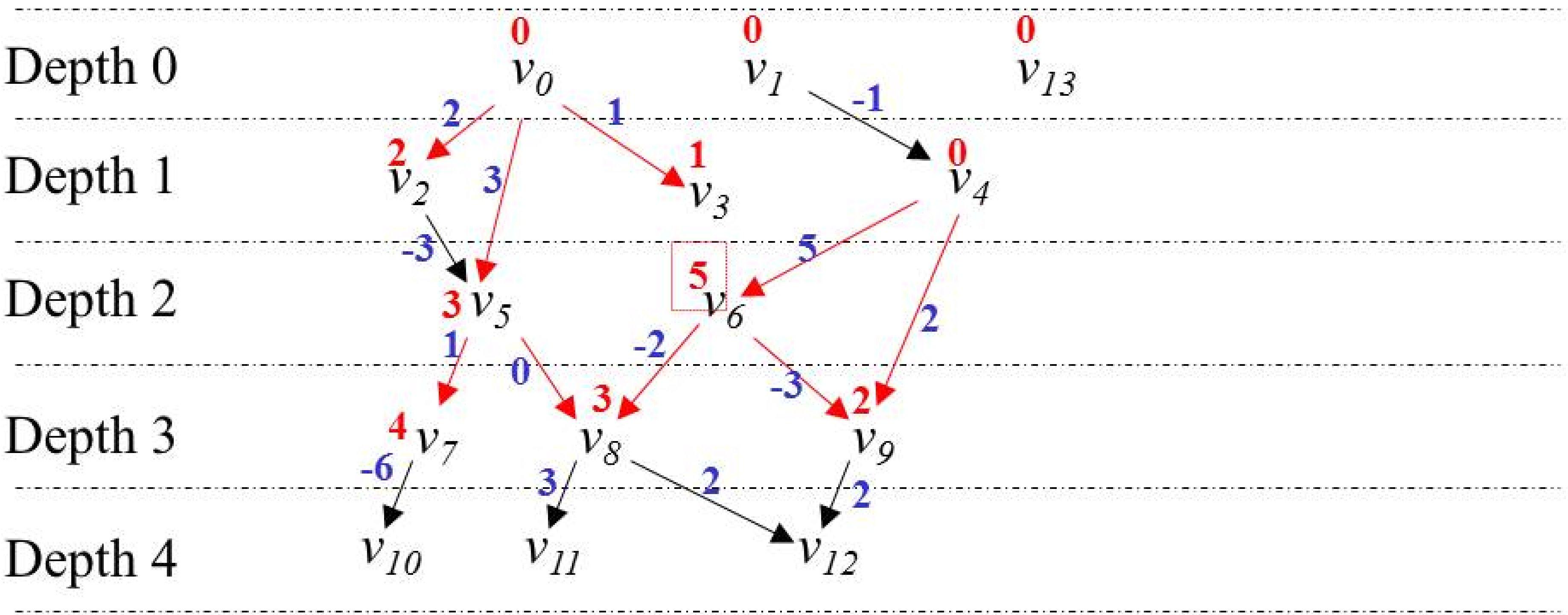
Discussion section #2

- HW1 questions?
- HW2: maximum-weight path on a DAG
- Shortest (minimum-weight) path algorithms
- Memoization

HW1 questions?

