COMPSCI 3MI3 : Assignment 4
Fall 2021
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Assignments created using the LaTeXdocumentation preparation system will recieve one bonus mark on this assignment, provided the latex source file has been provided. Handwritten solutions will not be accepted.

1. **Abstract Syntax Trees**
   Convert the following lambda expressions to abstract syntax tree diagrams, similar to those given in the topic 5 lecture slides. If all your diagrams are generated using **graphviz** (`https://graphviz.org/`), with source code files provided with your submission, you will recieve 1 extra mark on this question (note, that's 1 bonus point in total, not one bonus point per part of this question).

   (a) (3 points) $\lambda x.\lambda y.(a\ (\lambda c.b\ c))\ x\ y\ z$

   (b) (3 points) $(\lambda q.q\ r)\ (\lambda s.s\ (\lambda t.t))$

   (c) (4 points) $\lambda z.\lambda a.\lambda b.\lambda c.a\ (\lambda x.x\ c)\ z\ (\lambda z.z\ c)$

2. (10 points) **Logical Or**
   Design a λ expression which performs a logical or operation over Church Booleans. To demonstrate the correctness of your expression, be sure to include derivations for all 4 possible input combinations.

3. (12 points) **Exponentiation with Church Numerals**
   Design a λ expression which performs an exponentiation operation over Church Numerals. Demonstrate your method works by evaluating 2^2.