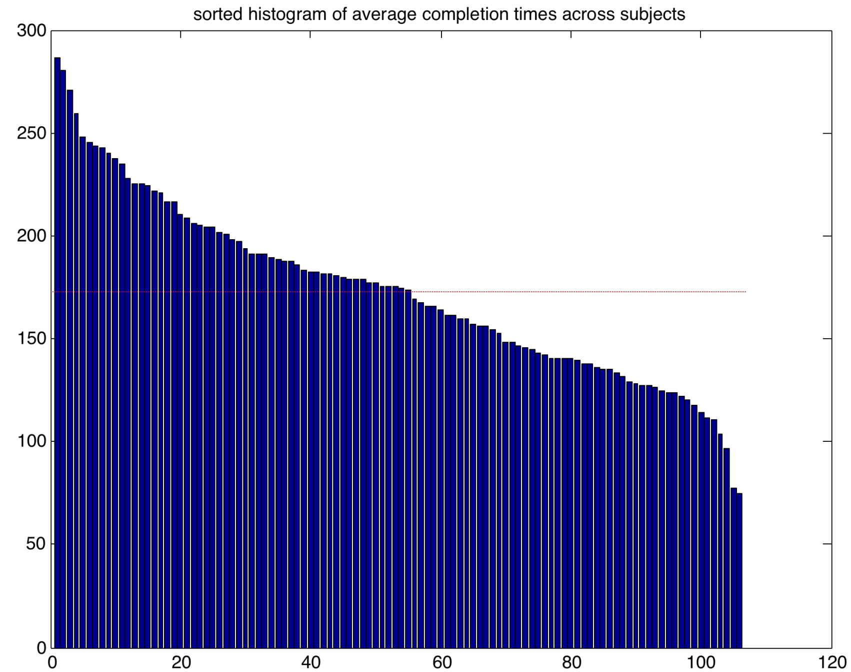
	Ave Elapsed	Ave # Attempts	Ave # Conflicts
Random	163.85	1.18	28.07
Pref Att	157.37	1.1520	33.54
Sm World	196.56	1.3697	46.94

Ordering Small World > Erdos-Renyi > Preferential Attachment holds with each pairwise comparison passing $P < 0.05$ significance.

Are Some Graphs Harder Than Others?



Are Some Players Better Than Others?



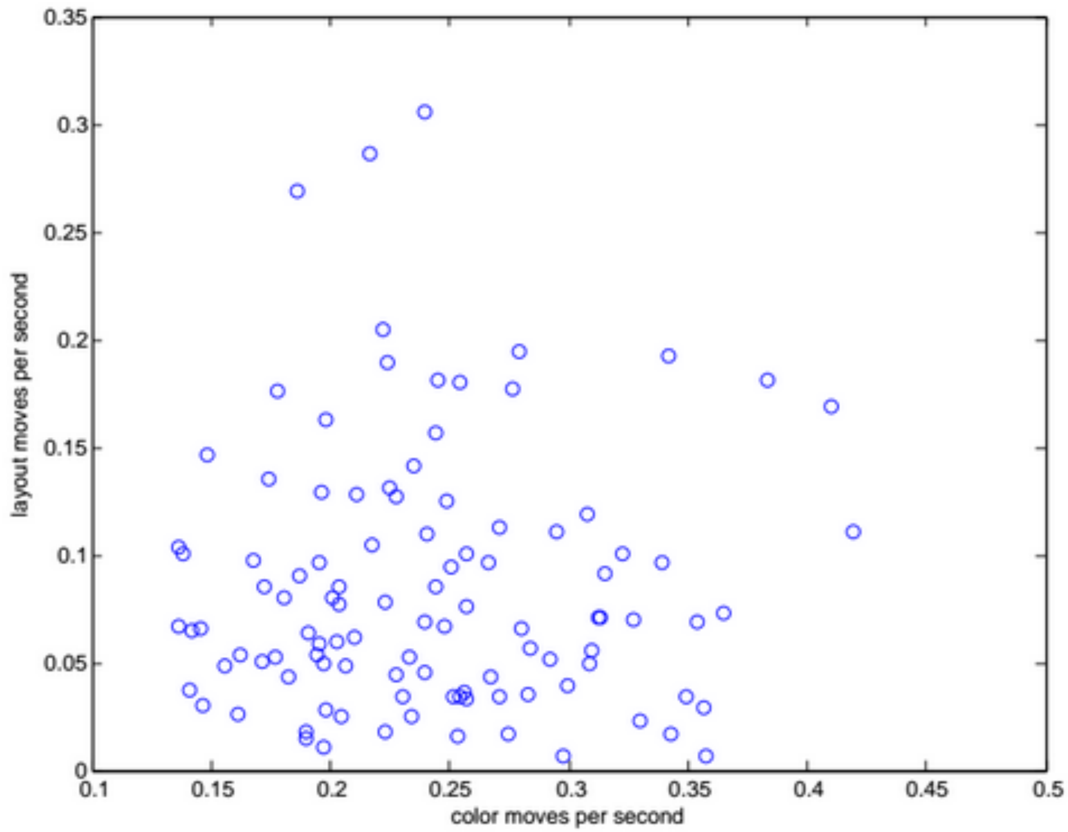
What Correlates With Population Solution Time?

