CS 91 USACO

Bronze Division

Unit 3: Problem Solving Using Algorithms

LECTURE 11: COMPLETE SEARCH – PROBLEM SOLVING SESSION A

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Objectives

- Practice Problem : Name that number
- Practice Problem: Palindromic Squares
- Guided Student Practice Session

Practice: Name that Number (namenum)

SECTION 1

Problem Statement

- Among the large Wisconsin cattle ranchers, it is customary to brand cows with serial numbers to please the Accounting Department. The cow hands don't appreciate the advantage of this filing system, though, and wish to call the members of their herd by a pleasing name rather than saying, "C'mon, #4734, get along."

Problem Statement

- Help the poor cowhands out by writing a program that will translate the brand serial number of a cow into possible names uniquely associated with that serial number. Since the cow hands all have cellular saddle phones these days, use the standard Touch-Tone(R) telephone keypad mapping to get from numbers to letters (except for "Q" and "Z"):

```
2: A,B,C      5: J,K,L      8: T,U,V
3: D,E,F      6: M,N,O      9: W,X,Y
4: G,H,I      7: P,R,S
```

Problem Statement

- Acceptable names for cattle are provided to you in a file named "dict.txt", which contains a list of fewer than 5,000 acceptable cattle names (all letters capitalized). Take a cow's brand number and report which of all the possible words to which that number maps are in the given dictionary which is supplied as dict.txt in the grading environment (and is sorted into ascending order).

Problem Statement

- For instance, the brand number 4734 produces all the following names:

```
GPDG GPDH GPDI GPEG GPEH GPEI GPFG GPFH GPFI GRDG GRDH GRDI
GREG GREH GREI GRFG GRFH GRFI GSDG GSDH GSDI GSEG GSEH GSEI
GSFG GSFH GSFI HPDG HPDH HPDI HPEG HPEH HPEI HPFG HPFH HPFI
HRDG HRDH HRDI HREG HREH HREI HRFG HRFH HRFI HSDG HSDH HSDI
HSEG HSEH HSEI HSFG HSFH HSFI IPDG IPDH IPDI IPEG IPEH IPEI
IPFG IPFH IPFI IRDG IRDH IRDI IREG IREH IREI IRFG IRFH IRFI
ISDG ISDH ISDI ISEG ISEH ISEI ISFG ISFH ISFI
```

Problem Statement

- As it happens, the only one of these 81 names that is in the list of valid names is "GREG".
- Write a program that is given the brand number of a cow and prints all the valid names that can be generated from that brand number or ``NONE'' if there are no valid names. Serial numbers can be as many as a dozen digits long.

INPUT FORMAT (file namenum.in):

- A single line with a number from 1 through 12 digits in length.

SAMPLE INPUT:

```
4734
```

OUTPUT FORMAT (namenum.out):

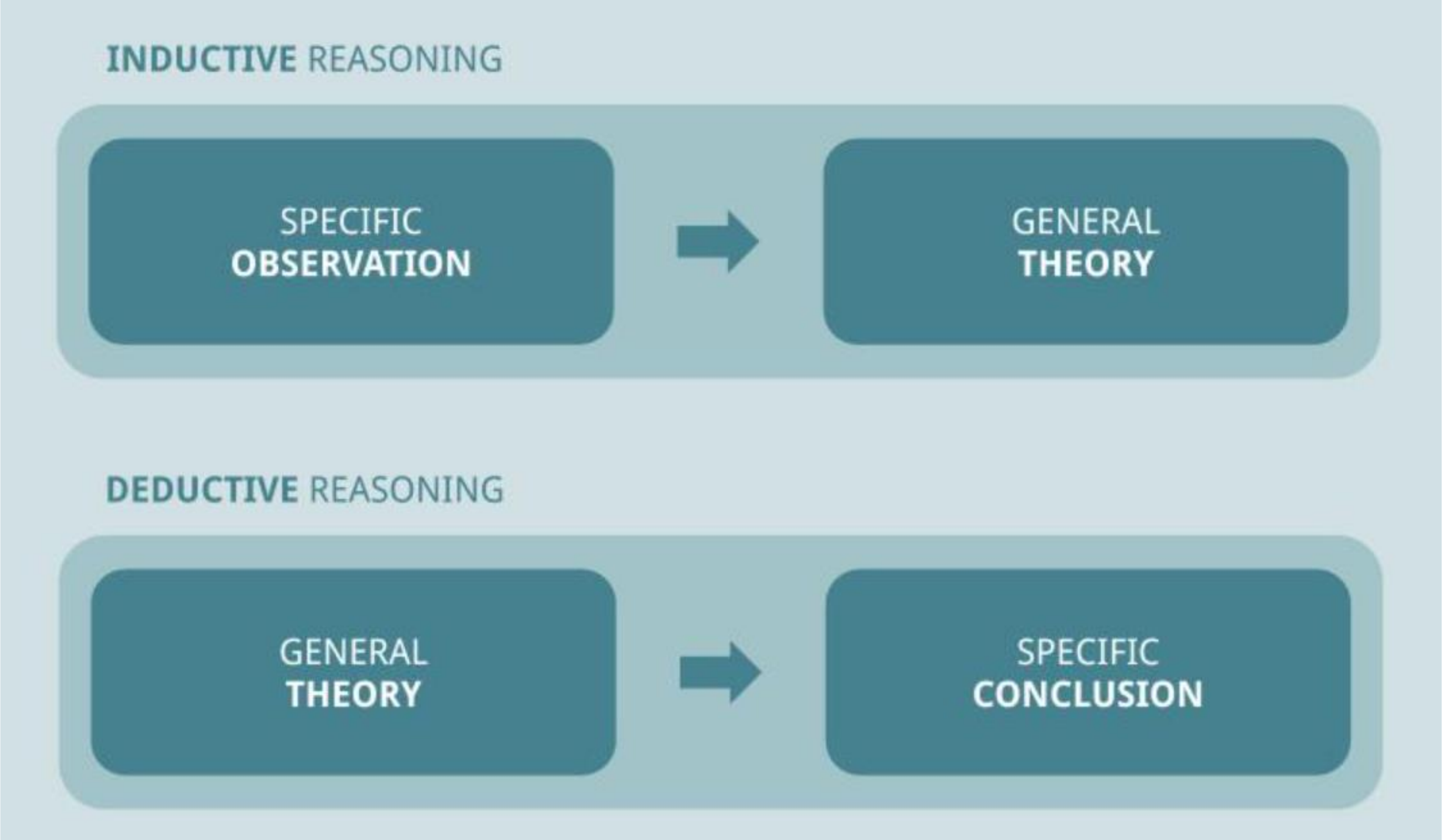
- A list of valid names that can be generated from the input, one per line, in ascending alphabetical order.

