INF5150 Solution to Exercises

The sequence diagrams for the exercises are on the final page.

1. Calculate the semantics of each of the sequence diagrams Ex1, Ex2 and Ex3.

Let

t1=<!a,?a,!b,?b,!c,?c>	t3=<!a,?a,!c,?c>	t4=<!a,?a,!b,?b,!d,?d,!c,?c>
t2=<!a,!b,?a,?b,!c,?c >		t5=<!a,!b,?a,?b,!d,?d,!c,?c>
		t6=<!a,?a,!b,?b,!d,!c,?d,?c>
		t7=<!a,!b,?a,?b,!d,!c,?d,?c>

[[Ex1]]={ ({t1,t2},∅) }
[[Ex2]]={ ({t3},{t1,t2}) }
[[Ex3]]={ ({t1,t2},{t4,t5,t6,t7}) }

2. Answer the following:
   a. Is Ex2 a refinement of Ex1?
   Yes; t1 and t2 have been moved from the positive to the negative (narrowing), while t3 has been moved from the inconclusive to the positive (supplementing).

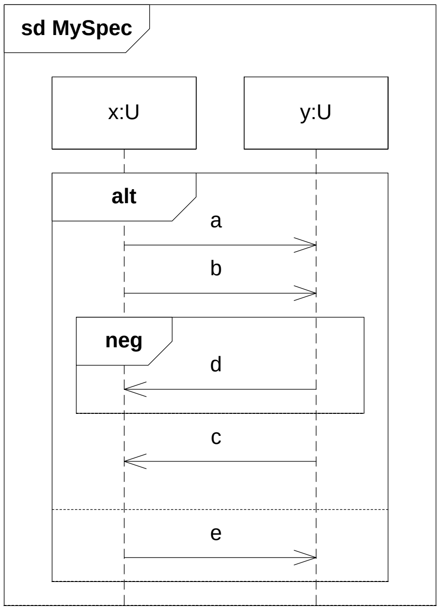
   b. Is Ex1 a refinement of Ex2?
   No; t1 and t2 have been moved from the negative to the positive, while t3 has been moved from the positive to the inconclusive.

   c. Is Ex3 a refinement of Ex1?
   Yes; The positive traces of Ex1 remain positive, while the traces t4,t5,t6 and t7 have been moved from the inconclusive to the negative (supplementing)

   d. Is Ex1 a refinement of Ex3?
   No; t4,t5,t6 and t7 have been moved from the negative to the inconclusive.

3. Make a specification called MySpec that is a refinement of Ex3.

This can of course be solved in many ways; below is one suggestion. A new positive trace t8=<!e,?e> has been added (supplementing).



a. Is Ex1 a refinement of MySpec?
No; the traces t4,t5,t6,t7 and t8 are inconclusive in Ex1, but not in MySpec.

b. Is MySpec a refinement of Ex1?
Yes; The traces that are positive in Ex1 remain positive in MySpec, while new traces that were inconclusive in Ex1 have become either positive (t8) or negative (t4,t5,t6,t7) in MySpec (supplementing).

4. Is Ex7 a refinement of Ex6?

Yes. Let
t9=<!f,?f,!g,?g> t10=<!f,?f,!h,?h,!g,?g>
t11=<!f,?f,!h,!g,?h,?g>
Then

[[Ex6]]={ ({t1,t2,t9},∅) }
[[Ex7]]={ ({t1,t2,t9},{t4,t5,t6,t7,t10,t11}) }
The positive traces of [[Ex6]] remain positive in [[Ex7]], while new negative traces have been added (supplementing)

5. Consider the sequence diagrams Ex1, Ex6 and Ex8. Does the refinement relation hold between any of these specifications?

Let

o1=({t1,t2},∅) o2=({t1,t2,t9},∅) o3=({t9},∅)
Then
[[Ex1]]={o1} [[Ex6]]={o2} [[Ex8]]={o1,o3}
We then have

[[Ex1]]$\rightsquigarrow$[[Ex6]] holds, since o2 refines o1 (supplementing).

[[Ex6]]$\rightsquigarrow$ [[Ex1]] does not hold, since o1 does not refine o2. So there is no interaction obligation in [[Ex1]] that refines o2.

[[Ex1]]$\rightsquigarrow$[[Ex8]] holds, since o1 refines o1 (every interaction obligation refines itself).

[[Ex8]]$\rightsquigarrow$ [[Ex1]] does not hold, since there is no interaction obligation in [[Ex1]] that refines o3 (because t9 is inconclusive in o1, which is the only interaction obligation in [[Ex1]])

[[Ex6]]$\rightsquigarrow$ [[Ex8]] does not hold, since neither o1 nor o3 refines o2. This is because t9 is inconclusive in o1, and t1 and t2 are inconclusive in o3.

[[Ex8]]$\rightsquigarrow$[[Ex6]] holds, since o2 refines both o1 and o3 (supplementing).

6. Consider only for the sake of this exercise an alternative refinement relation for interaction obligations defined by the following:

   (p',n') is a refinement of (p,n) if and only if $p \cup n = p' \cup n'$ & $p' \subseteq p$.

   What would this correspond to in pre/post-specifications?
   a. Weakening the pre-condition
   b. Strengthening the post-condition
   c. Both weakening the pre-condition and strengthening the post-condition
   d. None of the above

Answer: b. The requirement that $p \cup n = p' \cup n'$ means that supplementing is not allowed. Since supplementing corresponds to weakening the pre-condition, alternatives a and c cannot be correct.

The requirement that $p' \subseteq p$ (together with $p \cup n = p' \cup n'$) means that traces that were initially positive may become negative. This corresponds to strengthening the post condition. The traces that are in p but not in p' fulfill the original post-condition, but not the new post-condition. And all traces in p' are also in p.

Note1: The definition $p' \cup n'$ & $p' \subseteq p$ allows the two interaction obligations (and hence their positive sets) to be identical. Therefore the pre-conditions can also be identical.
Note2: In this exercise we have assumed that no trace is both positive and negative in the same interaction obligation. It is not possible for a trace to both fulfill and not fulfill a given post-condition, so there is no pre-post specification corresponding to an interaction obligation where a trace is both positive and negative.