Tuples

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Tuples

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Some examples with their types:

```
(1, 2)                      : int * int

("hello", 7 + 3, true)      : string * int * bool

('a', ("hello", "goodbye")) : char * (string * string)
```

Tuples

To use a tuple, we extract its components

General case:

```
let (id1, id2, …, idn) = e1 in e2
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A concrete example:

```
let (x,y) = (2,4) in x + x + y
```

Evaluating Tuple Expressions

```
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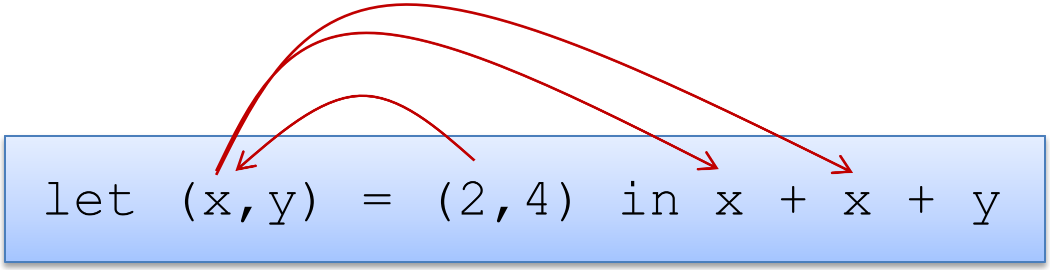
```

Evaluating Tuple Expressions

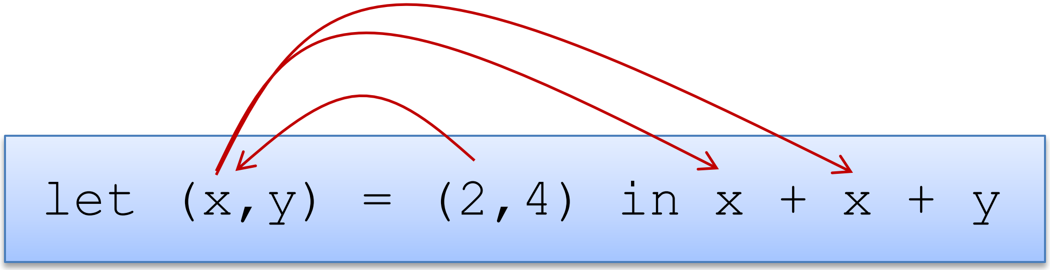


```
let (x,y) = (2,4) in x + x + y
```

substitute!

```
--> 2 + 2 + 4
```

Evaluating Tuple Expressions



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let (x,y) = (2,4) in x + x + y
```

substitute!

```
--> 2 + 2 + 4

--> 4 + 4

--> 8
```

Rules for Typing Tuples

if e1 : t1 and e2 : t2
then (e1, e2) : t1 * t2

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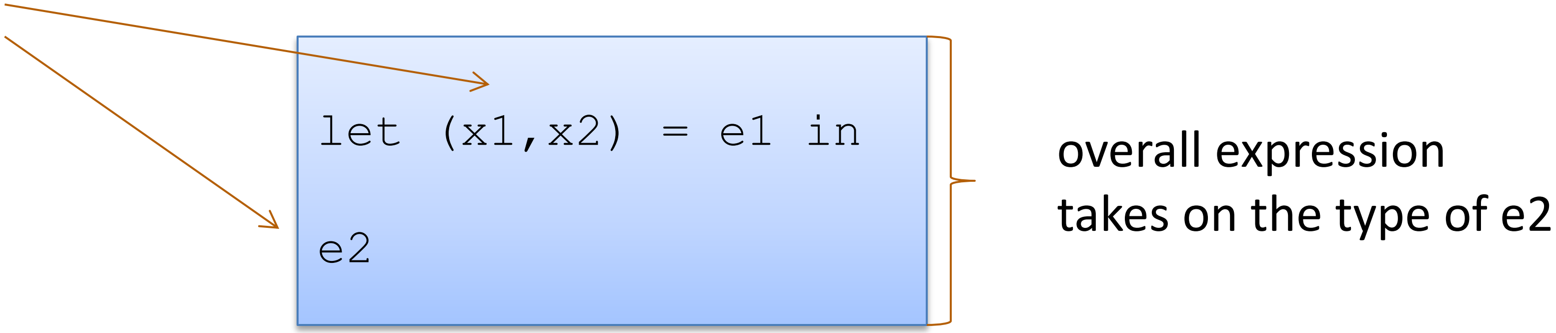
if e1 : t1 and e2 : t2
then (e1, e2) : t1 * t2

