

COM 6854: Verification and Testing

Exercise Sheet 5

Exercise 1: Consider a network of one way roads between four towns A, B, C and D . Roads go to from A to B and back, from B to C , from A to C and from C to D .

- (a) Model the network as a (typed) relation R in Z ; visualise it as a graph.
- (b) Calculate the values of R^{-1} , $R \circ R \circ R \circ R \circ R \circ R$.
- (c) Describe the meaning of $\text{dom}(R)$ and $\text{ran}(R)$.
- (d) Describe the following system properties in Z .
 - Every town has a road going to it.
 - Not all towns have roads going from them.
 - Any town can be reached from any other town without going through more than one other town.
 - No roads start at a town and finish there.

Exercise 2: Let $A = \{a, b, c\}$ and $B = \{1, 2\}$ be sets. Find the best type for each of the following relations.

- (a) $R = \{(a, 1), (b, 1)\}$
- (b) $R = \{(a, 2)\}$
- (c) $R = \{(a, 1), (b, 1), (c, 1)\}$
- (d) $R = \{(a, 1), (b, 1), (c, 2)\}$
- (e) $R = \{(b, 1), (b, 2), (c, 1)\}$
- (f) $R = \{(a, 1), (b, 2), (c, 2)\}$

Exercise 3: A car park has parking spaces that can be used to park cars. A company has a group of employees. Some people own cars. This can be modelled in Z as

$\text{parked} : \text{Place} \leftrightarrow \text{Car}$ $\text{employees} : \mathbb{P} \text{Person}$ $\text{owns} : \text{Person} \leftrightarrow \text{Car}$

- (a) Why is *parked* a partial function; why is *owns* a relation?
- (b) Describe the following entities in Z .
 - The cars which are parked.
 - The people who own the parked cars.
 - The places which are occupied.
- (c) Model the following property.
 - All the employees own a car.

Exercise 4: How can the following properties be modelled in Z?

- (a) A club has a group of members.
- (b) A company sells various articles. Each has a single price.
- (c) The frienship relation in a group of friends.
- (d) The score in a football game.