

### The Problem

One of our original goals in developing the Maximum-Flow Problem was to be able to solve the Bipartite Matching Problem, and we now show how to do this. Recall that a *bipartite graph*  $G = (V, E)$  is an undirected graph whose node set can be partitioned as  $V = X \cup Y$ , with the property that every edge  $e \in E$  has one end in  $X$  and the other end in  $Y$ . A *matching*  $M$  in  $G$  is a subset of the edges  $M \subseteq E$  such that each node appears in at most one edge in  $M$ . The Bipartite Matching Problem is that of finding a matching in  $G$  of largest possible size.

### Designing the Algorithm

The graph defining a matching problem is undirected, while flow networks are directed; but it is actually not difficult to use an algorithm for the Maximum-Flow Problem to find a maximum matching.

Beginning with the graph  $G$  in an instance of the Bipartite Matching Problem, we construct a flow network  $G'$  as shown in Figure 7.9. First we direct all edges in  $G$  from  $X$  to  $Y$ . We then add a node  $s$ , and an edge  $(s, x)$  from  $s$  to each node in  $X$ . We add a node  $t$ , and an edge  $(y, t)$  from each node in  $Y$  to  $t$ . Finally, we give each edge in  $G'$  a capacity of 1.

We now compute a maximum  $s$ - $t$  flow in this network  $G'$ . We will discover that the value of this maximum is equal to the size of the maximum matching in  $G$ . Moreover, our analysis will show how one can use the flow itself to recover the matching.



**Figure 7.9** (a) A bipartite graph. (b) The corresponding flow network, with all capacities equal to 1.

# Kleinberg Tardos Algorithm Design Solutions

**Lauren Gardner**



## **Kleinberg Tardos Algorithm Design Solutions:**

Algorithm Design: A Methodological Approach - 150 problems and detailed solutions Patrick Bosc, Marc

Guyomard, Laurent Miclet, 2023-01-31 A bestseller in its French edition this book is original in its construction and its success in the French market demonstrates its appeal It is based on three principles 1 An organization of the chapters by families of algorithms exhaustive search divide and conquer etc On the contrary there is no chapter devoted only to a systematic exposure of say algorithms on strings Some of these will be found in different chapters 2 For each family of algorithms an introduction is given to the mathematical principles and the issues of a rigorous design with one or two pedagogical examples 3 For the most part the book details 150 problems spanning seven families of algorithms For each problem a precise and progressive statement is given More importantly a complete solution is detailed with respect to the design principles that have been presented often some classical errors are pointed out Roughly speaking two thirds of the book is devoted to the detailed rational construction of the solutions

**Data Structures and Algorithms with Python** Aadinath Pothuvaal, 2025-02-20 Dive into the Heart of Pythonic Algorithms and Data Structures offers a comprehensive guide designed to empower both beginners and seasoned developers Whether you're mastering the foundations of computer science or enhancing your problem solving skills this book provides a roadmap through the intricacies of efficient data organization and algorithmic prowess We introduce the versatility of Python setting the stage for an exploration of various data structures including arrays linked lists stacks queues trees and graphs Each chapter presents practical examples and Python code snippets for easy comprehension and application As the journey progresses we shift focus to algorithms covering sorting techniques searching methods and dynamic programming Real world applications and case studies bridge the gap between theory and practical implementation reinforcing each algorithm's relevance in solving tangible problems The book emphasizes a hands on approach encouraging active engagement with Python code and algorithms Whether you're preparing for coding interviews building scalable software or honing your programming skills this book equips you with the knowledge and confidence to navigate the challenging terrain of Data Structures and Algorithms using Python

*Game Theory, Alive* Anna R. Karlin, Yuval Peres, 2017-04-27 We live in a highly connected world with multiple self interested agents interacting and myriad opportunities for conflict and cooperation The goal of game theory is to understand these opportunities This book presents a rigorous introduction to the mathematics of game theory without losing sight of the joy of the subject This is done by focusing on theoretical highlights e.g. at least six Nobel Prize winning results are developed from scratch and by presenting exciting connections of game theory to other fields such as computer science algorithmic game theory economics auctions and matching markets social choice voting theory biology signaling and evolutionary stability and learning theory Both classical topics such as zero sum games and modern topics such as sponsored search auctions are covered Along the way beautiful mathematical tools used in game theory are introduced including convexity fixed point theorems and

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