if e1 : t1 * t2 then
x1 : t1 and x2 : t2
inside the expression e2



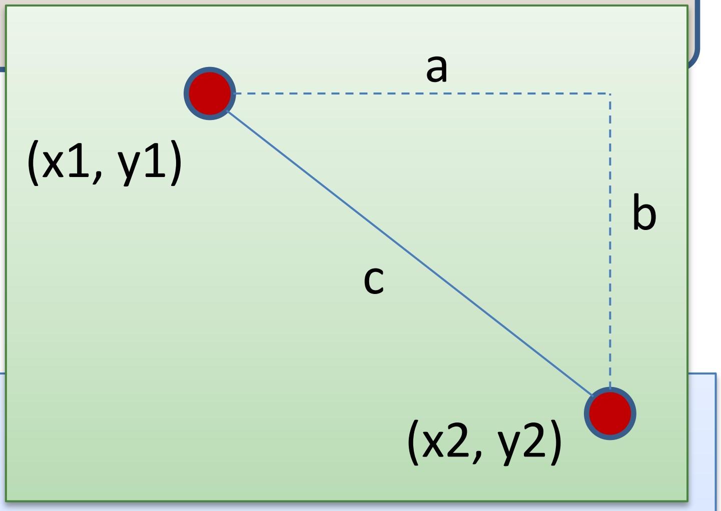
```
let (x1,x2) = e1 in

e2
```

overall expression
takes on the type of e2

DEVELOPING PROGRAMS

Distance between two points



$$c^2 = a^2 + b^2$$

Problem:

- A point is represented as a pair of floating point values.
- Write a function that takes in two points as arguments and returns the distance between them as a floating point number

Writing Functions Over Typed Data

Steps to writing functions over typed data:

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2. Write down argument and result types
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5. Build new output values
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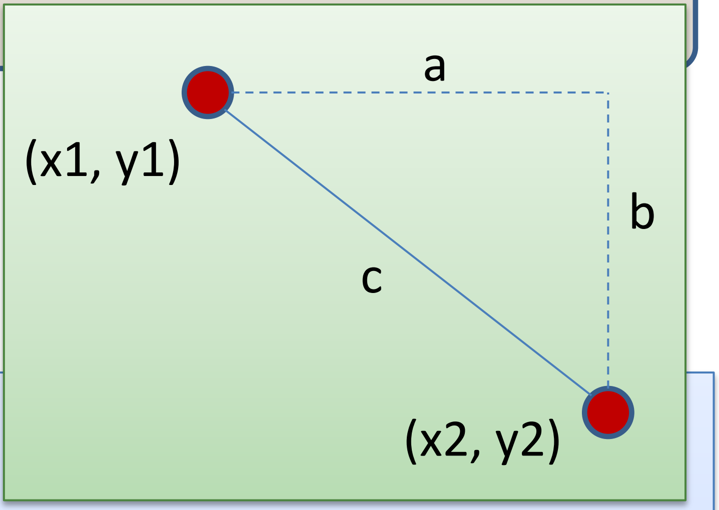
Types help structure your thinking about how to write programs.