HW2: maximum-weight path on a DAG



HW2: maximum-weight path on a DAG

- Create input file with one line for each vertex and edge

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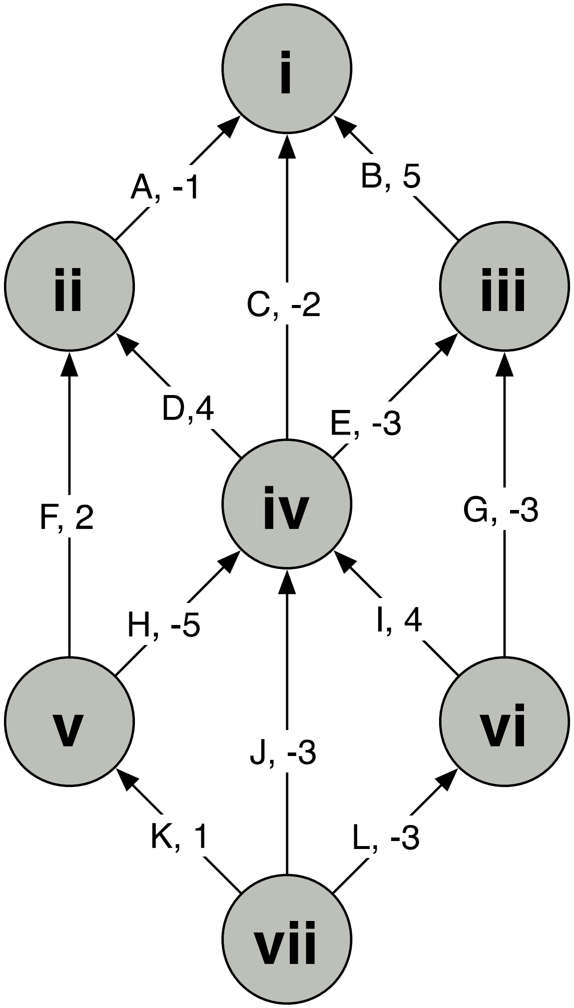
- Find the maximum-weight path on the graph

HW2: maximum-weight path on a DAG

- Create input file with one line for each vertex and edge
- Find the maximum-weight path on the graph
- Output:
  - Path length
  - Beginning and end vertex labels (positions)
  - The labels of all the edges on the path, in order

HW2: maximum-weight path on a DAG



Minimum-weight path on a DAG

- Similar to the homework
  - Looking for the minimum instead of the maximum
  - If no negative weights, then shortest path is technically weight 0
  - Otherwise, update vertex weights in depth order as normal

Minimum-weight path with cycles?

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  - All other vertex distances are infinity

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  - Repeat |V| - 1 times

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  - How would you check for a negative cycle?

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- Bellman-Ford algorithm (for a given start vertex)
  - Set start vertex distance to 0
  - All other vertex distances are infinity
  - For each edge (u, v), if v's distance can be reduced by taking that edge, update v's distance
  - Repeat |V| - 1 times
  - How would you check for a negative cycle?
  - What about checking all paths?

Minimum-weight path with no negative edges?

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  - Which vertex do we know the minimum-weight path to?

Minimum-weight path with no negative edges?

- Djikstra's algorithm (for a given start vertex)
  - Set start vertex distance to 0
  - All other vertex distances are infininty
  - Which vertex do we know the minimum-weight path to?
  - Do we ever need to update a vertex more than once?

Memoization
(similar to dynamic programming)

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  - Can imagine filling a table of values
  - Bottom-up approach

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  - Makes sense from a recursive standpoint
  - Top-down approach

Memoization
(similar to dynamic programming)

- Dynamic programming
  - Can imagine filling a table of values
  - Bottom-up approach

- Memoization
  - Makes sense from a recursive standpoint
  - Top-down approach
  - Some scenarios where more intuitive

