Name:

CS 421 — Big Step Semantics Activity

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Reading the Judgments

- $< i, \sigma >\Downarrow_e e$ "Expression i in environment σ evaluates to e."
- $< i, \sigma >\Downarrow_b e$ "Boolean Expression i in environment σ evaluates to e."
- $< i, \sigma >\Downarrow \sigma'$ "Executing statement i in environment σ results in environment σ'."

The Rules

$$\frac{}{< i, \sigma >\Downarrow_e i}$$ if i is an integer.

$$\frac{}{< u, \sigma >\Downarrow_e v}$$ if $u := v \in \sigma$.

$$\frac{< e_1, \sigma >\Downarrow_e v_1 \quad < e_2, \sigma >\Downarrow_e v_2}{< e_1 \oplus e_2, \sigma >\Downarrow_e v_1 \oplus v_2}$$

$$\frac{}{< \texttt{true}\ , \sigma >\Downarrow_b \texttt{true}} \qquad \frac{}{< \texttt{false}\ , \sigma >\Downarrow_b \texttt{false}}$$

$$\frac{}{< u, \sigma >\Downarrow_b v}$$ if $u := v \in \sigma$.

$$\frac{}{< \texttt{skip}\ , \sigma >\Downarrow \sigma}$$

$$\frac{< e, \sigma >\Downarrow_e v}{< x := e, \sigma >\Downarrow \sigma[x := v]}$$

$$\frac{< S_1, \sigma >\Downarrow \sigma' \qquad < S_2, \sigma' >\Downarrow \sigma''}{< S_1; S_2, \sigma >\Downarrow \sigma''}$$

$$\frac{< e_1, \sigma >\Downarrow_e v_1 \quad < e_2, \sigma >\Downarrow_e v_2}{< e_1 \sim e_2, \sigma >\Downarrow_b v_1 \sim v_2}$$

$$\frac{< B, \sigma >\Downarrow_b \texttt{true} \quad < S_1, \sigma >\Downarrow \sigma'}{< \texttt{if}\ B\ \texttt{then}\ S_1\ \texttt{else}\ S_2\ \texttt{fi}\ , \sigma >\Downarrow \sigma'} \qquad \frac{< B, \sigma >\Downarrow_b \texttt{false} \quad < S_2, \sigma >\Downarrow \sigma'}{< \texttt{if}\ B\ \texttt{then}\ S_1\ \texttt{else}\ S_2\ \texttt{fi}\ , \sigma >\Downarrow \sigma'}$$

$$\frac{< B, \sigma >\Downarrow_b \texttt{false}}{< \texttt{while}\ B\ \texttt{do}\ S\ \texttt{od}\ , \sigma >\Downarrow \sigma} \qquad \frac{< B, \sigma >\Downarrow_b \texttt{true} \quad < \texttt{while}\ B\ \texttt{do}\ S\ \texttt{od}\ , \sigma' >\Downarrow \sigma'' \quad < S, \sigma >\Downarrow \sigma'}{< \texttt{while}\ B\ \texttt{do}\ S\ \texttt{od}\ , \sigma >\Downarrow \sigma''}$$

Reductions

Reduce the following programs according to the semantic rules given.

Problem 1)

```
<x + y + z, {x:=10, y:=20, z:=12}>
```

Problem 2)

```
<t:=a,a:=b,b:=t, {a:=5,b:=10}>
```

Problem 3)

```
<if x>y then m:=x-y else m:=y-x fi, {x:=10,y:=30}>
```

Problem 4)

```
<while x > 1 do x:=x/2 od, {x:=2}>
```

Make your own rules!

Problem 5)

Write a rule to explain the `when B S` statement. It executes S only if B is true.

Problem 6)

Write a rule for `do S while B od`. It is like while, but executes S at least one time.