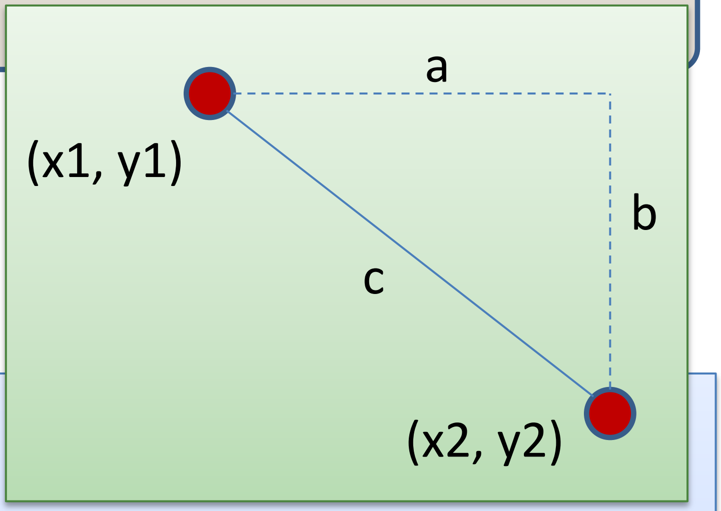
Distance between two points



a type abbreviation

```
type point = float * float
```

Distance between two points

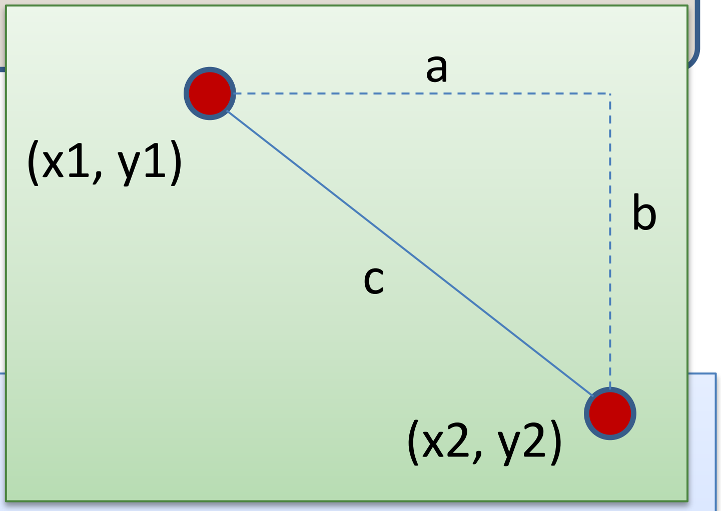


```
type point = float * float

let distance (p1:point) (p2:point) : float =
```

write down function name
argument names and types

Distance between two points



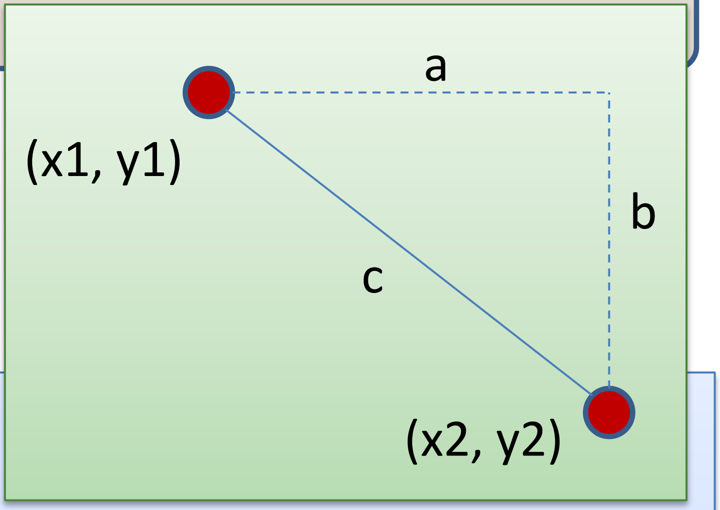
examples

```
type point = float * float


(* distance (0.0,0.0) (0.0,1.0) == 1.0
 * distance (0.0,0.0) (1.0,1.0) == sqrt(1.0 + 1.0)
 *
 * from the picture:
 * distance (x1,y1) (x2,y2) == sqrt(a^2 + b^2)
 *)


let distance (p1:point) (p2:point) : float =
```

Distance between two points



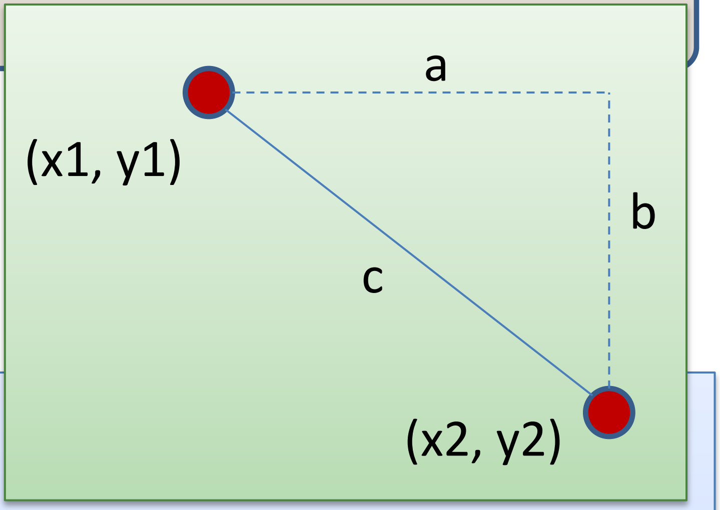
```
type point = float * float

let distance (p1:point) (p2:point) : float =

  let (x1,y1) = p1 in
  let (x2,y2) = p2 in
  ...
```