RNA folding

AUGCUAUAUAAACGCGAUACUAUACGCGAUAAUCGCGCGAGA

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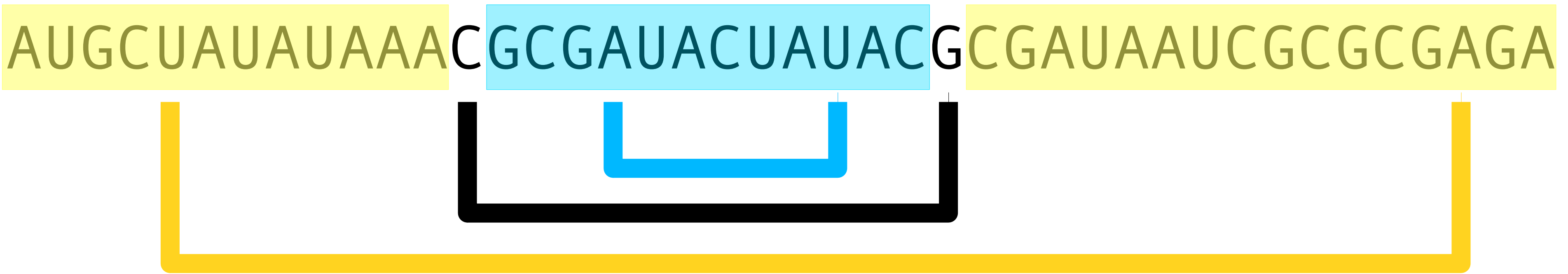
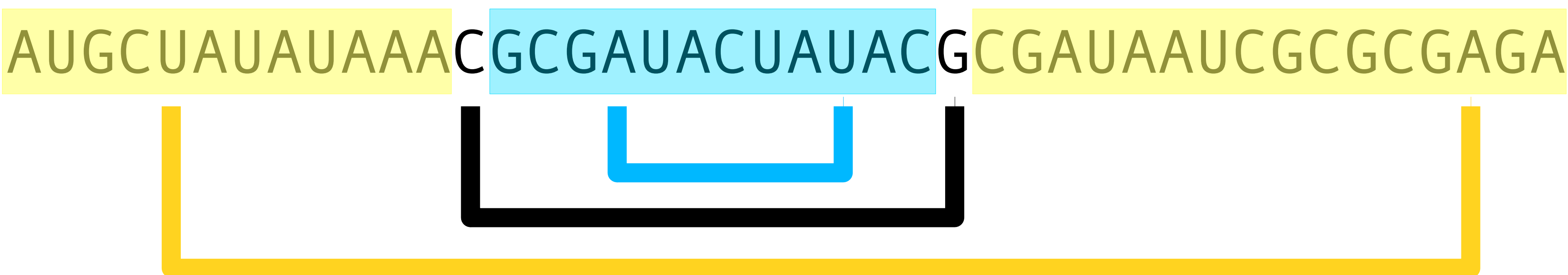
RNA folding



