Design and Analysis of Algorithms

L03: Algorithm Simple Exercises

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Resources

- https://introcs.cs.princeton.edu/java/11hello/

Understanding Programs: 01

- What does following code segment outputs

```
int n = 987654321;
int digits = 0;
while (n > 0) {
    n = n / 10;
    digits++;
}
System.out.println(digits);
```

Understanding Programs: 02

- What does following code segment outputs

```
int n = 987654321;
String s = "";
while (n > 0) {
    int digit = n % 10;
    s = s + digit;
    n = n / 10;
}
System.out.println(s);
```

Understanding Programs: 03

- What does following code segment outputs

```
int num = 100;
num = num++;
System.out.println(num);
num = ++num;
System.out.println(num);
num = num++ + num++;
System.out.println(num);
num = num++ + ++num;
System.out.println(num);
```

Algo 1a: Prime Factors

- Given an integer n, find its prime factors

```
for factor = 2 to n, do
   while remainder(n,factor) eq 0, do
      print factor
      replace n by n/factor
   done //while
done //for
```

Algo 1b: Prime Factors (improved)

- Given an integer n, find its prime factors

```
for factor = 2 to sqrt(n), do
  while remainder(n, factor) eq 0, do
    print factor
    replace n by n/factor
  done //while
done // for
if n is greater than 1, then
  print n
fi
```

Algo 02: Harmonic series

- Print first `n` terms of harmonic series and its sum

```
print "1/1"
sum = 1.0
for num = 2 to n, do
   print "1/", num
   sum = sum + 1/num
done  // for
print sum
```

Algo 03: Binary Conversion

- Given number `n`, outputs its value in binary

```
binstr = ""
while number > 0:
  remainder = number % 2
  binstr = str(remainder) + binstr
  number = number // 2
print(binstr)
```

Algo 04: Fibonacci Series

- Print first n terms of Fibonacci series starting from `1, 1`

```
prev = 1
curr = 1
print("1, 1")
while number > 2:
    sum = prev + curr
    prev = curr
    curr = sum
    number = number - 1
    print(",", sum)
print("\n")
```

Algo 05: Ramanujan 1729

- Given n, find all possible values of a, b, c and d such that $a^3+b^3=c^3+d^3 \leq n$, e.g.

  $1^3+12^3 = 10^3+9^3 = 1729$

- How should you proceed.
  - Need 4 for loops
  - First : $a=1$ to $n^{1/3}$
  - Second: $b=a$ to $n^{1/3}$ and $a^3+b^3<=n$
  - Third: $c=a+1$ to $n^{1/3}$
  - Fourth: $d=c$ to $n^{1/3}$ and $c^3+d^3 < a^3+b^3$
  - Output line:
    - c^3+d^3 equals a^3+b^3

Algo 05: Ramanujan 1729

```
for a=1; a³ ≤ n; a++
  for b=a; a³+b³ ≤ n; b++
    for c=a+1; c³ ≤ n; c++
      for d=c; c³+d³ ≤ a³+b³; d++
        if c³+d³ == a³+b³ then
          print a³ + b³ = c³ + d³
```

Summary

- Basic understanding how programming logic is to be defined to write a program.