deconstruct
function inputs

Distance between two points



```
type point = float * float

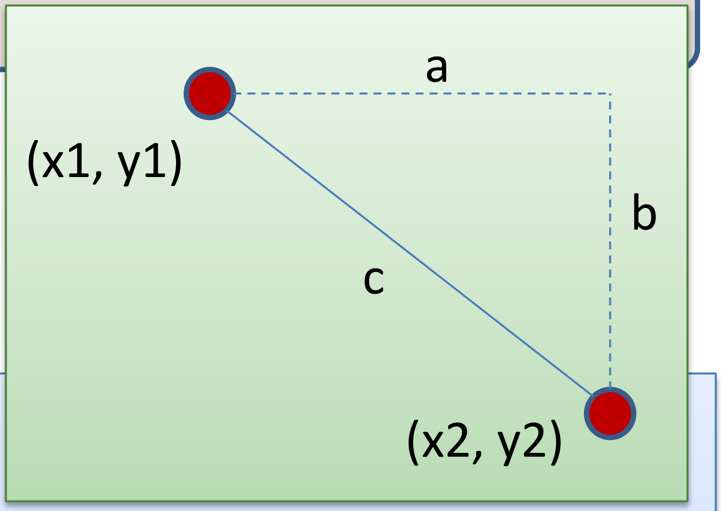
let distance (p1:point) (p2:point) : float =

  let (x1,y1) = p1 in
  let (x2,y2) = p2 in
  sqrt ((x2 -. x1) *. (x2 -. x1) +.
        (y2 -. y1) *. (y2 -. y1))
```

compute function results

notice operators on floats have a "." in them

Distance between two points

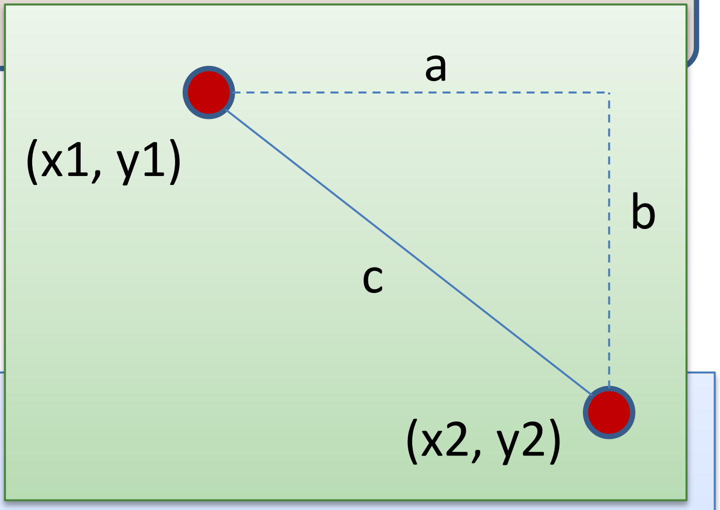


```
type point = float * float

let distance (p1:point) (p2:point) : float =
  let square x = x *. x in
  let (x1,y1) = p1 in
  let (x2,y2) = p2 in
  sqrt (square (x2 -. x1)) +.
        square (y2 -. y1))
```

