Hi, I’m Nick!

- 3rd year undergrad, but this is my second to last quarter hopefully (woooo!)
- I like computer security and summer camp
- Office hours = my favorite time of the week, please stop by!
  - Tuesdays, 12pm-1pm, CSE 021
- Took this course with Dan previously
  - I’m really excited to have the opportunity to TA it!

Today’s Agenda

- ML Development Workflow
  - Emacs
  - Using `use`
  - The REPL

- More ML
  - Shadowing Variables
  - Debugging Tips
  - Boolean Operations
  - Comparison Operations

Emacs

- Recommended (not required) editor for this course
- Powerful, but the learning curve can at first be intimidating
- Helpful resources
  - [CSE 341 Emacs Guide](#)
  - Google it!
  - /r/emacs Foot Pedals???
    - Mike Ernst literally has foot pedals
    - It’s like a spaceship
  - Course staff, or ask around in the labs
  - (I learned from the official Emacs tutorial – “C-h t”)

Quick Emacs Demo

```
use "foo.sml";
```

- Enters bindings from the file `foo.sml`
  - Like typing the variable bindings one at a time in sequential order into the REPL (more on this in a moment)
- Result is `()` bound to variable `it`
  - Ignorable
The REPL

- Read-Eval-Print-Loop is well named
- Conveniently run programs: `C-c C-s`
  - Useful to quickly try something out
  - Save code for reuse by moving it into a persistent .sml file
- Expects semicolons
- For reasons discussed later, it’s dangerous to reuse `use` without restarting the REPL session
  - End the REPL session with `C-d`

Shadowing of Variable Bindings

```
val a = 1; (* a -> 1 *)
val b = a * 10; (* a -> 1, b -> 10 *)
val a = 2; (* a -> 2, b -> 10 *)
```

- Expressions in variable bindings are evaluated “eagerly”
  - Before the variable binding “finishes”
  - Afterwards, the expression producing the value is irrelevant
- Multiple variable bindings to the same variable name, or “shadowing”, is allowed
  - When looking up a variable, ML uses the most recent binding by that name in the current environment
- Remember, there is no way to “assign to” a variable in ML
  - Can only `shadow` it in a later environment
  - After binding, a variable’s value is an immutable constant

Try to Avoid Shadowing

```
val x = "Hello World";
val x = 2; (* is this a type error? *)
val res = x * 2; (* is this 4 or a type error? *)
```

- Shadowing can be confusing and is often poor style
- Why? Reintroducing variable bindings in the same REPL session may...
  - make it seem like wrong code is correct; or
  - make it seem like correct code is wrong.

Using a Shadowed Variable

```
val x = "Hello World";
fun add1(x : int) = x + 1; (* shadow x in func body *)
val y = add1 2;
val z = x ^ "!!"; (* "Hello World!!" *)
```

- Is it ever possible to use a shadowed variable? Yes!
  And no...
- It can be possible to uncover a shadowed variable when the latest binding goes out of scope

Use `use` Wisely

- Warning: Variable shadowing makes it dangerous to call `use` more than once without restarting the REPL session.
- It `may` be fine to repeatedly call `use` in the same REPL session, but unless you know what you’re doing, be safe!
  - Ex: loading multiple distinct files (with independent variable bindings) at the beginning of a session
  - The behavior of `use` is well-defined, but even expert programmers can get confused
- Restart your REPL session before repeated calls to `use`

Debugging Errors

Your mistake could be:

- Syntax: What you wrote means nothing or not the construct you intended
- Type-checking: What you wrote does not type-check
- Evaluation: It runs but produces wrong answer, or an exception, or an infinite loop

Keep these straight when debugging even if sometimes one kind of mistake appears to be another
Play Around

Best way to learn something: Try lots of things and don’t be afraid of errors

Work on developing resilience to mistakes

• Slow down
• Don’t panic
• Read what you wrote very carefully

Maybe watching me make a few mistakes will help...

Boolean Operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Syntax</th>
<th>Type-checking</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>andalso</td>
<td>e1 andalso e2</td>
<td>e1 and e2 must have type bool</td>
<td>Same as Java’s e1 &amp;&amp; e2</td>
</tr>
<tr>
<td>orelse</td>
<td>e1 orelse e2</td>
<td>e1 and e2 must have type bool</td>
<td>Same as Java’s e1</td>
</tr>
<tr>
<td>not</td>
<td>not e1</td>
<td>e1 must have type bool</td>
<td>Same as Java’s ‘!e1’</td>
</tr>
</tbody>
</table>

• not is just a predefined function, but andalso and orelse must be built-in operations since they cannot be implemented as a function in ML.
  • Why? Because andalso and orelse “short-circuit” their evaluation and may not evaluate both e1 and e2.
  • Be careful to always use andalso instead of and.
  • and is completely different. We will get back to it later.

Style with Booleans

Language does not need andalso, orelse, or not

Using more concise forms generally much better style
And definitely please do not do this:

Comparisons

For comparing int values:

\[ = <> > < >= <= \]

You might see weird error messages because comparators can be used with some other types too:

• > < >= <= can be used with real, but not a mixture of 1 int and 1 real
• = <> can be used with any “equality type” but not with real

• Let’s not discuss equality types yet