**Exercise:**

1. specify: `let r = ref 5 and s = ref 3 and t = r`.

2. specify the state after subsequently executing: `incr r`.

3. specify the state after subsequently executing: `incr t`.

In-place list reversal. Before the loop: After the loop: Loop invariant:

Mlength with a while loop. Before the loop:

After the loop:

where \( L \) denotes the list of items in the list segment from \( p \) (inclusive) to \( q \) (exclusive).

**Exercise:** generalize `MList` to define \( p \rightarrow MlistSeg q L \),

\[ p \rightarrow MlistSeg q L \]

Enter:

Exit:
Step:

**Exercise:** define the representation predicate $p \leadsto \text{Queue } L$.  

**Exercise:** define $p \leadsto \text{Mtree } T$.  

**Exercise:** define $p \leadsto \text{MtreeDepth } nT$ by generalizing $p \leadsto \text{Mtree } T$.  

**Exercise:** give an alternative definition of “$p \leadsto \text{MtreeDepth } nT$”, this time by reusing the definition of $p \leadsto \text{Mtree } T$ without modification.  

**Exercise:** define a predicate $p \leadsto \text{MtreeComplete } T$ for describing a mutable complete binary tree, of some unspecified depth.  

**Exercise:** define a predicate $p \leadsto \text{MsearchTree } E$ for describing a mutable binary search tree storing the set of elements $E$.  

**Exercise:** specify the
primitive operations on references.

\( (\text{ref } v) \)

\( (!r) \)

\( (r := v) \)

Give specifications for:

\( (\text{Array.get } i \ p) \)

\( (\text{Array.set } i \ p \ v) \)

\( (\text{Array.length } p) \)

\( (\text{Array.create } n \ v) \)

Interpretation of triples (1/3).
How is a triple \( \{H\} t \{Q\} \) interpreted?

\[ \forall m. \ H m \ \Rightarrow \ \exists v, \exists m'. \ (t, m) \downarrow \langle v, m' \rangle \land \]

Interpretation of triples (2/3).
In Separation Logic, a triple describes only a part \( m_1 \) of the heap.
The rest of the heap, call it \( m_2 \), is assumed to remain unchanged. How is a triple \( \{H\} t \{Q\} \) interpreted?

What is the natural specification of function \text{myref}? What is missing from our current interpretation of triple?