

# Homework # 1

## due January 30

### 1 Reading

Please read Appendix A in your textbook.

### 2 Problems

- Suppose we are doing an analysis in which we determine at each program point whether the following two facts is true or false or unknown:  $x = 0$ ,  $x = 1$ . Suppose we wish to preserve as much information as possible about these facts. Draw the entire lattice. Indicate what the bottom  $\perp$  and  $\top$  values are.
- Do the same for the two facts  $y = 0$ ,  $z = 0$ . Why is there a difference?
- The proof of Lemma A.2 is too concise. It doesn't convince the reader that the (A.1) is actually a lower bound. ("Clearly" is not clear to me). Give a proof that (A.1) is indeed a lower bound of  $Y$ .
- On page 396, the authors assert that the monotone function space is a complete lattice if the input lattices are complete lattices. Prove this result. In particular, you must prove that the definition of  $\sqcup Y$  actually results in a *monotone* function.
- Come up with an example lattice and a monotone function for which  $\sqcup_0^\infty f^n(\perp)$  is *not* the least fixed point of  $f$ .
- Can you come up with an example for which  $f$  is affine? Why not?

### 3 Submission

As with all homeworks, please turn in your homework on paper at the beginning of lecture.