SAMPLE OUTPUT:

```
GREG
```

Nature of the Problem

- Sketching the right solution space
- Do not generate every possible candidate strings. It can be as many as 3^{12}
- Should search through dictionary to filter out the valid words.
- From Answer to Problem Space is better than from Problem Space to Answer this time.



INDUCTIVE REASONING

SPECIFIC **OBSERVATION** → GENERAL **THEORY**

DEDUCTIVE REASONING

GENERAL **THEORY** → SPECIFIC **CONCLUSION**

Practice: Palindromic Squares (palsquare)

SECTION 2

Problem Statement

- Palindromes are numbers that read the same forwards as backwards. The number 12321 is a typical palindrome.
- Given a number base B (2 <= B <= 20 base 10), print all the integers N (1 <= N <= 300 base 10) such that the square of N is palindromic when expressed in base B; also print the value of that palindromic square. Use the letters 'A', 'B', and so on to represent the digits 10, 11, and so on.
- Print both the number and its square in base B.

INPUT FORMAT (file palsquare.in):

- A single line with B, the base (specified in base 10).

SAMPLE INPUT:

```
10
```

OUTPUT FORMAT (palsquare.out):

- Lines with two integers represented in base B. The first integer is the number whose square is palindromic; the second integer is the square itself. NOTE WELL THAT BOTH INTEGERS ARE IN BASE B!

SAMPLE OUTPUT:

```
1 1
2 4
3 9
11 121
22 484
26 676
101 10201
111 12321
121 14641
202 40804
212 44944
264 69696
```

Nature of the Problem

- Read in a number from input file. The number is a radix (base) of a number system. But the number is represented in decimal value. B in [2, 20]
- Then, you need to find the numbers that has its own square to be a Palindrome number (using String to check) from 1 to 300.
- Time complexity: 300 * C

Key Function

- Integer.toString(i*i, base)
- isPalindrome(str)

Student Practice Session

SECTION 3

Procedure

- Each Student Pick a practice question.
- Allow each student to think about it for about 5-10 minutes
- Discuss how to solve it with students. Make sure students have their own directions.
- Students work on the problem.
- Review problems with students.

Feb 2016 Problem 1: Milk Pails (pails)

SECTION 4

Problem Statement

- Farmer John has received an order for exactly M units of milk (1≤M≤1,000) that he needs to fill right away. Unfortunately, his fancy milking machine has just become broken, and all he has are three milk pails of integer sizes X, Y, and M (1≤X<Y<M). All three pails are initially empty. Using these three pails, he can perform any number of the following two types of operations:

Problem Statement

- He can fill the smallest pail (of size X) completely to the top with X units of milk and pour it into the size-M pail, as long as this will not cause the size-M pail to overflow.
- He can fill the medium-sized pail (of size Y) completely to the top with Y units of milk and pour it into the size-M pail, as long as this will not cause the size-M pail to overflow.

Problem Statement

- Although FJ realizes he may not be able to completely fill the size-M pail, please help him determine the maximum amount of milk he can possibly add to this pail.

INPUT FORMAT (file pails.in):

- The first, and only line of input, contains X, Y, and M, separated by spaces.

SAMPLE INPUT:

```
17 25 77
```

OUTPUT FORMAT (pails.out):

- Output the maximum amount of milk FJ can possibly add to the size-M pail.

SAMPLE OUTPUT:

```
76
```

In this example, FJ fills the pail of size 17 three times and the pail of size 25 once, accumulating a total of 76 units of milk.

Nature of Problem

- Integer Programming

Goal Function: $g = a X + b Y \leq M$