COM2001 — Advanced Programming Topics

Exercise Sheet 1: Type Classes

Spring Semester

Problem 1. Look online to find out what functions are associated with members of the type classes `Show` and `Num`. A programmer defines the type `Nat` (representing the set $\mathbb{N} = \{0, 1, 2, \dots\}$ of *natural numbers*) as follows:

```
data Nat = Zero | Succ Nat  deriving Eq
```

(a) Write down suitable code to make `Nat` an instance of `Num`. Subtraction should be defined so that $x - y = 0$ whenever $y \geq x$.

(b) Show how to make `Nat` a member of `Show` so that natural numbers are printed as integers, e.g.,

- `show Zero`$\rightsquigarrow$`"0"`
- `show (Succ Zero)`$\rightsquigarrow$`"1"`
- `show (Succ (Succ Zero))`$\rightsquigarrow$`"2"`
- `show (Succ (Succ (Succ Zero)))`$\rightsquigarrow$`"3"`

Problem 2. Recall the following definition from the lectures of a computational model:

```
class (Eq cfg) ⇒ Model cfg where
    initialise  :: String → cfg
    acceptState :: cfg    → Bool
    doNextMove  :: cfg    → cfg
    runFrom     :: cfg    → cfg
    runModel    :: String → cfg

    -- Default implementation
    runModel = runFrom ∘ initialise
```

Look online to refresh your memory as to what a pushdown automaton (PDA) is. Show in detail how to implement a PDA using the class `Model`.