COMP302: Programming Languages and Paradigms

Assignment Project Exam Help

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MACHINE   ASSEMBLY   PROCEDURAL   OBJECT ORIENTED   FUNCTIONAL

"The analytical engine weaves algebraic patterns just as the Jacquard loom weaves flowers and leaves."

10 Dec 1815 – 27 Nov 1852
Inventor of the Analytic Engine

Happy (belated) Ada Lovelace Day!
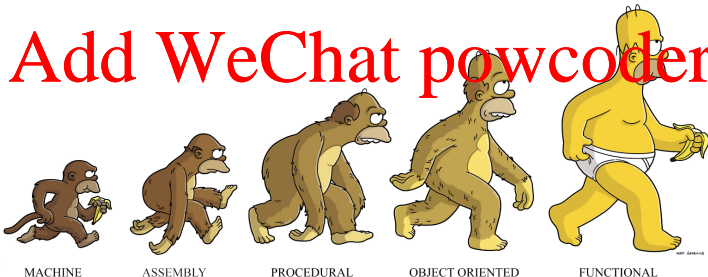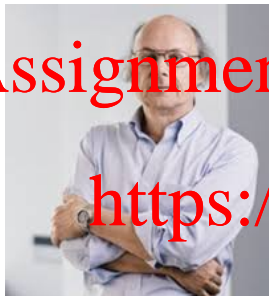
"I find languages that support just one programming paradigm constraining."

- Bjarne Stroustroup

So far:

Expressions in OCaml have characteristics:

- An expression has a type
- An expression evaluates to a value (or diverges).

Today:

Expressions in OCaml may also have an *effect*.

Example 1:

```
1 let (k : int) = 4;;
2 let (k : int) = 2 + k * k;;
3 k;;
```

Example 1:

```
1 let (k : int) = 4;;
2 let (k : int) = 2 + k * k;;
3 k;;
```

Example 2:

```
1 let pi = 3.4;;
2 let area (r:float) = pi *. r *. r;;
3
4 let a2 = area (2.0)
5
6 let (pi : float) = 6.0;;
7
8 let b1 = area (2.0) = a2
9
10 let area (r:float) = pi *. r *. r;;
11 let b2  = area (2.0) = a2
```

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How to program with state?

How to program with state?

– Demo –

- How to allocate state?

  `x = {NewCell 0}`

  Allocates a reference cell with the name `x` in memory and initializes it with `0`.

- How to allocate state?

  ```
  X = {NewCell 0}
  ```

  Allocates a reference cell with the name `x` in memory
  and initializes it with `0`.

- How to compare two reference cells?

- How to allocate state?

  `Using x = ref 0`

  Allocates a reference cell with the name `x` in memory
  and initializes it with `0`.

- How to compare two reference cells?

  Compare their address: `r == s`

  Succeeds, if both `r` and `s` are names for the same
  location in memory.

  Compare their content: `r = s`

  Succeeds, if both reference cells store the same value.

- How to read value stored in a reference cell?

```
1  ! x
```

Read value that is stored in the reference cell with name x.

```
1  let {contents = x} = r
```

Pattern match on value that is stored in the reference cell with name x.

- How to update the value stored in a reference cell?

```
1  x := 3
```

Writes the value in the reference cell with the name x
The previously stored value is overwritten.

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– Demo –

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```ocaml
let imperative_fact n =
  begin
    let result = ref 1 in
    let i = ref 0 in
    let rec loop () =
      if !i = n then ()
      else (i := !i + 1; result := !result * !i; loop ())
    in
    (loop (); !result)
  end
```

Imperative Programming in OCaml

```ocaml
let imperative_fact n =
  begin
    let result = ref 1 in
    let i = ref 0 in
    let rec loop () =
      if !i = n then ()
      else (i := !i + 1; result := !result * !i; loop ())
    in
    (loop (); !result)
  end
```

- More complicated than the purely functional version
- Considered bad style in a functional language
- Harder to reason about its correctnes

```
1  let counter = ref 0
2
3  (* newName (): returns a fresh name *)
4  (* Names are described by strings and all that *)
5  let newName () =
6    (counter := !counter + 1;
7     "a" ^ string_of_int (!counter))
```