Methodology: Create vector of 30 population average solution times; Correlate with properties of graphs or other population properties.

1.1.1 Correlations with elapsed time

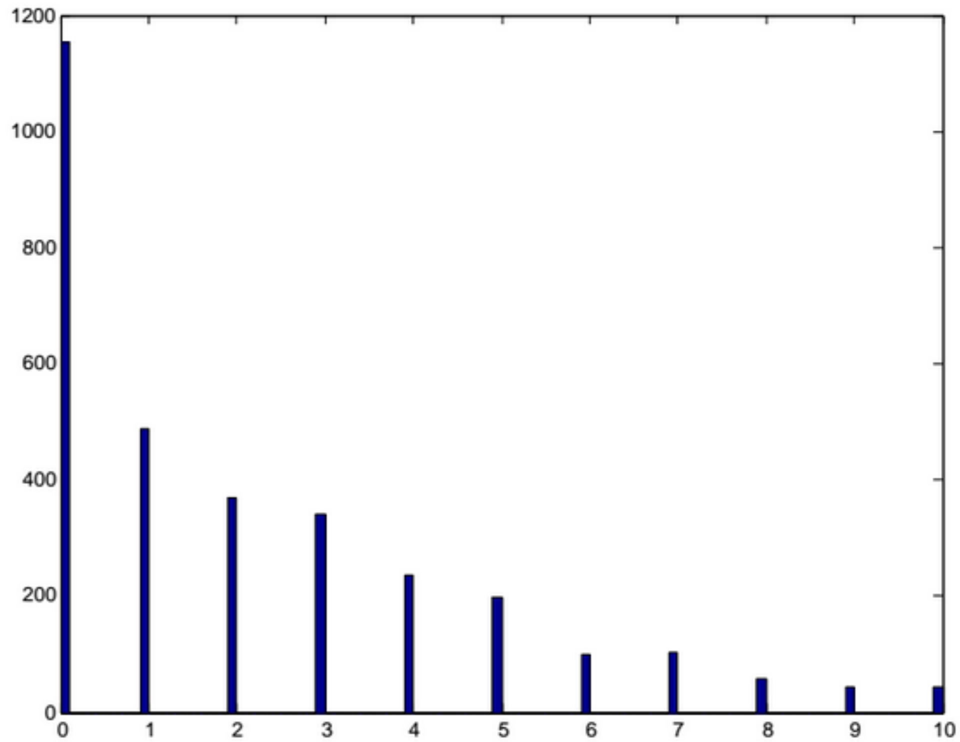
Property	Coefficient	P-value
Max-Degree	-0.3950	0.03
Crossing #	-0.0875	0.6457
Backtrack	0.0233	0.9028
Annealing	0.67	0.0001
Optimal	0.108	0.5680
Color Changes	0.9338	0
Display Changes	0.9327	0
# Attempts	0.8506	0
# Conflicts	0.8929	0

How Do People Play?



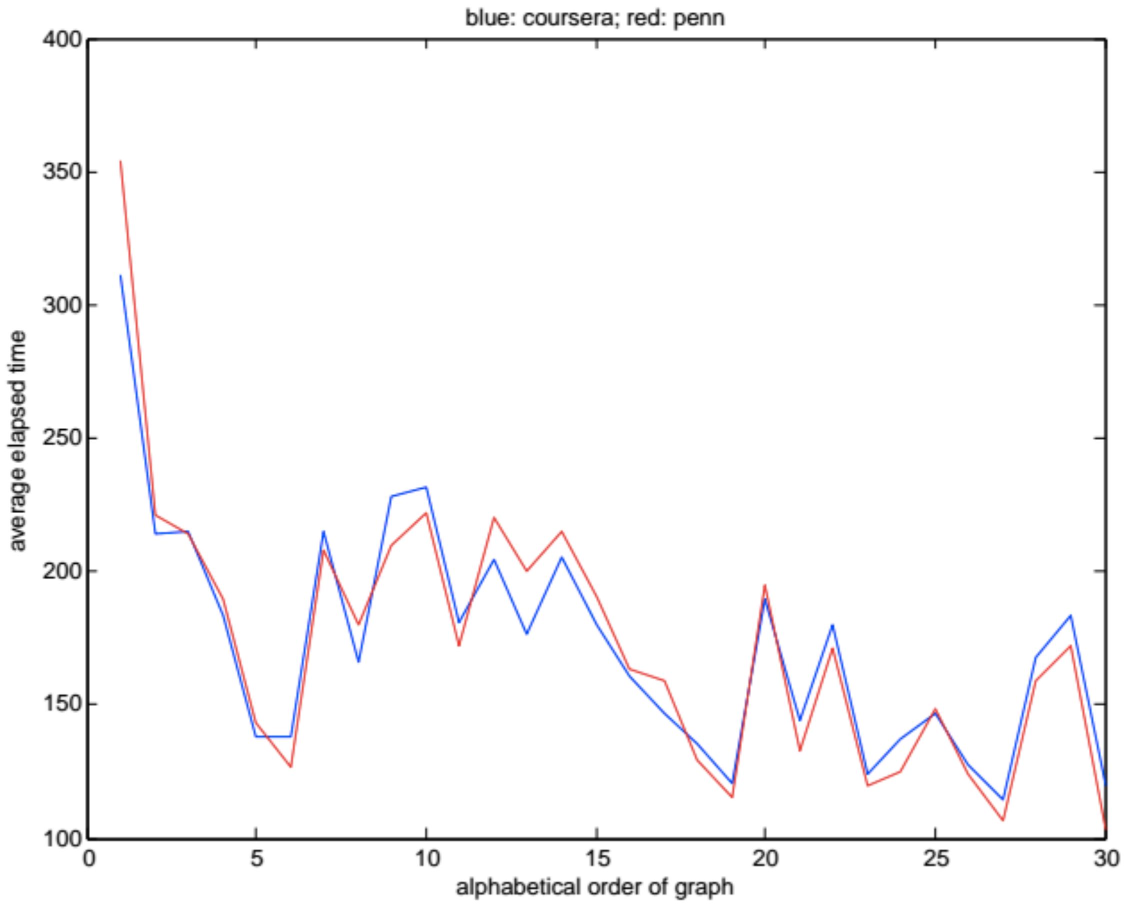
Faster is Better: At the subject level, correlation between average solution time and average color changes/second = -0.53

