

National University of Singapore
School of Computing
CS1010X: Programming Methodology
Semester II, 2024/2025

Recitation 10
Dynamic Programming & Memoization

Python

1. *Exception*

Exceptions are error detected during execution. For example, `ZeroDivisionError`, `NameError` and `TypeError`

2. *Exception handling syntax*

```
try:
    statements
except <ErrorType>:
    statements
except (<ErrorType1>,<ErrorType2>, <ErrorType3>):
    statements
except: # wildcard
    statements
finally: # always executed
    statements
```

3. *Optional else syntax*

```
try:
    statements
except <ErrorType>:
    statements
else:
    statements
```

4. Raising Exceptions

```
raise <ErrorType>
```

Problems

1. Recall the `count_change` algorithm shown in the earlier lectures. In a call to `cc(11, 5)`, there are actually computations of repeated subproblems, for example, repeated computation of `cc(1, 2)`.

```
# A certain path in the recursion tree:
cc(11, 5) -> cc(11, 4) -> cc(11, 3) -> cc(11, 2) -> cc(6, 2) -> cc(1, 2)
# Another path in the recursion tree:
cc(11, 5) -> cc(11, 4) -> cc(11, 3) -> cc(1, 3) -> cc(1, 2)
```

- (a) Implement a memoized version of `cc(amount, kind_of_coins)` that uses a table to store previously calculated values.

- (b) Implement a dynamic programming version of `cc(amount, kind_of_coins)` that fills up a table systematically.

2. Suppose you have a rod of length n meters and you hope to cut it into pieces and sell them. You can only cut them into integer lengths. The profit of rod with different lengths are displayed in the table below. How would you cut the rod to maximize the profit?

length	1	2	3	4	5	6	7	8	9	10
price	1	5	8	9	10	17	17	20	24	30

Here is an example, suppose your rod is 4 meters. The different ways to cut rod and the corresponding profits are displayed below.

Do not cut at all. You make 9 dollars. Cut into 1 meter and 3 meters. You make $1 + 8 = 9$ dollars.

Cut into 2 meters and 2 meters. You make $5 + 5 = 10$ dollars. This is the optimal.

Cut into 1 meter, 1 meter and 2 meters. You make $1 + 1 + 5 = 7$ dollars.

Cut into four 1 meter rods. You make $1 + 1 + 1 + 1 = 4$ dollars.

Now write a function `cut_rod` that takes in an integer n , the length of the rod, and a dictionary mapping lengths to prices and returns the maximum profit that can be made. For example,

```
>>> prices = {1:1, 2:5, 3:8, 4:9, 5:10, 6:17, 7:17, 8:20, 9:24, 10:30}
>>> cut_rod(4, prices)
10
```

- (a) Can you come up with a recursive solution?

(b) Can you give a solution that makes use of dynamic programming?