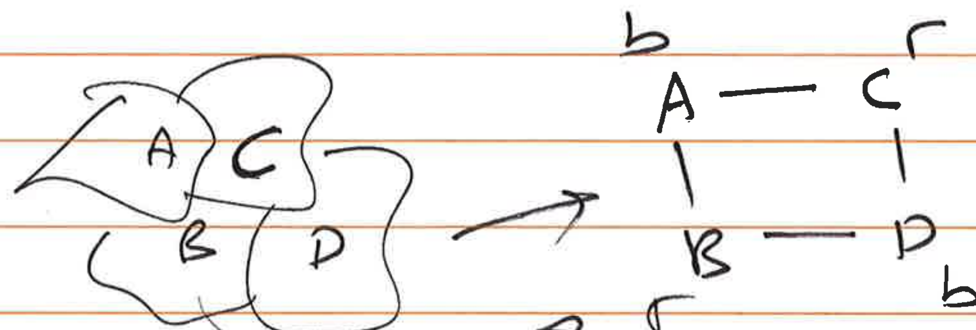
EE 597
3/6/12

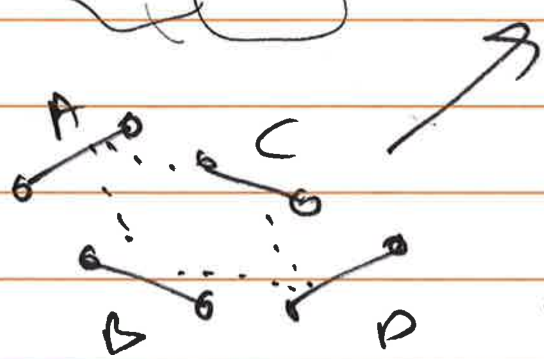
from last Class:

Graph Coloring.

$G = (V, E)$

Vertex coloring: allocate a color (label) to each vertex such that neighboring vertices do not share the same color. Goal: min # colors.



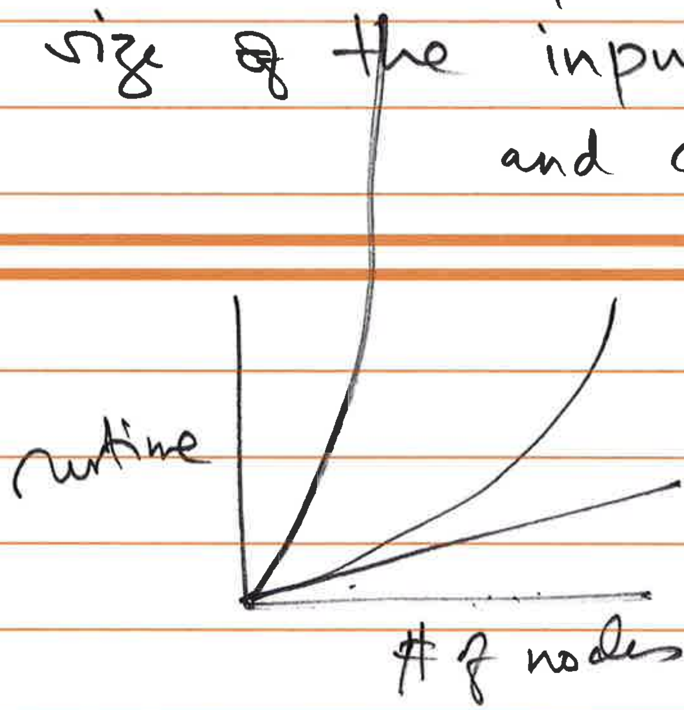


B	A	B	A	…
C	D	C	D	

Throughput of 1/2 for each link

Graph Coloring is NP-hard

↳ no known computational algorithm that is <u>efficient</u> (run time polynomial in the size of the input graph) and can solve all instances optimally.



① Algorithm that is optimal but not efficient.

