

**Problem 1.** (*PicoBot: Empty Room Coverage*) Write a PicoBot program `empty_room.pb` with rules that instruct the bot to cover the entirety of an empty rectangular room. Your program should work regardless of how big the room is and regardless of where the bot starts.

```
$ python picobot.py -e env1.txt < empty_room.pb
...
Coverage reached!
```

**Problem 2.** (*Squared Distance*) Write an HMMM program `squared_distance.hmmm` that takes four numbers  $x_1, y_1, x_2, y_2$  representing the coordinates of two points on a plane and prints the approximate squared Euclidean distance between the two, calculated as  $(x_1 - x_2)^2 + (y_1 - y_2)^2$ .

```
$ python hmmmSimulator.py -f squared_distance.b -n
3
2
-1
5
25
```

**Problem 3.** (*Sum of Ints*) Write an HMMM program `sum_of_ints.hmmm` that takes a nonnegative integer  $n$  as input and prints the sum  $1 + 2 + 3 + \dots + (n - 1) + n$ .

```
$ python hmmmSimulator.py -f sum_of_ints.b -n
100
5050
```

**Problem 4.** (*Primality Testing*) Write an HMMM program `primality.hmmm` that takes an integer  $n > 2$  as input and prints 1 if  $n$  is prime, and 0 otherwise. Hint: a number  $n$  is prime if it is not divisible by any number  $i \in [2, \sqrt{n}]$ .

```
$ python hmmmSimulator.py -f primality.b -n
31
1
$ python hmmmSimulator.py -f primality.b -n
35
0
```

**Problem 5.** (*Euclid's Algorithm, Iterative Approach*) Write an HMMM program `gcd_iter.hmmm` that takes two nonnegative integers  $x$  and  $y$  as input and prints their greatest common divisor, calculated iteratively using *Euclid's Algorithm*: if  $y$  divides  $x$ , the gcd of  $x$  and  $y$  is  $y$ ; otherwise, the gcd of  $x$  and  $y$  is the same as the gcd of  $y$  and  $x \bmod y$ , ie, in the next iteration  $y$  takes the place of  $x$  and  $x \bmod y$  takes the place of  $y$ .

```
$ python hmmmSimulator.py -f gcd_iter.b -n
54
24
6
$ python hmmmSimulator.py -f gcd_iter.b -n
22
45
1
```

**Problem 6.** (*Euclid's Algorithm, Recursive Approach*) Write an HMMM program `gcd_rec.hmmm` that takes two nonnegative integers  $x$  and  $y$  as input and prints their greatest common divisor (gcd), calculated recursively using Euclid's Algorithm:

$$\text{gcd}(x, y) = \begin{cases} \text{gcd}(y, x \bmod y) & \text{if } y \neq 0, \text{ and} \\ x & \text{if } y = 0. \end{cases}$$

```
$ python hmmmSimulator.py -f gcd_rec.b -n
54
24
6
$ python hmmmSimulator.py -f gcd_rec.b -n
22
45
1
```

## Files to Submit

1. empty\_room.pb
2. squared\_distance.hmmm
3. sum\_of\_ints.hmmm
4. primality.hmmm
5. gcd\_iter.hmmm
6. gcd\_rec.hmmm
7. report.txt

Before you submit:

- Make sure your programs meet the input and output specifications by running the following command on the terminal:

```
$ python run_tests.py [<problems>]
```

where the optional argument `<problems>` lists the numbers of the problems you want to test; all the problems are tested if no argument is given.

- Make sure your report doesn't exceed 400 lines, doesn't contain spelling mistakes, and doesn't contain lines that exceed 80 characters.