HW01

Xinhao Luo

February 7, 2020

1 Problem 1

1. x is even && y == x + 1 is strongest

2. $1 \leq x \leq 3$ is strongest

3. $x > 0$ && $y > 0$ is strongest

4. x is divisible by 50 is strongest

5. None

6. $abs(result * result - x) \leq 0.000001$ is strongest

2 Problem 2

1. Is Valid

2. Is Valid

3. Not valid, since $i + j + 1 - 1 = i + j$, so the post-condition can still be $i + j! = 0$

4. Not valid, if $m == y$ then it must be the reverse of if condition: $y >= x$ for sure.
   The post condition should be $(m == x \text{ \&\& } x > y) || (m == y \text{ \&\& } y >= x)$

3   Problem 3

1. Valid, since C code F, and we have B =¿ C. As B is stronger than C, it can also achieve what C can do.

2. Possibly invalid, since we only have C code F, while E =¿ F. We cannot induce from the weaker one to the stronger one.

4 Problem 4

1.
```
{ x > 0 }
    x = 10;
        { x == 10 }
    y = 20 - x;
        { x == 10 && y == 10 }
    z = y + 4;
        { x == 10 && y == 10 && z == 14 }
    y = 0;
        { x == 10 && z == 14 && y == 0 }
```

2.
```
{ |x| > 11 }
    x = -x;
        { |x| > 11 }
    x = x * x;
        { x > 121 }
    x = x + 1;
        { x > 122 }
```

3.
```
{ |x| < 5 }
    if (x > 0) {
        { (|x| < 5 && x > 0) = (0 < x < 5) }
         y = x + 2;
        { (0 < x < 5) && (2 < y < 7) }
     } else {
        { |x| < 5 && x <= 0) = (-5 < x <= 0) }
         y = x - 1;
        { (-5 < x <= 0) && (-6 < y <= -1) }
     }
        { ((0 < x < 5) && (2 < y < 7)) || ((-5 < x <= 0) && (-6 < y <= -1)) }
```

5

5 Problem 5

1.
```
    { wp(x = -5, y > -2 * x) = (y > 10) }
        x = -5;
    { wp(z = 2 * x + y, z > 0) = (2 * x + y > 0) = (y > -2 * x) }
        z = 2 * x + y;
    { z > 0 }
```

2.
```
    { wp(if (x > 0) x = x + 6; else x = 4 - x;, x > 7)
        = (x > 0 && x > 1) || (x <= 0 && x < -3)
        = (x > 1) || (x < -3) }
    if (x > 0) {
        { wp(x = x + 6 && x > 7) = (x > 1) }
      x = x + 6;
    else {
        { wp(x = 4 - x && x > 7) = (x < -3) }
      x = 4 - x;
    }
 { x > 7 }
```

3.
```
     { wp(if (x > 4) x = x - 3; else if (x < -4) x = x + 3; else x = x + 1;, x > 0)
        = (x > 4 && x > 3) || (x <= 4 && ((x < -4 && x > -3) || (x >= -4 && x > -1))
        = (x > 4) || (-1 < x <= 4)
        = (x > -1) }
  if (x > 4) {
          { wp(x = x - 3, x > 0) = (x > 3) }
        x = x - 3;
  } else {
                 { wp(if (x < -4) x = x + 3; else x = x + 1;, x > 0
                   = (x < -4 && x > -3) || (x >= -4 && x > -1)
                   = (x > -1) }
          if (x < -4) {
                  { wp(x = x + 3, x > 0) = (x > -3) }
             x = x + 3;
          } else {
                  { wp(x = x + 1, x > 0) = (x > -1) }
             x = x + 1;
          }
  }
          { x > 0 }
```

4.
```
   { wp(x = y + 2, x > 2 * y - 1) = (y + 2 > 2 * y - 1) = (y < 3)  }
   x = y + 2;
    { wp(z = x + 1, z > 2 * y) = (x > 2 * y - 1) }
```

```
   z = x + 1;
    {  z > 2 * y }


5. { wp(if (x >= 0) z = x; else z = x + 1;, z != 0)
      = (x >=0 && x != 0) || (x < 0 && x != -1)
      = (x > 0) || (x < -1) }
  if (x >= 0)
   { wp(z = x, z != 0) = (x != 0) }
    z = x;
  else
   { wp(z = x + 1, z != 0) = (x != -1) }
      z = x + 1;
   { z != 0 }
```

6 Problem 6

1.   { x < 2 }
    ```
        { wp(z < 0, z = x - 1 ) = (x < 1) }
          z = x - 1;
        { wp(w > 0, w = -z) = (z < 0) }
          w = -z;
        { wp(w > 1, w = w + 1) = (w > 0) }
          w = w + 1;
      { w > 1 }
    ```
    Sufficient or Insufficient: Insufficient, since (x < 1) is stronger than (x < 2)

2.
    ```
          { (x == y && y > 0) || (y != x) }
        { wp(if (x == y) x = -1; else x = y - 1;, x < y)
              = (x == y && y > -1) || (x != y && true)
              = (x == y && y > -1) || (x != y) }
          if (x == y)
        { wp(x < y, x = -1) = (y > -1)}
            x = -1;
          else
        { wp(x < y, x = y - 1) = true }
            x = y - 1;
        { x < y }
      Sufficient or Insufficient: Sufficient
    ```