

A201/A597 Introduction to Programming I

First Summer 2007



Lecture Thirteen: Thursday May 24, 2007 (ED1204)

We continue to review for the exam. Lab today wraps it up.



Minute paper: to be announced in class.



Lab Nine: Thursday May 24, 2007 (ED2025)

Write programs to solve the following problems:

- a) play the game of nim with the user
- b) play first-to-100 with the user
- c) determine if a positive integer is prime or not
- d) determine the greatest common divisor between two positive integers
- e) determine the prime factors of a positive integer

Let's take these programs one by one:

a) in the game of nim we start with a pile of marbles (usually 100, but you could play with a different initial height) and the two players remove marbles by taking turns. You will be writing a program where the user plays against the computer. Removing marbles must be done with this restriction in mind: always take at least one marble, but not more than half the current pile. The one who removes the last marble loses the game, that is, the winning move leaves just a marble behind.

Here's the basic conversational loop:

```
height = 100
print "The user moves first."
while height > 1:
    print "The height is:", height
    user = int(raw_input("How many do you take: "))
    height = height - user
    print "Computer's turn. The height is: ", height
    computer = 1
    height = height - 1
    print "Computer has moved", computer,"piece."
    print "User's turn now. "
```

You can start from this but notice that there are no checks, user can take any amount (even a negative number of marbles), computer always takes 1 piece (should be a random number between 1 and half the pile's height and we don't determine when the game ends and who wins. You need to add all of these.

b) first-to-100 is a similar game. The user moves first. The game starts with a sum of 0. Each time one player moves that player adds a number between 1 and 10 to the sum. The first player to make the sum 100 wins the game.

The game has a winning strategy: 1, 12, 23, 34, 45, 56, 67, 78, 89, 100.

Here's a starting point:

```
import random
sum = 0

while True:
    user = int(raw_input("User move: "))
    if user <= 10 and user >= 1:
        sum += user
    else:
        print "User lost: illegal move."
        break
    computer = random.randrange(10) + 1
    sum += computer
```

Unlike the starting point at a) this code isn't as verbose, so you need to add that, and finish it too.

c) A number is prime if it is divisible with itself, 1 and no other number. (We are talking positive integers). Thus to determine if a number is prime you need to start at 2 and check all the way up to $n - 1$ (assume n is the number) including. If at any point k divides n the number is not a prime number. Otherwise the number is prime. (k is the loop variable that helps you examine the values 2, 3, 4, ..., $n-2$, $n-1$).

d) The greatest common divisor of two numbers is just what it names says it is. Thus the idea is to look at the two numbers (both positive integers) and realize that the greatest common divisor can't be bigger than the smaller of the two numbers. Now we should look at all the numbers between 1 and $\min(n, m)$ where n and m are the two given numbers and the biggest such number that divides both n and m is declared $\text{gcd}(n, m)$.

e) This is a more demanding version of the problem at c). Be the computer. How would you solve this problem? Suppose you are being given 12. What are its prime factors? You would start at 2 and ask: is $12 \% 2 == 0$? Yes. So print 2, and divide 12 by 2. Now we are working with 6. We are still on 2. Is $6 \% 2 == 0$? Yes, so we print another 2 and take it out of the number: $6 / 2 = 3$. We are still on 2, but $3 \% 2$ is no longer 0. So we need to move from 2 to 3. Now $3 \% 3 == 0$. We print 3 and we take it out of the number. The number becomes $3 / 3$, that is, 1. At this point we stop. The prime factors are what we printed up to this point: 2, 2, 3.

Another example: 21. Start at 2. Let's build a table:

2	21 not divisible with 2
3	$21 \% 3 == 0$. print 3. Turn 21 into 7. 7 not divisible with 3.
4	7 not divisible with 4.
5	7 not divisible with 5.
6	7 not divisible with 6.
7	$7 \% 7 == 0$. print 7. Turn 7 into 1. Stop.



Homework Seven.

Produce a concise and complete summary of chapters 4 and 5 in the text.

Just summarize all that you think is essential to the problems we've worked out.