

Homework 6 CS 381

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Problem 1

```
1 [x:?]
2 [x:?, z:?]
3 [x:?, z:4]
4 [x:?, f:{}, z:4]
11: [f: {}, z: 4, x: f(3)]
>>
4: [x: 3, f: {}, z: 4, x: f(3)]
8: [x: 3, f: {}, z: f(x - 1) * z + 2, x: f(3)]
>>
4: [x: 2, x: 3, f: {}, z: f(x - 1) * z + 2, x: f(3)]
8: [x: 2, x: 3, f: {}, z: f(x - 1) * z + 2, x: f(3)]
>>
4: [x: 1, x: 2, x: 3, f: {}, z: f(x - 1) * z + 2, x: f(3)]
8: [x: 1, x: 2, x: 3, f: {}, z: f(x - 1) * z + 2, x: f(3)]
>>
4: [x: 0, x: 1, x: 2, x: 3, f: {}, z: f(x - 1) * z + 2, x: f(3)]
6: [x: 0, x, 1, x: 2, x: 3, f: {}, z: 1, x: f(3)]
9:
<<
8: [x: 1, x: 2, x: 3, f: {}, z: 1 * 1 + 2 = 3, x: f(3)]
9:
<<
8: [x: 2, x: 3, f: {}, z: 3 * 3 + 2 = 11, x: f(3)]
9:
<<
8 [ x=3 , f={}, z=(11*11+2), x=f(3)]
9 [x=123, f={}, z=123, x=f(3)]
<<
11[f={}, z=18, x=18]
[z=123, x=123]
```

Problem 2

Static:

```

1 [x:?]
2 [y:?, x:?]
3 [z:?, y:?, x:?]
4 [x:4, y:?, z:?]
5 [y:6, x:4, z:?]
6 [f{}, y:6, x:4, z:?, RES:52]
12 >>
    7 [f{}, y:6, x:4, z:?]
    8 [y:13, f{}, x:4, z:?]
    9 [g:{}, y:6, x:4, z:?, RES:52]
    12>>
        10 [y:6, g:{}, x:4, z:?]
        11 [y:14, g:{}, x:4, z:?]
        12 [x:4, y:14, g:{}, x:4, z:52]
    <<
<<

```

Z = 52

Dynamic:

```

1 [x:?]
2 [y:?, x:?]
3 [z:?, y:?, x:?]
4 [x:4, y:?, z:?]
5 [y:6, x:4, z:?]
6 [y:?, f{}, y:6, x:4, z:?]
12 >>
    7 [y:?, y:?, f{}, y:6, x:4, z:?]
    8 [y:13, y:?, f{}, y:6, x:4, z:?]
    9 [x:?, g:{}, y:6, x:4, z:?]
    12>>
        10 [y:?, y:13, y:?, x:?, y:6, g:{}, x:4, z:?]
        11 [y:14, y:13, y:?, x:?, y:6, g:{}, x:4, z:?]
        12 [y:14, y:13, y:?, x:3, y:6, g:{}, x:4, z:42] | 14 * 3 = 42
    <<
<<

```

Z = 42

Problem 3

Call-by-Name:

```
1 [y:?]
2 [z:?, y:?]
3 [y:6, z:?]
4 [f:{}, y:6, z:?]
8 [ g:{}, f:{}, y:6, z:?]
13 >>
    8 [x:(y*2), g:{}, y:6, z:?]
    9 >>
        4 [a:(x+1), x:(y*2), g:{}, y:6, z:?]
        5 [a:(x+1), x:(y*2), g:{}, y:14, z:?]
        6 [res:43, a:(x+1), x:(y*2), g:{}, y:6, z:?]
        <<
    9 [x:(y*2), g:{}, f:{}, y:43, z:?]
    10 >>
        4 [a:(x-y+2), x:(y*2), g:{}, f:{}, y:43, z:?]
        5 [a:(x-y+2), x:(y*2), g:{}, f:{}, y:46, z:?]
        6 [res:95, a:(x-y+2), x:(y*2), g:{}, f:{}, y:46, z:?]
        <<
    10 [x:(y*2), g:{}, f:{}, y:46, z:94]
    11 [res:95, x:(y*2), g:{}, f:{}, y:46, z:95]
    <<
13 [g:{}, f:{}, z:95, y:46]
[Z = 95, Y = 46]
```

Call-by-Need:

```
1 [y:?]
2 [z:?, y:?]
3 [y:6, z:?]
4 [f:{}, y:6, z:?]
8 [ g:{}, f:{}, y:6, z:?]
13 >>
    8 [x:12 ,g{} ,y:6, z:?]
    9 >>
        4 [a:13, x:12, g:{}, y:6, z:?]
        5 [a:13, x:12, g:{}, y:14, z:?]
        6 [res:27, a:13, x:12, g:{}, y:14, z:?]
```

```
<<
9 [x:12, g:{}, f:{}, y:29, z:?]
10 >>
    4 [a:x-y+2, x:12, g:{}, f:{}, y:29, z:?]
    5 [a:-15, x:12, g:{}, f:{}, y:-14, z:?]
    6 [res:-29, a:-15, x:12, g:{}, f:{}, y:-14, z:?]
    <<
    10 [x:12, g:{}, f:{}, y:-14, z:-29]
    11 [res:-29+1, x:12, g:{}, f:{}, y:-14, z:-29]
    <<
13 [g:{}, f:{}, z:-29, y:-14]
[Z= -28, Y =-14 ]
```