FMSE Exercise Course 2: Solutions

1.

```
┌─ Init ─────────────────────────────────────
│ Library
│ cc? : ℙ COPY
├────────────────────────────────────────────
│ collection = cc?
│ readers = ∅
└────────────────────────────────────────────
```

2. In the given modelling u has only v in his possession, but not anymore the videos he had already. The correct modelling:
   $hasVideo' = hasVideo \oplus \{(u, hasVideo(u) \cup \{v\})\}$

3. (a)

```
┌─ Return ───────────────────────────────────
│ ΔLibrary
│ r? : READER
│ c? : COPY
├────────────────────────────────────────────
│ issued(c?) = r?
│ issued' = issued \ {(c?, r?)}
│ readers' = readers
│ collection' = collection
└────────────────────────────────────────────
```

   (b)

```
┌─ Titles ───────────────────────────────────
│ ΞLibrary
│ tt! : ℙ TITLE
├────────────────────────────────────────────
│ tt! = {t : TITLE | ∃ c : collection • title(c) = t}
└────────────────────────────────────────────
```

4. (a) $\forall i, j : 1..\#s \bullet i < j \Rightarrow s(i) < s(j)$
   (b) $\exists i, j : 1..\#s \bullet i \neq j \wedge s(i) = s(j) = 0$
   (c) $\operatorname{ran} s = \operatorname{ran} t$

5. (a)

   $[CUSTOMER, CHECKOUT]$

```
┌─ Supermarket ──────────────────────────────
│ checkouts : ℙ CHECKOUT
│ queue : CHECKOUT ⇸ iseq CUSTOMER
├────────────────────────────────────────────
│ dom queue = checkouts
│ ∀ o, o' : checkouts •
│       o' ≠ o ⇒ ran queue(o') ∩ ran queue(o) = ∅
└────────────────────────────────────────────
```

So there is a queue (possibly empty) for each checkout.

(b)

```
┌─ Enter ──────────────────────────────────────────
│ ΔSupermarket
│ c? : CUSTOMER
│ o? : CHECKOUT
├──────────────────────────────────────────────────
│ o? ∈ checkouts
│ ∀ o : checkouts • c? ∉ ran queue(o)
│ queue′ = queue ⊕ {(o?, queue(o?) ⌢ ⟨c?⟩)}
│ checkouts′ = checkouts
└──────────────────────────────────────────────────
```

(c)

```
┌─ Close ───────────────────────────────────────────────────────────
│ ΔSupermarket
│ o?, o′? : CHECKOUT
├───────────────────────────────────────────────────────────────────
│ o?, o′? ∈ checkouts
│ queue′ = queue ⊕ {(o′?, queue(o′?) ⌢ queue(o?)), (o?, ⟨⟩)}
│ checkouts′ = checkouts
└───────────────────────────────────────────────────────────────────
```

6.

```
│ sum : seq ℤ ⟶ ℤ
├──────────────────────────
│ sum ⟨⟩ = 0
│ sum ⟨x⟩ = x
│ sum s ⌢ t = sum s + sum t
```