Introduction to Computer Science – Final Exam

June 19, 2002

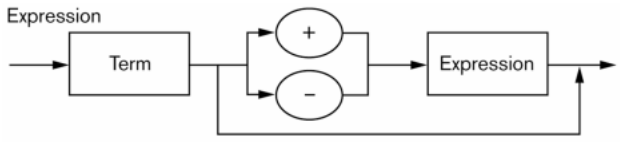
1. (5%) Suppose the procedure modify is defined by

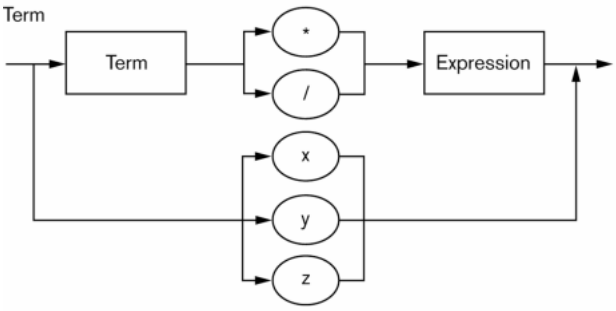
   procedure modify(Y)
   assign Y **the value** 7;
   print the value of Y

If parameters are passed by value, what will be printed when the following program segment is executed? What if parameters are passed by reference?

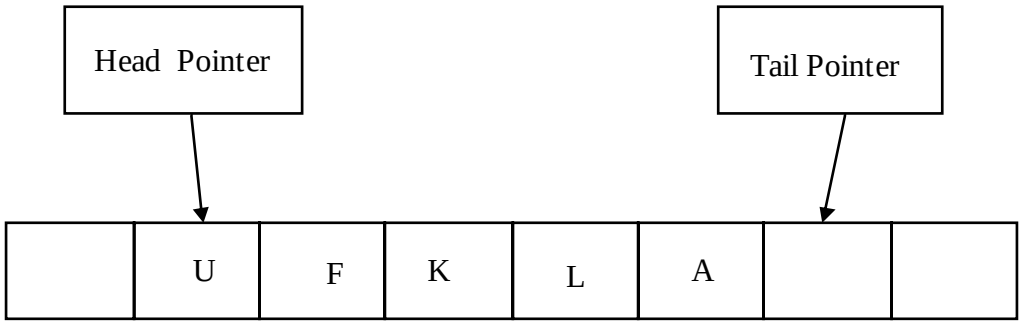
   assign x **the value** 5;
   apply modify **to** x;
   print the value of x

2. (5%) Draw the parse tree for the expression x * y + x + z based on the following syntax diagrams





3. (5%) Is the collection of statements $\neg R$, $(T\ OR\ R)$, $(P\ OR \neg Q)$, $(Q\ OR \neg T)$, and $(R\ OR \neg P)$ consistent? Explain your answer.
4. (5%) Design a procedure to compare the contents of two stacks.
5. (5%) Suppose a queue implemented in a circular fashion is in the state shown in the figure below. Draw a diagram showing the structure after the letters G and R are inserted, three letters are removed, and the letters D and P are inserted



6. (5%)Draw a binary tree that you could use to store the list R, S, T, U, V, W, X, Y, and Z for further searching.
7. (5%) If a hashed file is hashed into 10 buckets, what is the probability of at least two of three arbitrary records hashing to the same section? (Assume the hash algorithm gives no bucket priority over the others.) How many records must be stored in the file until it is more likely for collisions to occur than not?
8. (5%) Using the commands SELECT, PROJECT, and JOIN, write a sequence of instructions to answer each of the following questions about parts and their manufacturers in terms of the following database:

PART relation

PartName	Weight
Bolt2X	1
Bolt2Z	1.5
NutV5	0.5

MANUFACTURER relation

CompanyName	PartName	Cost
Company X	Bolt2Z	.03
Company X	NutV5	.01
Company Y	Bolt2X	.02
Company Y	NutV5	.01
Company Y	Bolt2Z	.04
Company Z	NutV5	.01

(1) Which company makes Bolt2Z?
(2) Obtain a list of the parts made by Company X along with each part's cost.
(3) Which companies make a part with weight 1?

9. (5%) Answer Problem 8 using SQL.
10. (5%) Reduce the following database into the 1st, 2nd, and 3rd normal forms.

