

Section 2.12 of notes

Q1. Let $u, v: \text{seqCITY}$
 $u = \langle \text{London, Amsterdam, Madrid} \rangle$
 $v = \langle \text{Paris, Frankfurt} \rangle$

- (a) Write down the values of $u \hat{\vee} v$, $\text{rev}(u \hat{\vee} v)$, $\text{rev } u$, $\text{rev } v$ and $(\text{rev } v) \hat{\vee} (\text{rev } u)$.
 (b) Find the values of $\text{squash}(2..4 \triangleleft \text{rev}(u \hat{\vee} v))$ and $\text{squash}(4..2 \triangleleft \text{rev}(u \hat{\vee} v))$.
 (c) Find the value of $u \hat{\vee} v \upharpoonright \{ \text{London, Moscow, Paris, Rome} \}$
 (d) Find the value of $\text{tail}(u \hat{\vee} v) \hat{\text{front}}(\text{Moscow, Berlin, Warsaw})$

Q2. Suppose that the following declarations are defined:
 [CHAR] the set of all possible characters

Text

stream: seqCHAR

P

$\exists \text{Text}$

pat?: seqCHAR

pos!: \mathbb{N}

$(\exists \text{before, after: seqCHAR} \bullet \text{before} \hat{\text{pat}} \hat{\text{after}} = \text{stream} \wedge \text{pos!} = \# \text{before} + 1)$

\vee

$(\neg(\exists \text{before, after: seqCHAR} \bullet \text{before} \hat{\text{pat}} \hat{\text{after}} = \text{stream}) \wedge \text{pos!} = 0)$

- (a) Explain the meaning of each line of and the overall effect of the schema P.
 (b) Write a scheme *Delete* which deletes the first occurrence of the subsequence *pat?* from the stream and sets *pos!* to the start position of the subsequence (or to zero if the subsequence was not found).

Q3. Maintenance of a file consisting of a sequence of bytes

- (a) Define a schema for the state of a system that will maintain a file that is a sequence of bytes.
 (b) Give a schema for a suitable initialisation operation.
 (c) Give a schema for an operation to insert a sequence of bytes after a given position in the file.
 (d) Give a schema to delete a sequence of bytes within the file, given suitable starting and ending positions.
 (e) Give a schema to copy a sequence of bytes within the file, given the starting and ending positions, into an output buffer.

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Q4. A company lets its apartments to known customers for fixed time slots. At any given time an apartment may only be booked to one person. A system is required to handle bookings. From time to time apartments are acquired and given up. For a formal specification of this system give the following:

- (a) Schemas to describe the state of the system and an initialisation operation.
 (b) A schema for the operation to add a new customer.
 (c) A schema for the operation to acquire a new apartment.

- (d) A schema for the operation to make a booking of a given apartment to a given customer at a given time.
 (e) A schema for an enquiry operation to show all apartments that are free at a given time.

Q5. The Swiss Air Rescue organisation, REGA, has a fleet of helicopters that operate within Switzerland. Part of a formal specification for a control system for the helicopters is given here:

[AIRCRAFT] the set of all aircraft

[POINT] the set of all coordinates

helis: $\mathbb{P} \text{AIRCRAFT}$

Switzerland: $\mathbb{P} \text{POINT}$

base: $\text{AIRCRAFT} \rightarrow \text{POINT}$

dom base = helis

ran base \subseteq Switzerland

The set *helis* is the set of all aircraft (helicopters) operated by REGA. *Switzerland* is the set of points that are on Swiss territory. The function *base* gives the point that is the normal base for a given helicopter. Every REGA helicopter has a base and all REGA bases are in Switzerland.

The state of REGA's helicopters at any given time is given by the following: The functions *position*, *minsLeft* and *flightMins*, respectively, give the helicopter's current position, its remaining flying time in minutes, and its flight time to a given point in minutes.

REGA

position: $\text{AIRCRAFT} \rightarrow \text{POINT}$

minsLeft: $\text{AIRCRAFT} \rightarrow \mathbb{N}$

flightMins: $\text{AIRCRAFT} \rightarrow (\text{POINT} \rightarrow \mathbb{N})$

dom position = dom flightMins = dom minsLeft = helis

Use the variables from the schema REGA in answering the following questions.

- (a) Explain the meaning of each component of the predicate of the schema REGA.
 (b) Write an expression that states that all REGA's helicopters are currently within Switzerland.
 (c) Write an expression to state that any point in Switzerland can be reached by a REGA helicopter within 15 minutes.
 (d) Write an expression to state that each REGA helicopter is currently at a REGA base.
 (e) Write an expression to state that each REGA helicopter is currently at its own base.
 (f) Write an expression to state that every REGA helicopter has enough flying time left to reach a REGA base.