Quiz 4 - Greedy Counterexamples

Due Date ..... October / 1^{st} / 2021
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Contents

1 Instructions

- The solutions **should be typed**, using proper mathematical notation. We cannot accept hand-written solutions. Here's a short intro to LaTeX.
- You should submit your work through the **class Canvas page** only. Please submit one PDF file, compiled using this LaTeX template.
- You may not need a full page for your solutions; pagebreaks are there to help Gradescope automatically find where each problem is. Even if you do not attempt every problem, please submit this document with no fewer pages than the blank template (or Gradescope has issues with it).
- You **may not collaborate with other students**. **Copying from any source is an Honor Code violation. Furthermore, all submissions must be in your own words and reflect your understanding of the material.** If there is any confusion about this policy, it is your responsibility to clarify before the due date.
- Posting to **any** service including, but not limited to Chegg, Discord, Reddit, StackExchange, etc., for help on an assignment is a violation of the Honor Code.
- You **must** virtually sign the Honor Code (see Section 2). Failure to do so will result in your assignment not being graded.

2 Honor Code (Make Sure to Virtually Sign)

Problem 1.

- My submission is in my own words and reflects my understanding of the material.
- Any collaborations and external sources have been clearly cited in this document.
- I have not posted to external services including, but not limited to Chegg, Reddit, StackExchange, etc.
- I have neither copied nor provided others solutions they can copy.

I agree to the above, Michael Ghattas. □

3 Standard 4- Greedy Counterexamples

3.1 Problem 2

Problem 2. Consider the Making Change problem where we have three coins: 3 cent pieces, 5 cent pieces, and 20 cent pieces. We take as input an integer $n \geq 0$. The goal is to make change for n using the fewest number of coins. Consider a greedy algorithm which selects as many 20 cent pieces as possible, followed by as many 5 cent pieces, then lastly 3 cent pieces.

Give an integer $n \geq 0$ such that (i) the greedy algorithm will not make change for n (even using more coins than necessary), yet (ii) it is possible to make change for n using **at least one of each coin**.

Answer:

Let $n \in \mathbb{N}$ be the amount for which we wish to make change for. Furthermore, since we need to make change for n using at least one of each coin, then $n > (20 + 5 + 3) = 28$.

- **Using the below algorithm, we can note that while the Greedy algorithm fails, we are still able to make change using the instructions of the problem when $n = 31$. When $n = 31$, the Greedy algorithm will attempt to create $\{[(1 * 20c) = 20] + [(2 * 5c) = 10]\} = 30$. However, there will be a $remainder = (1)$ that is not devisable by 20, or 5, or 3. Thus the algorithm will fail to make the needed change.**
- **That being said, we can clearly see that $\{[(1 * 20c) = 20] + [(1 * 5c) = 5] + [(2 * 3c) = 6]\} = 31$. Thus we can make the need change, using at least one of each coin, from the 20c, 5c, and 3c coins.**

function $CoinChange(n)$:

$Count = [20c, 5c, 3c]$

$20c = 0$

$5c = 0$

$3c = 0$

$r = 0$

while $(n\ != 0)$:

if $(n\%20)$:

$n = (n - 20)$

20c++

$r = n$

else if $(n\%5)$:

$n = (n - 5)$

5c++

$r = n$

else if $(n\%3)$:

$n = (n - 3)$

3c++

$r = n$

if $(r\ != 0)$:

print ("Can not make change!")

else:

return$(Count)$;

□