RNA folding



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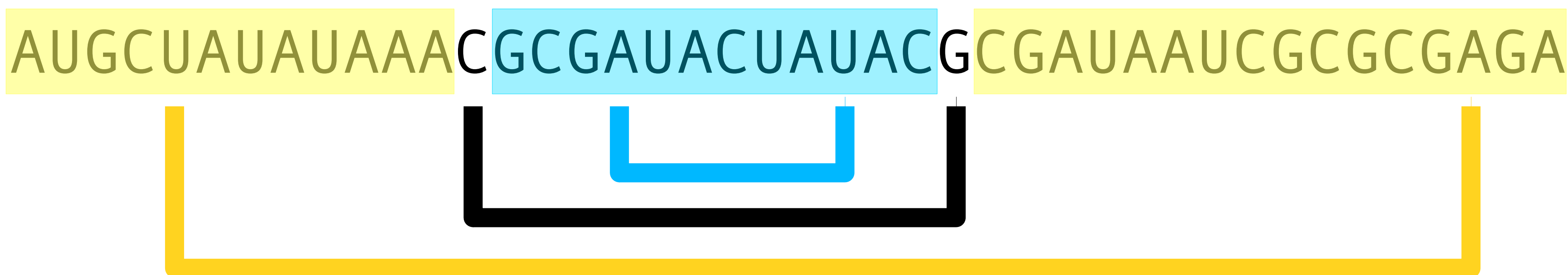
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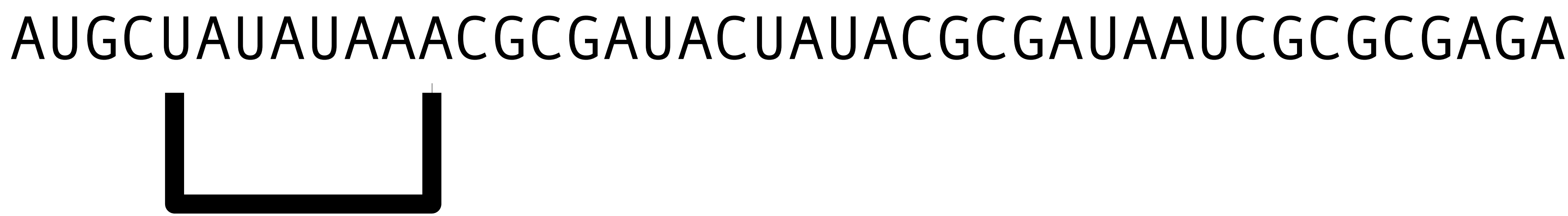
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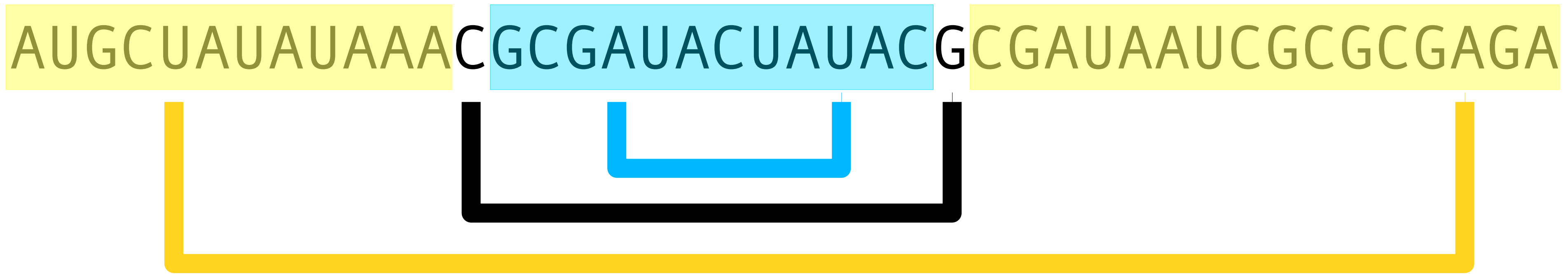
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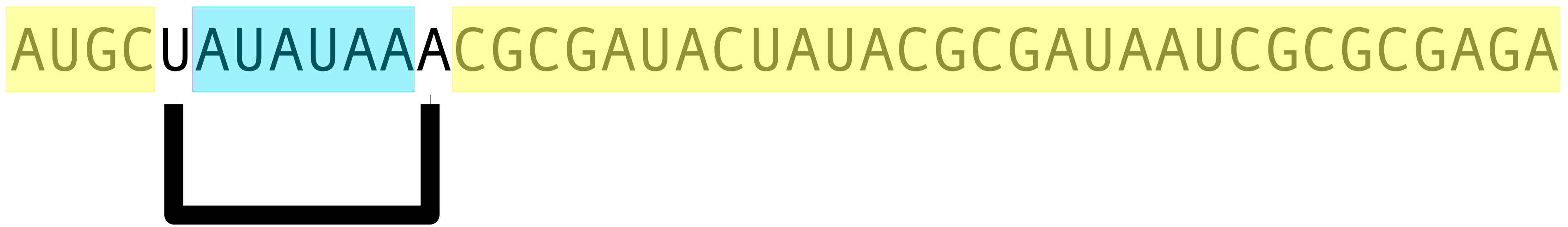
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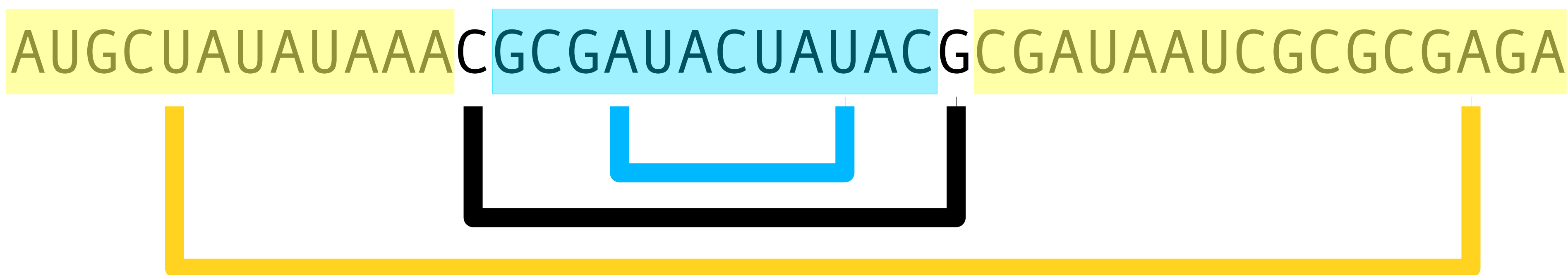
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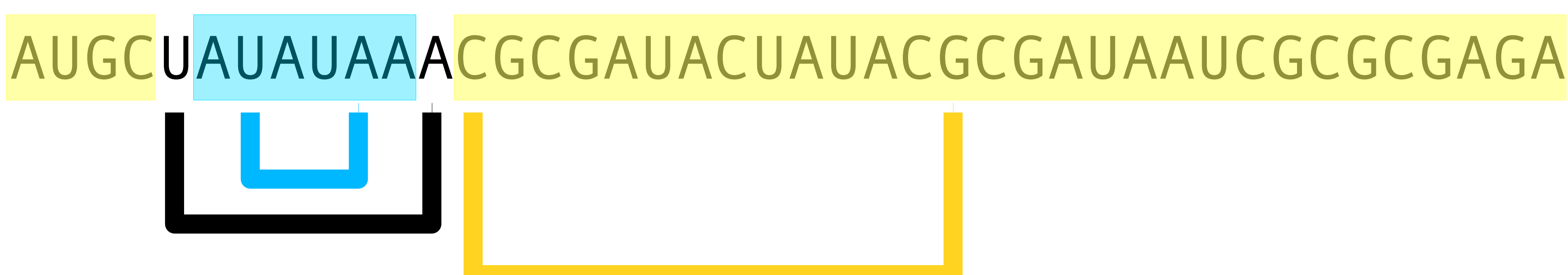
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RNA folding

```
function max_folds(seq)


    if length(seq) <= 1
        return 0
    current_max = 0
    for i in 1..length(seq)
         for j    in i..length(seq)
            if complement(seq[i], seq[j])
                left = seq[1:i-1]
                middle = seq[i:j]
                right = seq[j+1:length(seq)]
                num_folds = 1 + max_folds(left + right)
                               + max_folds(middle)
                if num_folds > current_max
                    current_max = num_folds

    return current_max
```

