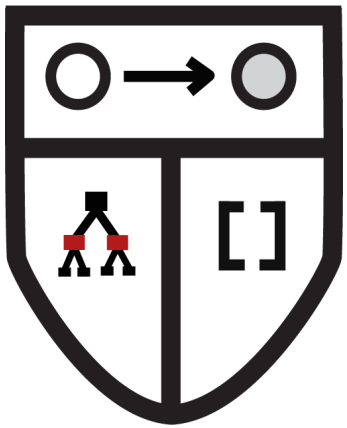


CS 3110

Variants

Prof. Clarkson

Fall 2018

Today's music: *Union* by The Black Eyed Peas (feat. Sting)

Attendance question

Have you used Queue-Me-In?

A. Yes, and overall it's better than not having it
B. Yes and overall it's about the same
C. Yes, and overall it's worse
D. No

GIST

A1: tonight, 8 pm, Gates 310

Review

Previously in 3110:

- Lists, records, tuples
- Pattern matching

Today:

- Variants

VARIANTS

Demo

Variant types

Type definition syntax:

```
type t =
| C1 of t1
| ...
| Cn of tn
```

Optional data carried by constructor

Constructors *aka* tags

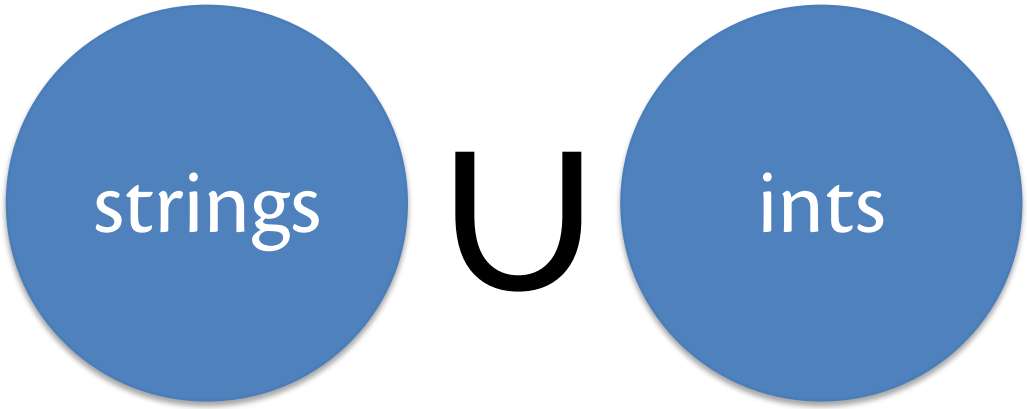
Question

Which of the following would be better represented with records rather than variants?

A. *Coins*, which can be pennies, nickels, dimes, or quarters
B. *Students*, who have names and id numbers
C. A *dessert*, which has a sauce, a creamy component, and a crunchy component
D. A and C
E. B and C

