

Admin

Double check all of your scores on Gradescope (and Sakai for midterms 2 & 3)

Assignment 10 & 11 back soon

I'll have my normal office hours through next Monday

Mentor hours to be posted

A	Admin
F	inal posted on Gradescope due Wednesday (11/1) at 11:59pm itme-limited (3 hours to take – 3.5 hours upload back to Gradescope) You may use: the book
	 your notes the class notes the assignments ONLY these things Do NOT discuss it with anyone until after Wednesday at 11:59pm

Test taking advice

- Read the questions carefully!
- Don't spend too much time on any problem
 if you get stuck, move on and come back
- When you finish answering a question, reread the question and make sure that you answered everything the question asked
- Think about how you might be able to reuse an existing algorithm/approach
- Show your work (I can't give you partial credit if I can't figure out what went wrong)
- Don't rely on the book/notes for conceptual things
 Do rely on the notes for a run-time you may not remember, etc.

High-level approaches

Algorithm tools

Divide and conquer

- assume that we have a solver, but that can only solve subproblems
- define the current problem with respect to smaller problems
- Key: sub-problems should be non-overlapping
- Dynamic programming
- Same as above Key difference: sub-problems are overlapping
- Once you have this recursive relationship:
- figure out the data structure to store sub-problem solutions work from bottom up
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High-level approaches

Algorithm tools cont.

Greedy

Same idea: most greedy problems can be solve using dynamic programming (but generally slower) Key difference: Can decide between overlapping subproblems without having to calculate them (i.e., we can make a local decision)

Flow

- Min-capacity cut
- Bottleneck edge Matching problems
- Numerical maximization/minimization problems

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Data structures

A data structure

- 🗖 Stores data
- □ Supports access to/questions about data efficiently the different bias towards different actions
- No single best data structure

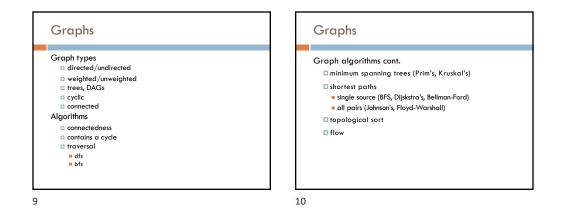
Fast access/lookup?

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- □ If keys are non-sequential or non-numerical: hashtable
- If keys are sequential: array
- Guaranteed run-time/ordered: balanced binary search tree

Data structures

- Min/max? 🗖 heap 🗖 binomial heap Fast insert/delete at positions? 🗖 linked list
- Others stacks/queues
- extensible data structures balanced BSTs
- 🗖 disjoint sets



Other topics...

- Analysis tools
- recurrences (master method, recurrence trees)
 big-O
 amortized analysis

. , .

- NP-completeness
- proving NP-completenessreductions

Proofs: general

Be clear and concise

Make sure you state assumptions and justify each step

Make sure when you're done you've shown what you need to show

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Proof by induction

- 1. State what you're trying to prove We show that XXX using proof by induction
- 2. Prove base case
- 3. State the inductive hypothesis
- 4. Inductive proof
- o. State what you want to show (may include a variable change, e.g., k in instead of n)
- b. Show a step by step derivation from the left hand side resulting in the right hand side. Give justifications for steps that are non-trivial

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Prof by induction: structural

Use induction to prove that the number of degree-2 nodes in a non-empty binary tree is 1 less than the number of leaves. Recall that the degree of a vertex in a tree is the number of children that it has.

State what you're trying to prove We show that XXX using proof by induction

- Prove base case
- State the inductive hypothesis
- Inductive proof 4.
- State what you want to show (may include a variable change, e.g., kin instead of n) Show a step by step derivation from the left hand side resulting in the right hand side. Give justifications for steps that are non-trivial

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Other (important) places we saw proofs Recurrences (substitution method) Big O (needed find constants c n_0) Greedy algorithm correctness (proof by contradiction or stays ahead—induction —)

Proof of algorithm correctness (MSTs, Flow)

NP-completeness (proving correctness of reductions)

Recurrences

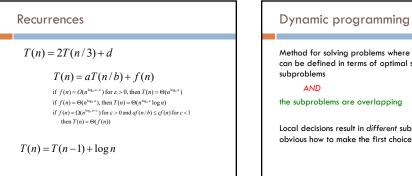
Three ways to solve:

Substitution

Recurrence tree (may still have to use substitution to verify)

Master method

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Method for solving problems where optimal solutions can be defined in terms of optimal solutions to

Local decisions result in different subproblems. Not obvious how to make the first choice.

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DP advice

Write the recursive definition

What is the input/output to the problem?

What would a solution look like? What are the options for picking the first component of a solution?

Assume you have a solver for subproblems. How can you combine the first decision with answer to subproblem.

Define DP structure: what are subproblems indexed by?

State how to fill in the table (including base cases and where the answer is)