Quiz 1

Due Date Sep/17/2021
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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 1- Proof by Induction

3.1 Problem 2

Problem 2. Consider the sequence defined by:

$$T_n = \begin{cases} n & : n = 0, 1, \\ 2T_{n-1} + 1 & : n > 1. \end{cases}$$

Prove by induction that for every $n \geq 0$, we have:

$$\sum_{i=0}^{n} T_i = T_{n+1} - (n+1).$$

Proof. **By induction on** $n \in \mathbb{N}$

- **Base Case:**

  When $(n = 0)$**,**

$$\begin{aligned} T_0 &= \sum_{i=0}^{0} T_{0+1} - (0+1). \\ &= T_{0+1} - (0+1) \\ &= T_1 - (1) \\ &= (2T_{1-1} + 1) - 1 \\ &= (2T_0 + 1) - 1 \\ &= [2(0) + 1] - 1 \\ &= (1 - 1) \\ &= (0) \end{aligned}$$

  When $(n = 1)$**,**

$$\begin{aligned} T_0 &= \sum_{i=0}^{1} T_{1+1} - (1+1). \\ &= T_{1+1} - (1+1) \\ &= T_2 - (2) \\ &= (2T_{2-1} + 1) - 2 \\ &= (2T_1 + 1) - 2 \\ &= [2(1) + 1] - 2 \\ &= (3 - 2) \\ &= (1) \end{aligned}$$

  Thus the base cases for $(n = 0, 1)$ **hold true.**

- **Inductive Hypothesis:** Fix $k \geq 1$, and suppose that for all $(0 \leq i \leq k)$ for $\sum_{i=0}^{n} T_i = T_{n+1} - (n+1)$ holds.

- **Inductive Step: We now consider the** $(k+1)$ **case:**

$$\begin{aligned} T_{k+1} &= 2T_{(k+1)-1} + 1 \\ &= 2T_k + 1 \\ &= T_{(k+1)+1} - [(k+1) + 1] \\ &= T_{k+2} - (k+2) \end{aligned}$$

  Conclusion: Thus we have that $T_{k+1} = T_{k+2} - (k+2)$ **as desired.**

$\square$