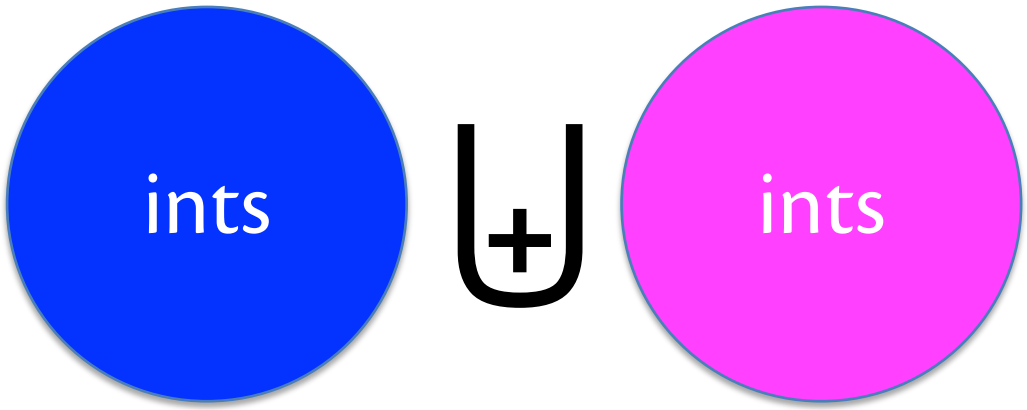
Variant: union

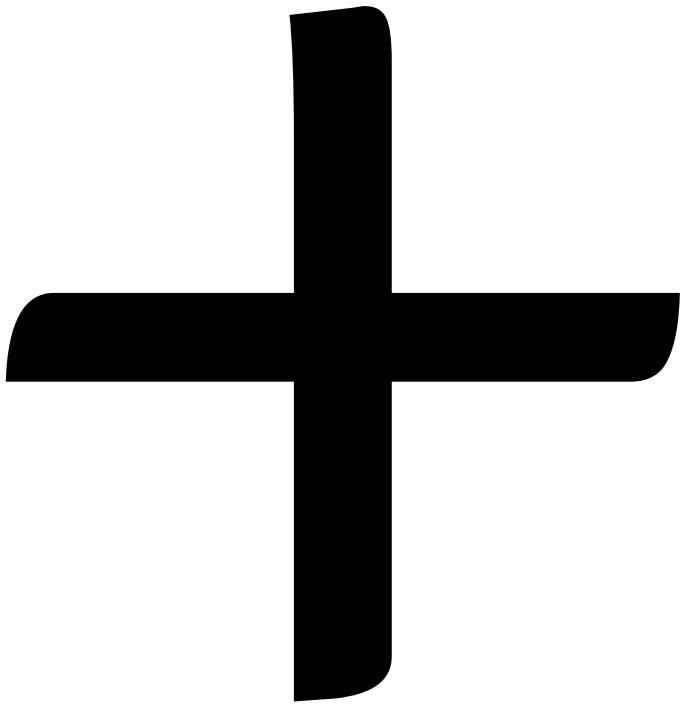
```
type stringOrInt =
    | String of string
    | Int of int
```



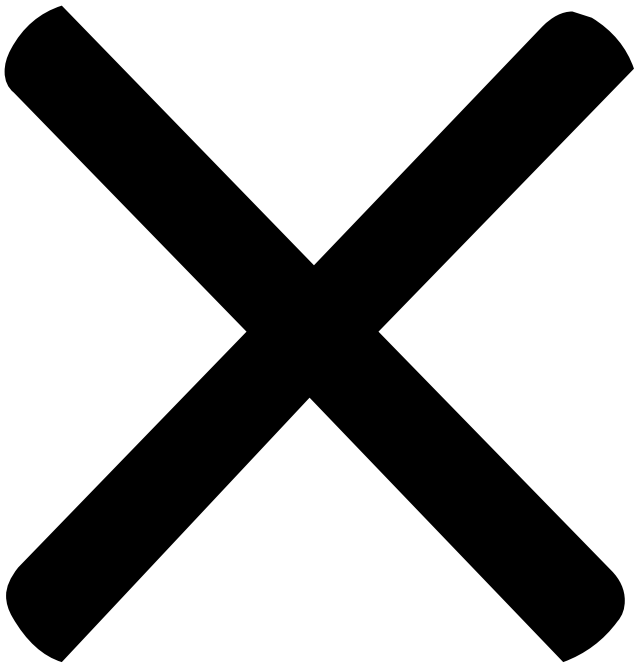
Variant: tagged union

```
type blueOrPinkInt =
  | Blue of int
  | Pink of int
```





One Of: Sum Type



Each Of: Product Type

Algebraic Data Types

RECURSIVE VARIANTS

Demo

PARAMETERIZED VARIANTS

Demo

Type variables

Variable: name standing for unknown value
Type variable: name standing for unknown type

Java example: `List<T>`

OCaml Syntax: single quote followed by identifier
e.g., `'foo, 'key, 'value`

But most often simply just: `'a`
Pronounced: "alpha"

Parametric polymorphism

- *poly* = many, *morph* = form
- write function that works for many arguments regardless of their type
- closely related to Java generics
- related to C++ template instantiation

VARIANTS ARE POWERFUL

Lists are just variants

OCaml effectively codes up lists as variants:

```
type 'a list = [] | :: of 'a * 'a list
```

- **`list`** is a type constructor parameterized on type variable **`'a`**
- **`[]`** and **`::`** are constructors
- Just a bit of syntactic magic in the compiler to use **`[]`** and **`::`** instead of alphabetic identifiers

Exceptions are (mostly) just variants

OCaml effectively codes up exceptions as slightly strange variants:

```
type exn
exception MyNewException of string
```

- Type **`exn`** is an extensible variant that may have new constructors added after its original definition
- Raise exceptions with **`raise e`**, where **`e`** is a value of type **`exn`**
- Handle exceptions with pattern matching, just like you would process any variant

OPTIONS

"I call it my billion-dollar mistake. It was the invention of the null reference in 1965. At that time, I was designing the first comprehensive type system for references in an object-oriented language. My goal was to ensure that all use of references should be absolutely safe, with checking performed automatically by the compiler. But I couldn't resist the temptation to put in a null reference, simply because it was so easy to implement. This has led to innumerable errors, vulnerabilities, and system crashes, which have probably caused a billion dollars of pain and damage in the last forty years."

– Sir Tony Hoare

Option: A built-in variant

```
type 'a option = None | Some of 'a
```

Demo


Null
Pointer
Exception
Pattern
Match
against None
imgflip.com

Upcoming events

- [tonight] A1 Gist
- [Mon] Level Up: git

This is powerful.

THIS IS 3110