# Semantics of Programming Languages
# Supervision 3

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All work should be submitted in PDF form 36 hours before the supervision to the email `josi2@cam.ac.uk`. If you have any questions on the course please include these at the top of the supervision work and we can talk about them in the supervision.
Please give both the original and modified code for any exercises that requires code to be changed. The extensions are encouraged but should only be attempted after the main work has been attempted.

## L3

1. What are the changes in L3 from L1 and L2, split these into sections:
   (a) syntax or expressions and types?
   (b) the definition of values?
   (c) the typing environment?
2. What are evaluation contexts, what structure of the language do they exploit to reduce the number of reduction rules we must define?
3. How about we change the definition $E$ on page 80 make this reduction rule follow CBN semantics.

### Exercises 5.6

- **Ex28**
- **Extension: Ex29** Using a very simple language, maybe with just

$$e \ ::= \ n \mid \text{fn} x : T \Rightarrow e \mid ee' \mid ...$$

, Then include exceptions and provide typing rules and reduction relations.

## Subtyping

1. What is the subsumption rule and the two subtype relations.
2. What are the three record subtyping relations.
3. **Ex 32** What are the problems with subtyping reference, for each case contra- and covariant subtyping how we loose the progress property.
4. What is the function subtyping rule and why does this make sense?
5. **Ex 33**
6. **Extension:**
   `http://www.cl.cam.ac.uk/teaching/exams/pastpapers/y2014p6q10.pdf`

## Concurrency

1. How are mutexes defined.
2. Ex37 for each case provide a program which either deadlocks or is not serializable

## Semantic Equivalence

1. How could we define typed equivalence for two expressions $e_1 \simeq^T_\Gamma e_2$ in L1, is this decidable?
2. **Extension:** What is the congruence property for L1.