

08. Maximum Flow

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Big Idea: Algorithm Frameworks

Algorithm framework: an algorithm with modular parts that can be swapped in for different performance properties; or to solve different but related problems

Example: hash tables are a framework, can swap in

- ▶ different collision resolution strategy (chaining, probing)
- ▶ different hash function (universal hash, linear congruential hash, etc.)

A framework generalizes several algorithm ideas into one pattern; “chunking”

Big Idea: Iterative Pattern

Recall greedy pattern:

1. initialize base-case result
2. for each piece of input,
update result

Iterative pattern (a.k.a. *fixed-point algorithm*):

1. initialize base-case result
2. while result is not optimal:
 - 2.1 improve result one step

Both use a *greedy heuristic*; iterative pattern makes a problem-wide decision.

Big Idea: Problem Reduction

problem A reduces to problem B = can use an algorithm for B to do all the hard work of solving problem A
= A is easier than B (or tied)

Sometimes A, B are closely related (e.g. forward-sorting, reverse-sorting)

More interesting: problems seem completely unrelated (e.g. SAT, CLIQUE; max-flow, bipartite matching)

Big Idea: Problem Duality

problem duality: when the input/output mathematical definition of a problem can be interpreted by humans in two (or more) very different ways

- ▶ one algorithm can solve multiple problems with different “stories”
- ▶ algorithms, computers, don’t actually care what data values mean
- ▶ turns out max-flow and min-cut are two different stories for the same problem
- ▶ max-flow and min-cut are the *dual of each other*

Link to Content Slides

See Kevin Wayne's slides at Titanium