define helper functions to avoid repeated code

Distance between two points



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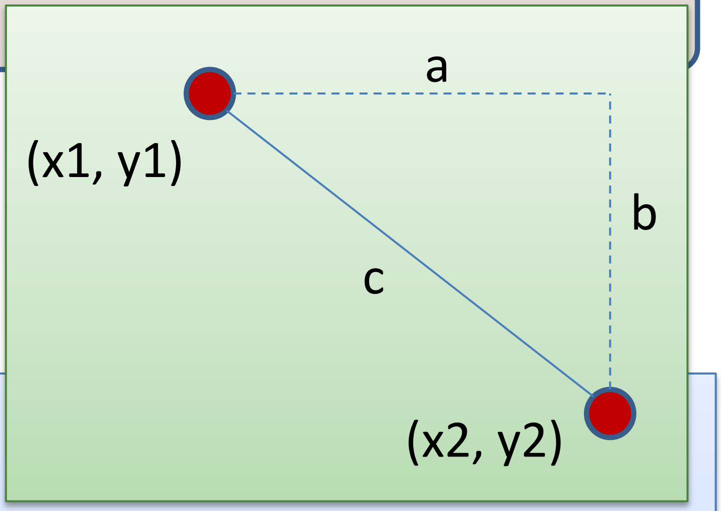
```

use tuple patterns
in function arguments
if you'd like

Distance between two points

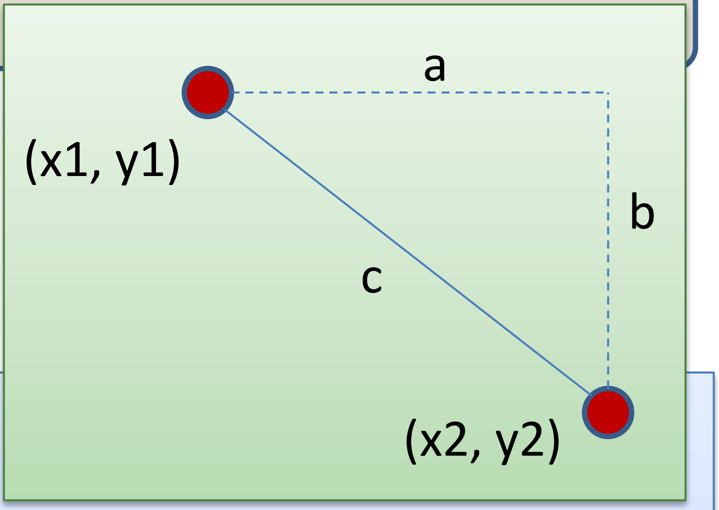


```
type point = float * float

let distance ((x1,y1):point) ((x2,y2):point) : float =
  let square x = x *. x in
  sqrt (square (x2 -. x1) +. square (y2 -. y1))
```

type annotations
can be included

Distance between two points



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let pt1 = (2.0,3.0)
let pt2 = (0.0,1.0)
let dist12 = distance pt1 pt2
```

implement some tests

MORE TUPLES

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Here's a tuple with 2 fields:

(4.0, 5.0) : float * float

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```

Here's a tuple with 3 fields:

```
(4.0, 5, "hello") : float * int * string
```

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```

Here's a tuple with 4 fields:

```
(4.0, 5, "hello", 55) : float * int * string * int
```

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Here's a tuple with 4 fields:

```
(4.0, 5, "hello", 55) : float * int * string * int
```

Here's a tuple with 0 fields:

```
() : unit
```

Unit

Why is it useful to have a tuple with zero fields?

Unit

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- Every expression in OCaml returns *some value*
- We need a value to return when we call a function that doesn't return any data …
- … but what good is a function that returns no data?

Unit

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Some functions have *effects*, which do their work:

- Functions that print to the terminal:

```
(print_string "hello world\n")  :   unit
```

Unit

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Some functions have *effects*, which do their work:

- Functions that print to the terminal:

```
(print_string "hello world\n")  :   unit
```

- Functions that create a sound, take a picture, or use a device
- Functions that raise an exception
- Functions that mutate a data structure

Records

Records are a lot like tuples. It’s just that they have named fields.

Having named fields (records rather than tuples) often makes it easier to understand a program, especially when there are more than just 2 or 3 fields in a structure.

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An example:

```
type name = {first:string; last:string;}

let my_name = {first=“David”; last=“Walker”;}

let to_string (n:name) = n.last ^ ", " ^ n.first
```

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```
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Note: Records come with several other useful features, like functional updates via “with expressions.” Google them for yourselves or see Real World OCaml for more info.

WRAP-UP

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For tuple types:

- when the input has type t1 * t2
  - use let (x,y) = … to deconstruct
- when the output has type t1 * t2
  - use (e1, e2) to construct

We will see this paradigm repeat itself over and over

Exercise

What error do you get when you try to compile this file? (Type it in.) Why?

```
type item = {
   number: int;
   name: string;
}

type contact = {
   name: string*string;  (* first and last name *)
   phone: phone;
}

let get_name x = x.name

let myphone = {number=122; name="iphone";}

let _ = print_endline (get_name myphone)
```