How Do People Play?



Histogram of max degree – degree of first vertex colored

Penn vs. Coursera: Average Solution Times



Next Assignment:
Experiments in Competitive Contagion

Scenario

- Your are the head of marketing for the Red Widget Company
- You are tasked with creating the “viral spread” of Red Widgets on Facebook
- Widgets are very compelling: once someone learns about them via their friends, they simply must have one
- Your budget permits you to give away two Red Widgets to seed their spread
- Unfortunately, your counterpart at Blue Widget Co also has two seeds
- Red and Blue Widgets are identical except for color, and have extreme network/platform effects: you want to adopt the color your friends have
- For a given network, your goal is to win more market share than your Blue opponent(s)

Detailed Dynamics

- Red and Blue each pick two seeds (duplicates chosen randomly)
- At the first step, all neighbors of the seeds will adopt/buy a widget
- At the next step, all their neighbors will buy a widget
- In general, if step T is the first step at which some neighbor of v has adopted a widget, then v will adopt on step T+1
- To decide which color widget to adopt, v looks at the number of Red and Blue widgets in their neighborhood, and adopts majority color (ties broken randomly)
- Any vertex in the connected component of any seed will eventually adopt
- Two sources of randomization: duplicate seeds, ties in neighborhoods

Discussion

- This is a (complex) game between Red and Blue
- Pure strategies: all choose(N,2) choices of 2 seeds
- Mixed strategies: all distributions over seed pairs
- Payoffs: number of adoptions won
- We will play a population opponent variant of this game
- Let pay(s1,s2) denote the (expected) payoff to Red when Red chooses seed set s1 and Blue chooses seed set s2
- Let pay(s1,P) denote the (expected) payoff to Red when Red chooses seed set s1 and Blue chooses a seed set randomly according to distribution P
- Then payoff to Red is pay(s1,P), where P is the empirical distribution of seed choices of all your classmates/opponents
- In general, there is no right/best choice for s1: depends on P!
- Let's go to the app

Questions Worth Pondering

- What does it mean for the population distribution P to be an equilibrium?
- If P is an equilibrium what can we say about different players' payoffs?
- If P is an equilibrium and G is connected, what can we say about payoffs?
- What if G is not connected?

How We Will Compute Scores

- Let P be the population distribution of seed choices on graph G
- For every seed set s that appears with non-zero probability in P, we will compute its *expected payoff with respect to P:*
  - average of pay(s,s’) over many trials and many draws of s’ from P
  - enough draws/trials to distinguish/rank expected payoffs accurately
- We will then rank the s that appear in P by their expected payoffs
- If you played s on G, you will receive a number of points equal to the *number of other players* you *strictly beat* in expected payoff
- Example: Suppose s1, s2 and s3 appear in P, and have expected payoffs and population counts as follows:
  - s1: payoff 0.57, count 11; s2: payoff 0.48, count 71; s3: payoff 0.31, count 18
  - if you play s1, your score is 71+18=89; if s2, your score is 18; if s3, your score is 0
- If everyone plays the same thing, nobody receives any points
- You must submit seeds for *all* graphs in order to receive any credit
- Your overall score/grade for the assignment is the sum of your scores over all graphs, which will then be curved
- In general, there is no right/best choice for seeds: depends on P!

More Details

- You can (and should) change seeds as often as you like
- Important: Since P will change/evolve during the assignment, you should revisit your seed choices in response
- Deadline for assignment: 11:59PM on Monday November
- URL for app: http://upenn-nwlife-contagion.herokuapp.com/
- Active at noon today