Product Supply Table

ProducerID	ProductID	Producer	Area	Code
P0001	C001	STK.CO	NY	002
P0001	C002	STK.CO	NY	002
P0002	C001	UCCE	SC	003
P0003	C003	STT.CO	NY	002

11. (5%) Using the heuristic-oriented search algorithm introduced in the class, draw the corresponding search trees in each step of the algorithm to solve the eight-puzzle from the following start state:

1	2	3
4	8	5
7	6	

12. (5%) Design a public key encryption system based on the list

    2 3 6 12 24

and the fact that 30 and 38 are multiplicative inverses in a modular system with modulus 67.

13. Explain the following concepts briefly
    (1) Software Development Phases (5%)
    (2) Design Patterns (5%)
    (3) File Allocation Tables (5%)
    (4) Partial Index (5%)
    (5) Genetic Algorithms (5%)
    (6) Artificial Neural Networks (5%)
    (7) Turing Computable (5%)
    (8) NP-Complete (5%)

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Solution for Reference

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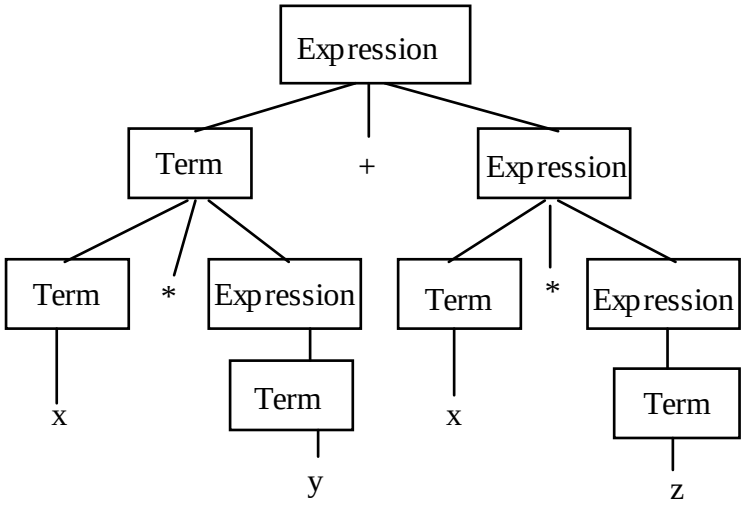
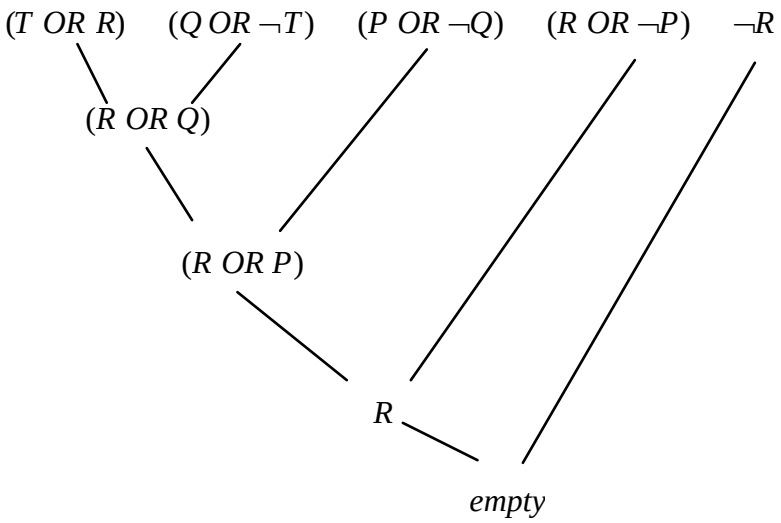
1. Pass by value: 7, 5
   Pass by reference: 7, 7

2.

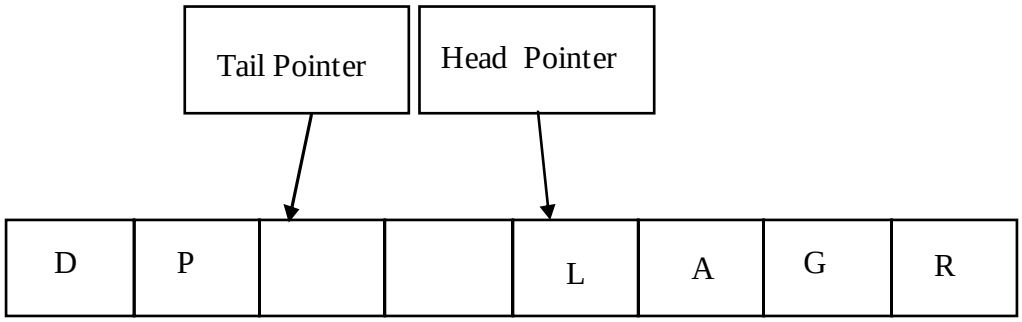


3. Inconsistent. Using resolution, as shown by the following graph, we can prove that it is impossible for all statements to be true at the same time.

