

# Review1. Final Review

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## Stable matching

- Perfect matching > stable matching.
- Men get best women while women get worst men.

## Analysis

- Upper bound, lower bound, and tight bound.
  - Transitivity and additivity properties.

## Graphs

- Bipartite: cannot contain odd cycles, vertices in same layer in BFS shouldn't have edges.

## Greedy algorithm

- *Online and offline algorithm.*
- Shortest path: Dijkstra algorithm.
- MST: Kruskal algorithm, reverse-delete, Prim algorithm.
  - Cut property and cycle property.
- K-clustering problem: delete k-1 most expensive edges from MST.
- Huffman code: fixed length encoding and prefix code (average bits per letter).

## Divide and conquer

- Time complexity for 2-division and linear merge:  $T(n) = 2T\left(\frac{n}{2}\right) + n$
- Classical problems: merge sort, counting inversions (sort-count, merge-count), closest pair of points, multiplication (complex, integer, Karatsuba).
- Fast Fourier transform: coefficient and point-value (multiply and evaluate).
  - Point-value evaluate formula:  $A(x) = \sum_{k=0}^{n-1} y_k \frac{\prod_{j \neq k} (x - x_j)}{\prod_{j \neq k} (x_k - x_j)}$
  - Decimation in frequency (low, high), time (even, odd).

## Dynamic programming

- Classical problems: weighted interval scheduling, segmented least squares, knapsack problem, RNA secondary structure.
- Sequence alignment: gap penalty, mismatch penalty.
- Shortest path with negative weight: add scalar to weight, Bellman-Ford algorithm.

## Network flow

- Maximum flow and minimum cut.
  - Capacity of cut and value of flow: weak duality, residual graph.
  - Augmenting path: bottleneck capacity.
    - Capacity scaling algorithm:  $G_f(\Delta)$ .
- Applications: bipartite matching, disjoint path.