

# Learning with a language of thought - exercises

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## 1. Inferring Functions

Consider our model of function inference from the chapter:

x
///fold:
...
viz.table(Infer({method: 'enumerate', maxExecutions: 100}, function() {
var e = randomArithmeticExpression();
var s = prettify(e);
var f = runify(e);
condition(f(0) == 0)
condition(f(2) == 4)
return {s: s};
}))

run ▼

a)

Why does this think the probability of  $x * 2$  is so much lower than  $x * x$ ?

HINT: Think about the probability assigned to  $x ^ 2$ .

b)

Let's reconceptualize our program as a sequence-generator by making the input arguments 1,2,3,\dots. Suppose that the first number in the sequence ( $f(1)f(1)$ ) is 1 and the second number ( $f(2)f(2)$ ) is 4. What number comes next?

```
///fold:
```

```
...
```

```
viz.table(Infer({method: 'enumerate', maxExecutions: 10000}, function() {
```

```
  var e = randomArithmeticExpression();
```

```
  var s = prettify(e);
```

```
  var f = runify(e);
```

```
  condition(f(1) == 1)
```

```
  condition(f(2) == 4)
```

```
  return {'f(3)':f(3)};
```

```
  }))
```

run ▼

Not surprisingly, the model predicts 9 as the most likely next number. However, it also puts significant probability on 27. Why does this happen?

c)

Many people find the high probability assigned by our model in (b) to 27 to be unintuitive (i.e. if we ran this as an experiment, 27 would be a very infrequent response). This suggests our model is an imperfect model of human intuitions. How could we decrease the probability of inferring 27? (HINT: Consider the priors).

## 2. Role-governed concepts (challenge!)

In the Rational Rules model we saw in the chapter, concepts were defined in terms of the features of single objects (e.g. “it’s a raven if it has black wings”). Psychologists have suggested that many concepts are not defined by the features of a single objects, but instead by **the relations the object has to other objects**. For instance, “a key is something that opens a lock”. These are called **role-governed concepts**.

Extend the Rational Rules model to capture role-governed concepts.

Hint: You will need primitive relations in your language of thought.

Hint: Consider adding quantifiers (e.g. *there exists*) to your language of thought.