Programming and Modelling
Robotic Arm Project Assignment Sheet

Weeks 3-4: Refining the System Boundary Definition model

Submit your solutions via the assignment dropbox on Brightspace, Week 3-4. Please make sure to submit your solutions **by 29 February**, 23:59. In your submission, please include your Overture project of your robotic arm model, and a text file or PDF file called "ANSWERS" with your answers to each question and subquestion.

Exercises

(1) Sketch four example line chart graphs of robotic arm angles vs time steps, similar to the scatterplot illustrated in the robotic arm description, Figure 4 (you may certainly create more graphs if you would like to). Use pen and paper, or any drawing program you like. Each point in your graphs should represent the actual angle of the robot arm at each time point. In each graph, include the initial and target angles, and give a brief description (1-2 sentences) of what is being illustrated in the graph and simulated scenario, particularly by referring to the requirements of the system.
   (a) At least one of your graphs should illustrate the ideal "perfect situation" with how the robotic arm should move.
   (b) At least one of your graphs should show examples of what can go wrong, i.e. what kinds of scenarios are undesirable and should be avoided if possible.

(2) For each of your graphs in exercise (1) above, create a corresponding scenario simulation in VDM-RT notation as operations in the World class. Follow the approach for the scenario operations Scenario1() and Scenario2() that we developed for the steam boiler case in lectures.
   Remark: The numerical values in your VDM-RT scenarios **do not** necessarily need to match exactly with your graph, but should be a fair approximation that captures the main concept of each of your graphs.

(3) In lectures we discussed *contracts* for the Step function of the steam boiler. These consisted of pre-conditions and post-conditions. In your "ANSWERS.TXT" file, write down a contract for your robotic arm step function.

(4) Based on your UML class diagram from the previous robotic arm assignment, create a first simple robotic arm formal model project in Overture.
   Remark: we recommend to only model the current state, rather than modelling time explicitly as sequences.

(5) Run your scenario operations that you developed for exercise (2) above on your model to create four simulation traces. For each scenario, write out the scenario table (as presented in the lecture slides) showing the value of state variables and time, for each scenario instruction.
   Remark: your tables should **not** have an excessive number of rows, e.g. more than 15 rows is probably too many. Remember, the main purpose of this modelling stage is to start to understand the environment, system and requirements.