CS2010 Semester 1 2012/2013

Data Structures and Algorithms II

# Tutorial 08 - Dynamic Programming - The Basics

For Week 10 (22 October - 26 October 2012)

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## 1 Introduction and Objective

This tutorial marks the transition to the third part of CS2010: DP, although DP is not yet examinable in this Saturday's Quiz 2. In this tutorial, we will look at two classic DP problems: Computing nth Fibonacci number and Coin Change in a detailed manner. We will also discuss PS6 Subtask 1 briefly.

DP can be challenging to master but it is an important algorithm design strategy as it can solve certain problems much more efficiently than using Complete Search. Do not hesitate to ask the teaching staffs if you encounter difficulties with this topic.

This tutorial will be shorter than usual to allow students to ask questions regarding Quiz 2, if any.

# 2  Tutorial 08 Questions

## Dynamic Programming - Basic Ideas

Q1. What are the important properties of a problem that allows for a DP solution?

Q2. You are given the following implementation for finding the n-th Fibonacci number. Is it a DP solution? If yes, explain! If no, how to to write a DP solution (either bottom-up or top-down) for finding the n-th Fibonacci number?

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**Algorithm 1** fib($n$)

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    **if** $n == 0$ or $n == 1$ **then**
        return $n$
    **end if**
    return fib($n$-2) + fib($n$-1)

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Q3. Given a target value $n$ in cents, and a list $C$ of $k$ different coin denominations (each coin denomination is also given in terms of cents), what is the minimum number of coins that we must use in order to obtain the amount $n$? You can assume we have an unlimited supply of coins of any type, and the smallest coin denomination is a 1 cent coin.

e.g. Given $n = 10$, $k = 2$ and $C = \{1,5\}$, we can use
1). Ten 1 cent coins = 10x1 = 10. Total coins used = 10
2). One 5 cents coin + five 1 cent coins = 1x5 + 5x1 = 10. Total coins used = 6
3). **Two 5 cents coins = 2x5 = 10. Total coins used = 2** $\rightarrow$ Optimal

Now your tasks:
A). Model the coin change problem above as a DAG and show how to solve it with standard graph algorithm that you have learned in Lecture05!
B). Write both top-down and bottom-up DP solution for this problem!

## Problem Set 6

Q4. Discussion of PS6 Subtask 1 (a quick one)