For any combinatorial problem, can always do Brute Force Search.

here: N nodes

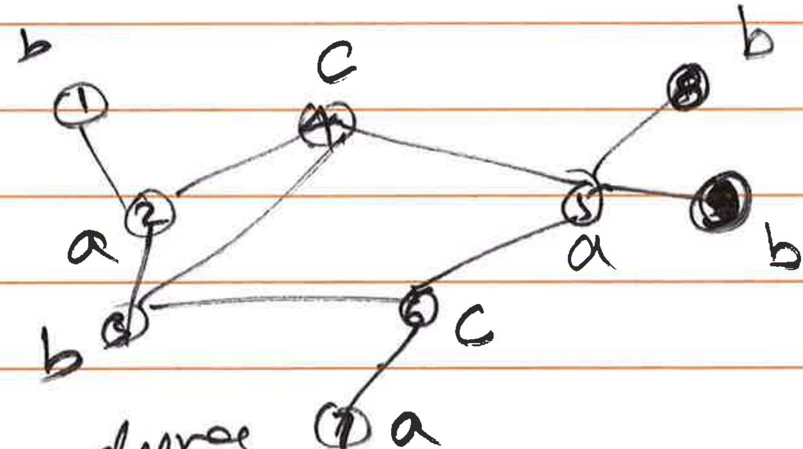
at most N colors.

worst-case: N^N

② Heuristic Algorithm that is efficient (in terms of run time) but not always optimal

Greedy Vertex Degree Ordering:

- sort the vertices in decreasing order of their degree (# of neighbors). Break ties arbitrarily.
- in order, give the earliest possible color to each vertex (sequentially) such that it does not conflict with previous colors allocated.



Node	degree
1	1
2	3
3	3
4	3
5	4
6	3
7	1
8	1
9	1

vertex degree ordering!

5 2 3 4 6 1 7 8 9

$$\omega(G) \le \chi(G) \le \Delta_{max}(G)+1$$

clique # chromatic # max degree

3 3 5

Exam Review

Exam on Thursday
in class 5–6:20 pm

Duration: 1 hr 20 minutes
Open notes, open books
but no electronic aids

Sample midterm to be posted soon.

Topics included:

Physical Layer

- digital modulation schemes

tradeoff between rate, error & SNR (power)

- RF propagation models:
  - path loss
  - log normal fading/shadowing
  - Rayleigh fading
  - Markov model

Two metrics for link performance under fading:

- Average prob. of error
- Outage probability

related concept: fading margin

- coding & coding rate
- CDMA, OFDM

- Perspectives on fading:
  - power-delay profile → delay spread

Freq. selective v. flat fading   Inter-Symbol Interference   Coherence Bandwidth.

  - Doppler Spread & Coherence Time

Slow vs fast fading

- MIMO & maximum ratio combining

diversity-multiplexing tradeoff.

MAC & Resource Allocation

Power Allocation $R \propto \log(1+SNR)$

total Power constraint

	fixed rate ($SNR > \theta$)	Rate Adaptive
parallel links	✓	✗
Independent links	✗	✓

individual power constraint

Random Access

- slotted Aloha
- all users have the same p
- 2-users w/ different $\underbrace{p_1, p_2}_{\text{throughput region}}$

· p - persistent CSMA

· throughput when all users have p

· when users have different p_i

$$T_i = \frac{p_i \prod_{j \neq i} (1 - p_j) \cdot T_s}{\left(\prod (1 - p_i)\right)\sigma + \sum_i p_i \prod_{j \neq i} (1 - p_j) \cdot T_s + \left[1 - \prod (1 - p_i) - \sum_i p_i \prod_{j \neq i} (1 - p_j)\right] \cdot T_c}$$

$p_i = p \; \forall i$:

$$T_i = \frac{p(1-p)^{n-1} T_s}{(1-p)^n \cdot \sigma + n p (1-p)^{n-1} T_s + (1 - (1-p)^n - n p (1-p)^{n-1}) T_c}$$

i^{th} user

· RTS / CTS & how it helps the hidden node problem, but w/ more overhead

Channel allocation using graph coloring:

- how to model the problem at hand as a graph coloring problem
- $\omega(G) \leq \chi(G) \leq \Delta_{max}(h)+1$
- Greed vertex ordering heuristic

<u>Format</u>: 4 question:
best 3 out of 4