RNA folding

```
function max_folds(seq, solutions)
    if seq in solutions
     return solutions[seq]
    if length(seq) <= 1
        return 0
    current_max = 0
    for i in 1..length(seq)
         for j    in i..length(seq)
            if complement(seq[i], seq[j])
                left = seq[1:i-1]
                middle = seq[i:j]
                right = seq[j+1:length(seq)]
                num_folds = 1 + max_folds(left + right, memo)
                               + max_folds(middle, memo)
                if num_folds > current_max
                    current_max = num_folds
    solutions[seq] = current_max
    return current_max
```

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- Floyd-Warshall
  - Calculates the minimum-weight path between all pairs of vertices simultaneously

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  - Calculates the minimum-weight path between all pairs of vertices simultaneously
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    - Given the shortest path between vertices u and v that only uses vertices 1 to k

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  - Calculates the minimum-weight path between all pairs of vertices simultaneously
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    - Given the shortest path between vertices u and v that only uses vertices 1 to k
      - What is the shortest path between u and v that only uses vertices 1 to k + 1?

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- Floyd-Warshall
  - Calculates the minimum-weight path between all pairs of vertices simultaneously
  - Basic idea
    - Given the shortest path between vertices u and v that only uses vertices 1 to k
      - What is the shortest path between u and v that only uses vertices 1 to k + 1?
  - How can we reconstruct a path?