CS161 Students' Guide

Sushil Upadhyayula
sushilu@stanford.edu

This guide is meant to be a supplement to all CS161 instruction and notes. Past students have found it particularly helpful to review online resources and videos to supplement understanding of the material to ingest the information through another medium. There's a lot of good content out there, so the purpose of this document is to narrow that down to a few videos and websites for each lecture that are particularly useful. Happy learning!

1 Why are you here? And do you know how to multiply integers?

Karatsuba Explained: https://www.youtube.com/watch?v=fQ3VgyNR49A

2 MergeSort, Recurrences, and Asymptotics

Insertion Sort Refresher: https://www.geeksforgeeks.org/insertion-sort/
Merge Sort in 3 minutes: https://www.youtube.com/watch?v=4VqmGXwpLqc
Big O, Ω, Θ Explained: https://www.youtube.com/watch?v=0oDAlMwTrLo
Recurrence Relation Proof by Induction: https://www.youtube.com/watch?v=t_3ACuzEe_8
Running Time Proof by Induction: https://www.youtube.com/watch?v=XWykCejG1Rk

3 More recurrences, the master theorem, and the substitution method

Master Theorem: https://www.youtube.com/watch?v=T68vN1FNY4o
Master Theorem Example: https://www.youtube.com/watch?v=mSX8jFgTCz0
Substitution Method step-by-step: https://www.youtube.com/watch?v=Ob8SM0fz6p0

4 More substitution method and the selection problem

kth largest element Leetcode Example: https://www.youtube.com/watch?v=FrWq2rznPLQ
Walkthrough: https://www.geeksforgeeks.org/kth-smallestlargest-element-unsorted-array/

5 Randomized Algorithms and QuickSort

Quick Sort Refresher: https://www.geeksforgeeks.org/quick-sort/
Quick Sort Worst Case Analysis: https://www.youtube.com/watch?v=auclbmnm4iA
Quick Sort Random Pivot: https://www.youtube.com/watch?v=X4MCd25VYFk
Quick Sort Time Complexity: https://www.youtube.com/watch?v=aMb5GHPGQ1U
Quick Sort Python Example:
https://leetcode.com/problems/k-closest-points-to-origin/discuss/219442/Python-with-quicksort-algorithm

6 BucketSort, RadixSort, and Sorting Lower Bounds

Bucket Sort Refresher: https://www.youtube.com/watch?v=VuXbEb5ywrU
Radix Sort Refresher: https://www.youtube.com/watch?v=nu4gDuFabIM
Radix Sort Explained: https://www.youtube.com/watch?v=XiuSW_mEn7g

7 Binary Search Trees and Red-Black Trees

BST Demo: https://www.youtube.com/watch?v=mtvbVLK5xDQ
Red-Black Tree Basics: https://www.youtube.com/watch?v=qvZGUFHWChY
Red-Black Tree Rules: https://www.youtube.com/watch?v=nMExd4DthdA
Red-Black Tree Rotation: https://www.youtube.com/watch?v=95s3ndZRGbk
Red-Black Tree Insertion: https://www.youtube.com/watch?v=5IBxA-bZZH8
Red-Black Tree Insertion Example: https://www.youtube.com/watch?v=A3JZinzkMpk

8 Hashing!

Hash Table Basics: https://www.youtube.com/watch?v=shs0KM3wKv8
Hash Functions in 2 minutes: https://www.youtube.com/watch?v=2BldESGZKB8
Universal Hashing: https://www.youtube.com/watch?v=3cTTzYc3gnE
Universal Hash Families: https://www.youtube.com/watch?v=GKtg72W_Xcg
Balls and Bins: https://www.youtube.com/watch?v=bPtCBqdf9L4

9 Graphs, BFS and DFS

Adjacency List: https://www.youtube.com/watch?v=9C2cpQZVRBA
BFS vs DFS: https://youtu.be/TIbUeeksXcI?t=25
Graph Search, BFS, DFS: https://www.youtube.com/watch?v=zaBhtODEL0w

10 Finding Strongly Connected Components

SCC Refresher: https://www.geeksforgeeks.org/strongly-connected-components/
Strongly vs. Weakly Connected Components:
https://www.quora.com/What-are-strongly-and-weakly-connected-components

11 Dijkstra's Algorithm and Bellman-Ford

Dijkstra's Shortest Path: https://www.youtube.com/watch?v=gdmf0wyQlcI
Dijkstra's Explained: https://www.youtube.com/watch?v=pVfj6mxhdMw
Dijkstra's Example in 3 minutes: https://www.youtube.com/watch?v=_lHSawdgXpI
Dijkstra's vs Bellman-Ford: https://www.youtube.com/watch?v=EQ_1i8nWnDs
Bellman-Ford: https://www.youtube.com/watch?v=9PHkk0UavIM
Bellman-Ford Example: https://www.youtube.com/watch?v=obWXjtg0L64
Bellman-Ford and negative cycles: https://www.youtube.com/watch?v=lyw4FaxrwHg

12 Dynamic Programming and shortest paths: Bellman-Ford and Floyd-Warshall

DP Explained: https://www.youtube.com/watch?v=vYquumk4nWw
DP Again: https://www.youtube.com/watch?v=P8Xa2BitN3I
Floyd-Warshall Simple: https://www.youtube.com/watch?v=4OQeCuLYj-4
Floyd-Warshall: https://www.youtube.com/watch?v=vYquumk4nWw=

13 More dynamic programming

DP Longest Common Subsequence: https://www.youtube.com/watch?v=ASoaQq66foQ
DP Longest Common Subsequence: https://www.youtube.com/watch?v=Qf5R-uYQRPk
DP 0-1 Knapsack: https://www.youtube.com/watch?v=xOlhR_2QCXY
DP 0-1 Knapsack: https://www.youtube.com/watch?v=xCbYmUPvc2Q

14 Greedy Algorithms

Greedy Algorithm Intro: https://www.youtube.com/watch?v=3XaqEng_K5s
Activity selection problem: https://www.youtube.com/watch?v=7UbMn9DlKxA
Scheduling problem: https://www.youtube.com/watch?v=nUShpavQae8
Scheduling problem: https://www.youtube.com/watch?v=BWlXudP7Unk
Scheduling Runtime analysis: https://www.youtube.com/watch?v=277RLZmhTK4

15 Minimum Spanning Trees

Prim's Algorithm: https://www.youtube.com/watch?v=cplfcGZmX7I
Kruskal's Algorithm: https://www.youtube.com/watch?v=71UQH7Pr9kU
Kruskal's Longer Explanation: https://www.youtube.com/watch?v=Yo7sddEVONg
Proof of Prim's: https://www.youtube.com/watch?v=UfhUr5QzfiI

16 Minimum Cuts and Karger's Algorithm

Karger's Explained: https://www.youtube.com/watch?v=KqMGeNZuwfI
Karger's refresher: https://www.youtube.com/watch?v=9SgM4RCpdu8
Karger's example: https://www.youtube.com/watch?v=wmPuTX2Wlgs
Karger's longer explanation: https://www.youtube.com/watch?v=GSeKbFjYei0