

## CS350 – SISO Model and Decision Problems

**Purpose:** We will be looking at models of computation throughout this course to examine the limits of what we can compute. We start with a model with which you should feel quite comfortable – a Python program. But we are going to be **very** precise with what that program looks like and what the output of the program looks like. This precision will be necessary so that we can study the computation process.

Since a program can be viewed as just a string of characters, it is also possible for a program to process itself.

The purpose of this module is to get you comfortable with this working model of computation and how programs can analyze themselves.

**Knowledge:** This module will help you become familiar with the following content knowledge:

- The precise definition of the Python program model of computation
- The precise definition of the output of a Python program

**Activity:** With your group perform the following tasks and answer the questions. You will be reporting your answers back to the class in 45 minutes.

1. We define  $P(I)$  as the output of program  $P$  on input  $I$ . We will be requiring both the program and the input to be strings.

Consider the following pairs of programs with an input and give the value of  $P(I)$  for each. The value of  $P(I)$  might be undefined if the program does not produce an output.

(a) 

```
P = "def f(inString):
      return inString[3:7]"
```

```
I = "abcdefghij"
```

(b) 

```
P = "def f(inString):
      return inString[3]"
```

```
I = "ab"
```

(c) `P = "def f(inString):  
 while True:  
 x = 'b'  
 return x"`

`I = "a"`

2. A decision problem is simply a problem for which the output is either "yes" or "no". Consider the program file "containsGAGA.py":

```
import utils; from utils import rf
2 def containsGAGA(inString):
    if 'GAGA' in inString:
4         return 'yes'
    else:
6         return 'no'
```

- (a) What is the value of `containsGAGA("CTGAGAT")`?  
(b) The function `rf` reads a file and returns the string of the text contained in that file. What is the value of `containsGAGA(rf('containsGAGA.py'))`?

Consider the program file "yes.py":

```
2 def yes(inString):
    return 'yes'
```

- (c) What is the value of `yes(rf('containsGAGA.py'))`?  
(d) What is the value of `yes(rf('yes.py'))`?

Consider the program file "longerThan1K.py":

```
def longerThan1K(inString):
2     if len(inString) > 1000:
        return 'yes'
4     else:
        return 'no'
```

- (e) What is the value of `longerThan1K(rf('containsGAGA.py'))`?  
(f) What is the value of `longerThan1K(rf('longerThan1K.py'))`?

Consider the program file "maybeLoop.py":

```
def maybeLoop(inString):
2   if not 'secret sauce' in inString:
      # enter an infinite loop
      i = 0
4     while i>=0:
          i = i + 1
6   else:
      # output 'yes' if input length is even and 'no' otherwise
8     if len(inString) % 2 == 0:
          return 'yes'
10    else:
          return 'no'
12
```

- (g) What is the value of maybeLoop("CTGAGAT")?
- (h) What is the value of maybeLoop("some secret sauce")?
- (i) What is the value of maybeLoop(rf('containsGAGA.py'))?
- (j) What is the value of maybeLoop(rf('maybeLoop.py'))?

Complete the following assignments for grading. Each should be done individually but you may consult with a classmate to discuss strategies. You will be using the definitions found on p24 of your text.

**Assignment 1:**

Try the Python function `hmmmm` that has been provided and answer the set of questions given in exercise 2.7 on p28 of your text.

**Criteria for Success:** You have clear and concise written answers for all four questions. When describing a set of strings you need to be clear on what strings are in the set and what strings are not in the set.

**Assignment 2:**

Try the Python function `ooooops` that has been provided and answer the set of questions given in exercise 2.9 on p29 of your text.

**Criteria for Success:** You have clear and concise written answers for all seven questions. When describing a set of strings you need to be clear on what strings are in the set and what strings are not in the set.

**Assignment 3:**

Our model is SISO (String In String Out) programs. Suppose we have a task where our input is a mouse click on a pixel in a window and our output is graphics appearing in that window. Explain how this task can be achieved with our SISO model.

**Criteria for Success:** You need to clearly explain how both the input and the output can each be viewed as strings.

**Assignment 4:**

Complete exercise 3.2 on p42 in order to deepen your understanding of programs that analyze themselves.

**Criteria for Success:** You need to have two python programs `countChars.py` and `countCharsB.py` and written answers to how these programs behave on themselves and why these equivalent programs behave differently when run on themselves.

Submit your two python programs and your written answers in Canvas for grading.