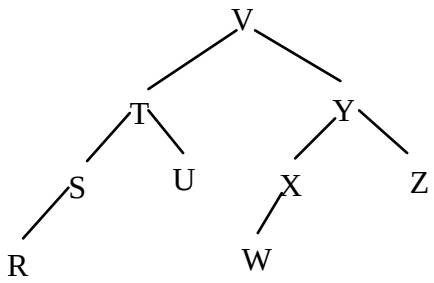


4. **procedure** StackEqual(Stack1, Stack2)
   while(Stack1 is not empty and Stack2 is not empty) **do**
   (Pop a data off Stack1;
     Pop a data off Stack2;
     if(data from Stack1 is not equal to data from Stack2) **then** (report unequal);
)
   if(Stack1 is empty and Stack2 is empty) **then** (report equal)
   else (report unequal)

5.



6.



7. (1) $1-\frac{10}{10}\times\frac{9}{10}\times\frac{8}{10}=0.28$

   (2) The probability of collisions for 4 records and 5 records are $1-\frac{10}{10}\times\frac{9}{10}\times\frac{8}{10}\times\frac{7}{10}=0.496<0.5$ and $1-\frac{10}{10}\times\frac{9}{10}\times\frac{8}{10}\times\frac{7}{10}\times\frac{6}{10}=0.6976>0.5$, respectively. Thus 5 or more records must be stored in the file such that it is more likely for collisions to occur than not

8. (1) NEW ← SELECET from MANUFACTURER where PartName = Bolt2Z
   RESULT ← PROJECT CompanyName from NEW
   (2) NEW ← SELECT from MANUFACTURER where
   CompanyName = CompanyX
   RESULT ← PROJECT PartName, Cost from NEW
   (3) NEW ← JOIN PART and MANUFACTURER where
   PART.PartName = MANUFACTURER.PartName
   NEW1 ← SELECT from NEW where PART.Weight = 1
   RESULT ← PROJECT MANUFACTURER.CompanyName from NEW1

9. (1) select CompanyName from MANUFACTURER where PartName = Bolt2Z
   (2) select PartName, Cost from MANUFACTURER where
   CompanyName = Company X
   (3) select MANUFACTURER.CompanyName from PART, MANUFACTURER where PART.PartName = MANUFACTURER.PartName and PART.Weight = 1

10. 1st normal form

ProducerID	ProductID	Producer	Area	Code
P0001	C001	STK.CO	NY	002
P0001	C002	STK.CO	NY	002
P0002	C001	UCCE	SC	003
P0003	C003	STT.CO	NY	002

2nd normal form

ProducerID	ProductID
P0001	C001
P0001	C002
P0002	C001
P0003	C003

ProducerID	Producer	Area	Code
P0001	STK.CO	NY	002
P0002	UCCE	SC	003
P0003	STT.CO	NY	002

3rd normal form

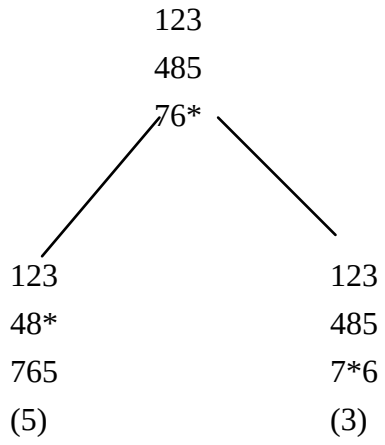
ProducerID	ProductID
P0001	C001
P0001	C002
P0002	C001
P0003	C003

