CSE 660 Homework 3
Thanh Ho

1. (10 points) A ring network has 10 logical nodes. Six distinct computers (i.e. each computer has a unique ID) are to be assigned to the nodes and each node can associate with at most one computer. How many different ways can we assign the 6 computers to the 10 nodes?

**Answer:**

\[ P(10, 6) = 151200 \text{ different ways} \]

2. (20 points) A DHT Chord network uses 4 bits (i.e. \( m = 4 \)) to identify machines and keys of entities. At a certain time, machines with identifiers 2, 5, 9, and 11 are attached to and active in the network.
   a. Draw a diagram to show the machine ids and keys of the network.
   b. Find the finger table of each of the machines.
   c. An application running in node 11 is looking for the entity with key value 7. Find the route the system takes to get to the node that has the entity. Show your steps clearly and draw the route on your diagram.

**Answer:** Search linear from node 11 \( \rightarrow 2 \rightarrow 5 \rightarrow 9 \). We found value 7 in node 9.
3. (10 points)

   a. Would you consider a URL such as http://www.acme.org/index.html to be location independent? What about http://www.acme.nl/index.html?

   Answer:

   a. Both addresses are location independent because their names can’t tell us where their locations are. Although they have hints: “.org” refers to organization and “.nl” refers to Netherlands, they do not decide the locations.

   b. 1000 times/msec = 60 000 000 times/min
       990 times/msec = 59 400 000 times/min
   => maximum clock skew is 600 000 times/min

4. (10 points) if each process uses a different value for d in the Lamport’s clock and vector clock equations, will the logical clocks and vector clocks schemes satisfy the total order relation => and the relation: a → b iff t^a < t^b. Explain your argument in detail.

   Answer:

   They are still satisfied, because:

   if a, b are in the same process, value d does not affect;

   if a is in Pi and b is in Pj,
   
   C_j(b) = max(C_j(b), tm + d) which tm = C_i(a)
   
   or all k, C_j(b)[k] = max(C_j(b)[k],tm[k]) which tm[k] = C_i(a)
5. (10 points)
Suppose Process P1 has events: \( e_{11}, e_{12}, e_{13}, e_{14}, e_{15}, e_{16}, e_{17} \)
P2 has events: \( e_{21}, e_{22}, e_{23}, e_{24}, e_{25}, e_{26} \)
P3 has events: \( e_{31}, e_{32}, e_{33}, e_{34}, e_{35}, e_{36} \)
There are message transits from \( e_{12} \) to \( e_{22} \), \( e_{24} \) to \( e_{15} \), \( e_{21} \) to \( e_{32} \), \( e_{35} \) to \( e_{25} \). Suppose the vector time clocks for \( e_{11}, e_{21}, \) and \( e_{31} \) are 
\[
\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}
\] respectively.

a) Draw a diagram to show all the transitions and events.
b) Find the vector clocks of all the events.
c) Give an example for each of the following:
   i) a strongly consistent state
   ii) a consistent but not strongly consistent state
   iii) an inconsistent state

Your global state should be consisted of the events given (e.g. \( e_{11} \)) but should not contain any event that is sending (e.g. \( e_{12} \)) or receiving a message (e.g. \( e_{22} \)).

**Answer:**

\[
\begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 2 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 3 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 4 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 5 \\ 4 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 6 \\ 4 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 7 \\ 4 \\ 0 \\ 0 \end{pmatrix}
\]
Inconsistent \(\{LS_{11}, LS_{23}, LS_{33}\}\)

Consistent \(\{LS_{14}, LS_{25}, LS_{35}\}\)

Strongly consistent \(\{LS_{12}, LS_{22}, LS_{32}\}\)