Let’s add **local variables** and **binary ops** to our compiler

```
expr := <number>
     |  (add1 <expr>)
     |  (let (<name> <expr>) <expr>)
     |  <name>
     |  (+ <expr> <expr>)
```

Result **Programs** **Stack Layout** **Assembly**

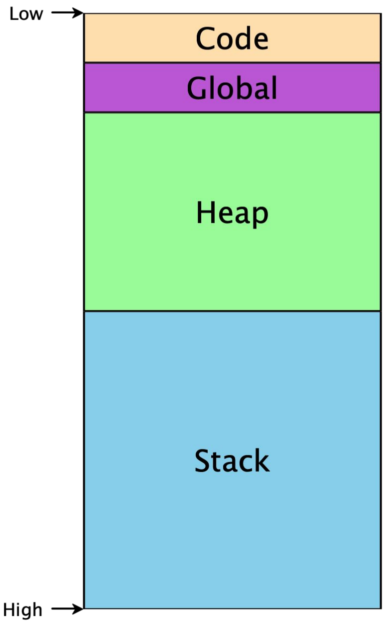
```
(let (x 10)
   (add1 x))
```

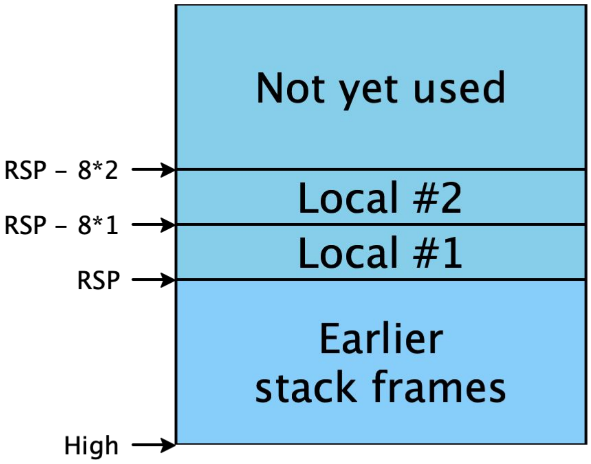
```
(let (x 10)
  (let (y (add1 x))
    (let (z (add1 y))
      (add1 z))))
```

```
(let (y (let (x10)
          (add1 x)))
  (add1 y))
```

```
(let (x 10)
  (let (x (add1 x))
    (add1 x)))
```

```
(let (a 1)
  (let (c
        (let (b (add1 a))
               add1(b)))
        add1 c))
```





Let’s add **local variables** and **binary ops** to our compiler

(+ (100 50) 2)

What assembly is produced?

```
expr := <number>
      |  (add1 <expr>)
      |  (let (<name> <expr>) <expr>)
      |  <name>
      |  (+ <expr> <expr>)
```

```
enum Expr {
  Num(i32),
  Add1(Box<Expr>),


}
```

```
enum Val {
  Reg(Reg),
  Imm(i32),


}
```

```
enum Reg {
  RAX,



}
```

```
enum Instr {
  IMov(Val, Val),
  IAdd(Val, Val),
  ISub(Val, Val),
  IMul(Val, Val),
}
```

```
fn compile(e: &Expr,                  ,is: &mut Vec<Instr>){
  match e {
    Expr::Num(n) => {
      is.push(is.push(mov(reg(Reg::RAX), imm(*n))))
    }
    Expr::Add1(e1) => {
      compile(e1, is);
      is.push(add(reg(Reg::RAX), imm(1)))
    }




















     }
}
```

Let’s add local variables and binary ops to our compiler

```
expr := <number>
     |  (add1 <expr>)
     |  (let (<name> <expr>) <expr>)
     |  <name>
     |  (+ <expr> <expr>)
```

(+ (100 50) 2)

What assembly is produced?

```
enum Expr {
  Num(i32),
  Add1(Box<Expr>),
  Plus(Box<Expr>, Box<Expr>),



}

fn compile_expr(e : &Expr, si: i32                    ) -> String {
  match e {
      Expr::Num(n) => format!("mov rax, {}", *n),
      Expr::Add1(subexpr) => {
          compile_expr(subexpr, si) + "\nadd rax, 1"
      },
      Expr::Plus(e1, e2) => {
         let e1_instrs = compile_expr(e1, si);
         let e2_instrs = compile_expr(e2, si + 1);
         let stack_offset = si * 8;
         format!("
            {e1_instrs}
            mov [rsp - {stack_offset}], rax
            {e2_instrs}
            add rax, [rsp - {stack_offset}]
         ")
      }
      Expr::Let(x, e, body) => {




      }
}
```

(let (x 10)
  (let (y 10)
    (+ x y)))

What assembly should we produce?

Let’s agree on what each of these programs should evaluate to…

(let (x 10)
  (let (y 10)
    (+ x y)))

(+ (let (x 10) (add1 x))
   (let (y 7) (+ x y)))

(let (x (let (y 10) (add1 y)))
  (add1 x))

(let (x 10)
  (let (x (add1 x))
    (+ x 10)))

Rust Immutable Data Structures: https://docs.rs/im/latest/im/

Module im::hashmap

An unordered map.
An immutable hash map using hash array mapped tries.
Most operations on this map are O(log$_x$ n) for a suitably high *x* that it should be nearly O(1) for most maps. Because of this, it’s a great choice for a generic map as long as you don’t mind that keys will need to implement Hash and Eq.

```
pub fn update(&self, k: K, v: V) -> Self
```

Construct a new hash map by inserting a key/value mapping into a map.
If the map already has a mapping for the given key, the previous value is overwritten.
Time: O(log n)

Examples

```
let map = hashmap!{};
assert_eq!(
  map.update(123, "123"),
  hashmap!{123 => "123"} );
```

```
pub fn get<BK>(&self, key: &BK) -> Option<&V> where
    BK: Hash + Eq + ?Sized,
    K: Borrow<BK>,
```

Get the value for a key from a hash map.
Time: O(log n)

Examples

```
let map = hashmap!{123 => "lol"};
assert_eq!( map.get(&123), Some(&"lol") );
```