ProducerID	Producer	Area
P0001	STK.CO	NY
P0002	UCCE	SC
P0003	STT.CO	NY

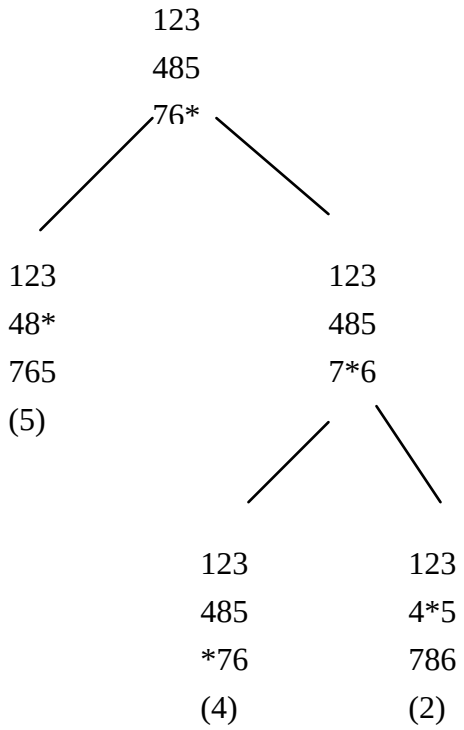
Area	Code
NY	002
SC	003
NY	002

11. Beginning

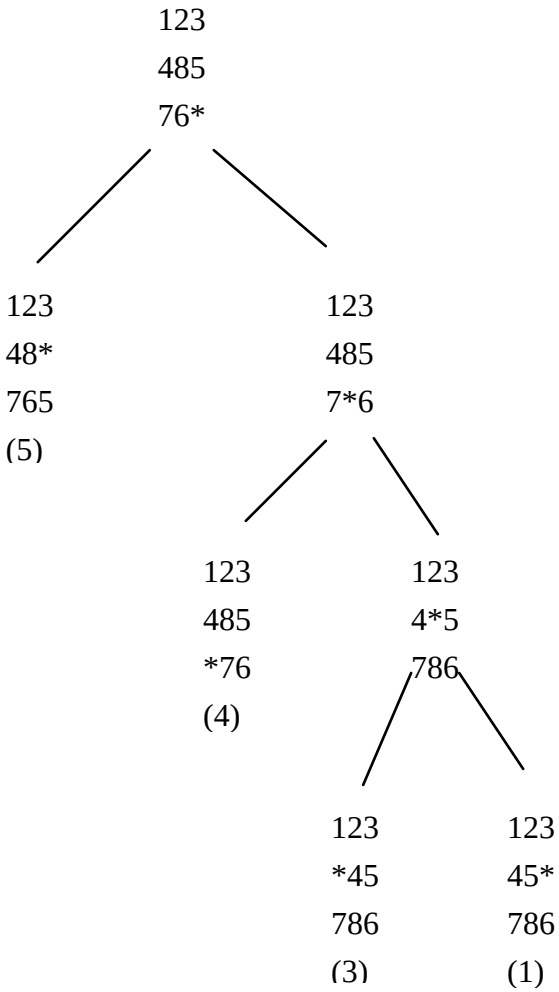
(a star is used to indicate an empty position)



