This homework is officially due in class on **Thursday, September 14**. However, it comes with an automatic extension: anything submitted to the labeled bin near CST 4-226 by **noon on Friday, September 15** will be accepted as being on time.

You **may work singly or in pairs** on this assignment: if you work with someone else, (1) make sure you’re both enrolled in the same version of the course (CIS 400 or CIS 632) and (2) turn in a single assignment with both names on it. Make sure you complete and attach a disclosure cover sheet.

**Exercises**

1. (30 points) Consider the following process definitions:

   \[ A \overset{\text{def}}{=} a.A' \quad B \overset{\text{def}}{=} c.B' \]

   \[ A' \overset{\text{def}}{=} \overline{c}.A \quad B' \overset{\text{def}}{=} \overline{b}.B \]

   Give formal derivations for each of the following transitions:

   (a) \((A' + B')\{a\} \xrightarrow{\overline{b}} B\{a\}\)

   (b) \((A|B)\{b,c\} \xrightarrow{a} (A'|B)\{b,c\}\)

   (c) \(a.c.B + (A'|B)\{a,c\} \xrightarrow{\tau} (A|B')\{a,c\}\)

2. (15 points) Consider the following process definitions:

   \[ C \overset{\text{def}}{=} a.(b.C + c.C) \]

   \[ D \overset{\text{def}}{=} a.(\tau.b.D + \tau.c.D) \]

   \[ E \overset{\text{def}}{=} \overline{b}.E \]

   (a) Draw the transition graph for \((C|E)\{b, c\}\).

   (b) Draw the transition graph for \((D|E)\{b, c\}\).

   (c) In a sentence or two, describe the difference between the two transition graphs in terms of the “choices” that \(C\) and \(D\) make and how \(E\) influences them.

3. (45 points) A particular student has the following behavior:

   The student repeatedly (until/unless he drops the class) does his homework (\(\text{doHW}\)), hands it in (\(\text{handin}\)), and then receives either a passing (\(\text{pass}\)) or failing (\(\text{fail}\)) grade on the assignment. That grade determines what he does next:

   - If he receives a passing grade, the student cheers (\(\text{cheer}\)), and then begins the entire cycle again.
   - If he receives a failing grade, the student immediately curses (\(\text{curse}\)) and then arbitrarily decides whether to drop the course (\(\text{drop}\), which would be his final action) or to continue with the next assignment (i.e., start the cycle again).

   (a) Write a CCS process \(\text{STU}\) to describe this student, using the following actions (plus \(\tau\), as necessary):

   \{\text{doHW, handin, pass, fail, cheer, curse, drop}\}
NOTE: The student’s environment (e.g., the instructor) has influence over whether or not he receives a passing or failing grade. However, the student’s environment does not have influence on whether (after receiving a failing grade) he drops the course or decides to continue on with the next assignment.

(b) There’s an instructor with the following very simple (and repetitive) behavior:

She unilaterally decides (with no apparent influence from her environment) whether to give a passing grade (pass) or a failing grade (fail). After assigning a grade, she prepares to grade the next assignment.

Write a CCS process INS to describe this instructor, using only actions from the set \{pass, fail, \(\tau\}\).

(c) Draw the transition graph of \((STU|INS)\setminus X\), where

\[ X = \{\text{pass, fail}\}. \]

You can use abbreviations for the subprocesses of \(STU\) and \(INS\), rather than spelling out the full processes for each node of the transition graph. I’ll explain more fully in lecture what I have in mind.