CS 337 **Test 3** **5/15/09**

Open book and notes.

Max points = 75 Time = 75 min Do all questions.

1. (Relational Databases; 15 points) You are given relations SL (denoting Stores and Locations), IT (Items and Types) and SIP (Stores, Items and Prices) in Table 1, Table 2 and Table 3, respectively.

Store	Location
Amazon	WA
Fry's	CA
Fry's	TX
Best Buy	TX
Olde Tire	TX

Table 1: SL: Stores and Locations

Item	Type
Nikon Cool-Pix	Camera
Sony Cybershot	Camera
Dell Inspiron	Computer
Firestone	Tire

Table 2: IT: Items and Types

Store	Item	Price
Amazon	Nikon Cool-Pix	240
Amazon	Dell Inspiron	1200
Fry's	Nikon Cool-Pix	250
Fry's	Sony Cybershot	310
Best Buy	HP Laptop	1300
Best Buy	Sony Cybershot	280
Olde Tire	Firestone	500

Table 3: SIP: Stores, Items and Prices

(a) (7 points) Compute their (natural) join, $SL \bowtie IT \bowtie SIP$.

(b) (4 points) Write a query for (but don't compute) the stores in TX that sell a Camera for less than 300.

(c) (4 points) Write a query for (but don't compute) the stores, locations, items and prices for all computers that are being sold.

2. (Rabin-Karp String Matching; 12 points)

   - (8 points) You are given the text string 01110011010001100111, and you are matching the pattern 1100. Use the hash function $m \bmod 3$, where m is 4-bit binary number. Show the values of the hash function, and the true matches. Repeat using mod 5 as the hash function.

     Hint: You are not required to apply the modular simplification rule to compute the hash function values; you may use simpler methods if you find them more convenient.
   - (4 points) What are the merits and demerits of using exclusive-or as the hash function in Rabin-Karp string matching over binary strings?

3. (KMP String Matching; 18 points)

   - (3 points) In doing string matching, which is better: prefixes of the pattern string have short cores or long cores? Write one sentence in explanation.
   - (9 points) It is given that cores of all prefixes of some string s are the empty string. State and briefly explain the necessary and sufficient conditions for s to satisfy this requirement (no formal proof needed).
   - (6 points) Find a shortest string whose core is "ababa". Argue that your answer is correct.

4. (Parallel Recursion; 30 points)

   (a) (4 points) Let function h be defined by

   $$h\langle x\rangle = \langle x\rangle$$
   $$h(p \bowtie q) = p \mid q$$

   What is $h\langle 0\ 1\ 2\ 3\ 4\ 5\ 6\ 7\rangle$?

   (b) (8 points) Use the following definitions of right rotate (rr) and reverse (rev).

   $$rr\langle x\rangle = \langle x\rangle \qquad rr(p \bowtie q) = q \bowtie rr(p)$$
   $$rev\langle x\rangle = \langle x\rangle \qquad rev(p \bowtie q) = rev(q) \bowtie rev(p)$$

   Prove that for any powerlist u, $rev(rr(rev(rr\ u))) = u$. You may assume that $rev(rev\ q) = q$, for any powerlist q.

   (c) (10 points) You are given two infinite families of powerlists, u and v, where u_i is the i^{th} powerlist in the u family, and similarly v_i. They are defined by,

   $$u_0 = \langle 0\rangle, \qquad v_0 = \langle 1\rangle$$
   $$u_{i+1} = u_i \mid v_i, \qquad v_{i+1} = v_i \mid u_i$$

   Show that for all i, $i \geq 0$,

   i. $u_{i+1} = u_i \bowtie v_i$, and $v_{i+1} = v_i \bowtie u_i$.

   ii. u_i is the bit-wise complement of v_i.

   (d) (8 points) It is required to compute the prefix-sum of $\langle 3\ 0\ 4\ 6\ 0\ 1\ 6\ 0\rangle$ using addition over integers as the (associative) operator. The result is the list $\langle 3\ 3\ 7\ 13\ 13\ 14\ 20\ 20\rangle$.

   Use the list function sps defined in your notes in Page 226, and graphically show the movement of data in computing this prefix-sum.