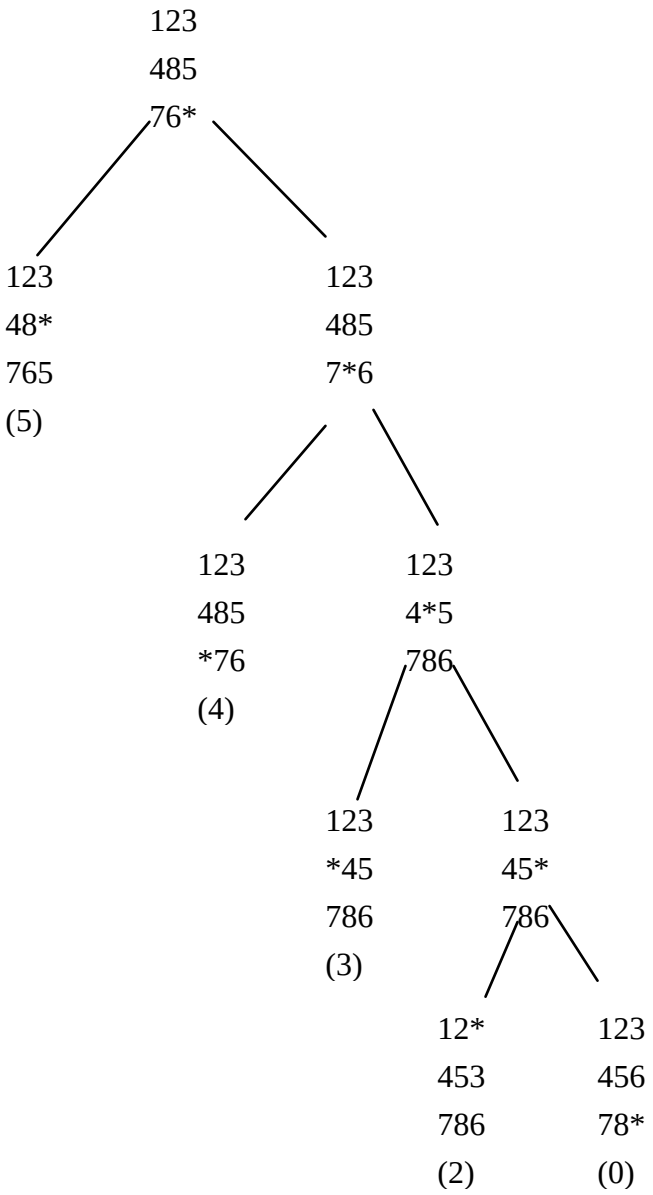
After Pass 1



After Pass 2


123
485
76*
123
48*
765
(5)
123
485
7*6
123
485
*76
(4)
123
4*5
786
123
*45
786
(3)
123
45*
786
(1)

After Pass 3



12. Solution 1:

$$2\times 30\,(\text{mod } 67) = 60,\ \ 3\times 30\,(\text{mod } 67) = 23,\ \ 6\times 30\,(\text{mod } 67) = 46,$$
$$12\times 30\,(\text{mod } 67) = 25,\ \ 24\times 30\,(\text{mod } 67) = 50$$

Solution 2:

$$2\times 38\,(\text{mod } 67) = 9,\ \ 3\times 38\,(\text{mod } 67) = 47,\ \ 6\times 38\,(\text{mod } 67) = 27,$$
$$12\times 38\,(\text{mod } 67) = 54,\ \ 24\times 38\,(\text{mod } 67) = 41$$

13. (1) Software Development Phases

Analysis, Design, Implementation, Testing

(2) Design Patterns

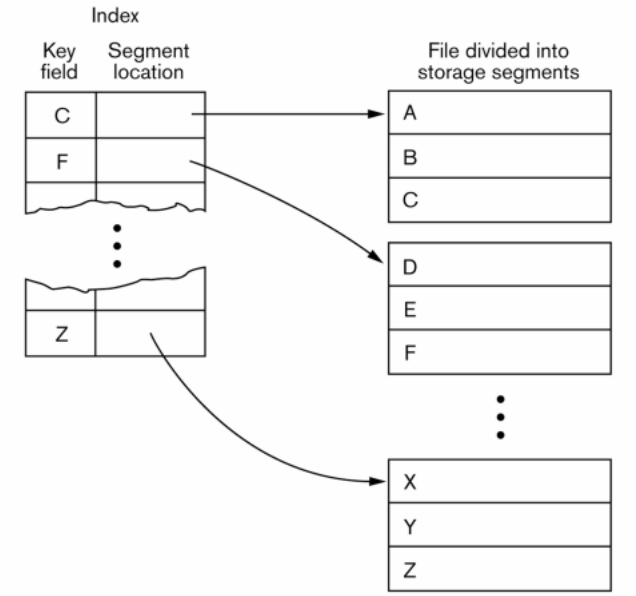
Some software design problems appear again and again. Their solutions can be collected as a set of patterns called design patterns. Each pattern consists of the statement of a problem followed by a proposed solution.

(3) File Allocation Tables

File allocation tables (FAT) are the tables that an operating system maintains to keep records of which disk cluster is assigned to which file

(4) Partial Index

An example is as the following figure, where we have indicated only the key field entry in each record and have assumed that these entries are single, alphabetical letters.



(5) Genetic Algorithms

Genetic algorithms are algorithms emulating natural evolution to the problem-solving task. The proposed solutions are represented by strings of symbols. The solutions that perform better are kept and their strings of symbols cross over and mutate to derive the next generation of proposed solutions. We can often get good solutions after several generations.

(6) Artificial Neural Networks

Artificial neural networks are networks of processors work like networks of biological neurons. Just like neurons, the processors output a significant value only when their weighted sums of inputs from other processors are larger than a threshold value.

(7) Turing Computable

A function that can be computed by a Turing machine is said to be Turing computable.

(8) NP-Complete

NP-complete problems are a class of problems within the NP (nondeterministic polynomial problems) class. These problems have the property that a polynomial time solution for any of them would provide a polynomial time solution for all the other problems in NP as well.