Understand structs in memory

Know how to save space in memory

Structures

① Structures

② Data Alignment

Structures

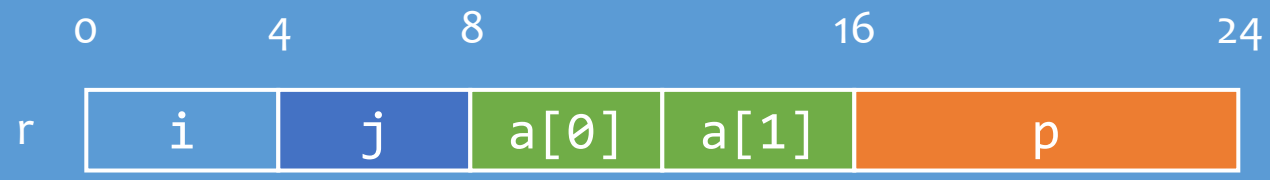
r in %rdi
i in %rsi

```
struct rec {
   int i;
   int j;
   int a[2];
   int *p;
};
```

```
movl     (%rdi),%eax
movl     %eax,4(%rdi)
```

```
leaq     8(%rdi,%rsi,4),%rax
```

```
movl     4(%rdi),%eax
addl     (%rdi),%eax
cltq
leaq     8(%rdi,%rax,4),%rax
movq     %rax,16(%rdi)
```

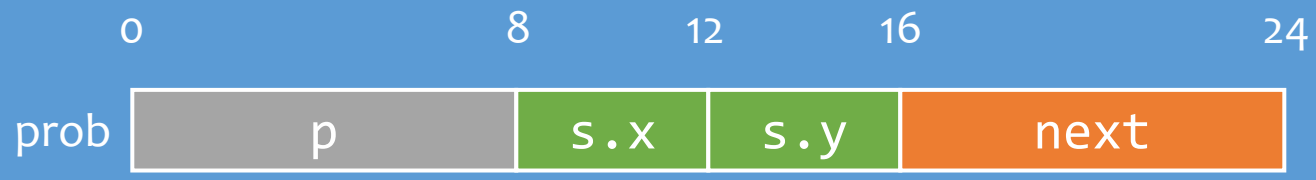


Example

```
void sp_init(struct prob *sp) {
   sp->s.x  = _____________;
   sp->p    = _____________;
   sp->next = _____________;
}
```

```
struct prob {
   int *p;
   struct {
      int x;
      int y;
   } s;
   struct prob *next;
};
```

```
sp_init:
   movl   12(%rdi),%eax
   movl   %eax,8(%rdi)
   leaq   8(%rdi),%rax
   movq   %rax,(%rdi)
   movq   %rdi,16(%rdi)
   ret
```



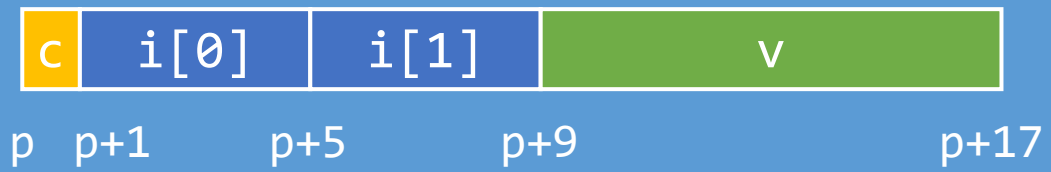
Example

```
fun:
   movl   $0,%eax
   jmp    .L2
.L3:
   addq   (%rdi),%rax
   movq   8(%rdi),%rdi
.L2:
   testq %rdi,%rdi
   jne    .L3
   rep; ret
```

```
long fun(struct ELE *ptr)
{
   long ret=0;
   while(ptr) {
      ret += ptr->v;
      ptr = ptr->p;
   }
   return ret;
}
```

```
struct ELE {
   long v;
   struct ELE *p;
};
```

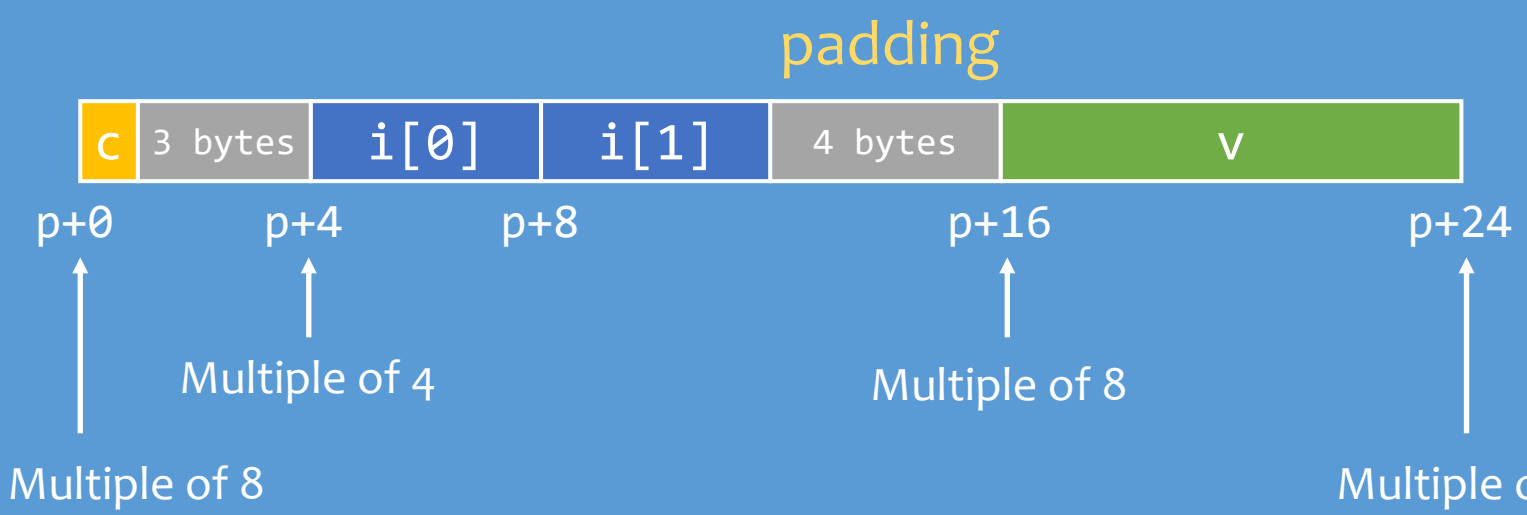
Data Alignment




```
struct S1 {
   char c;
   int i[2];
   double v;
} *p;
```

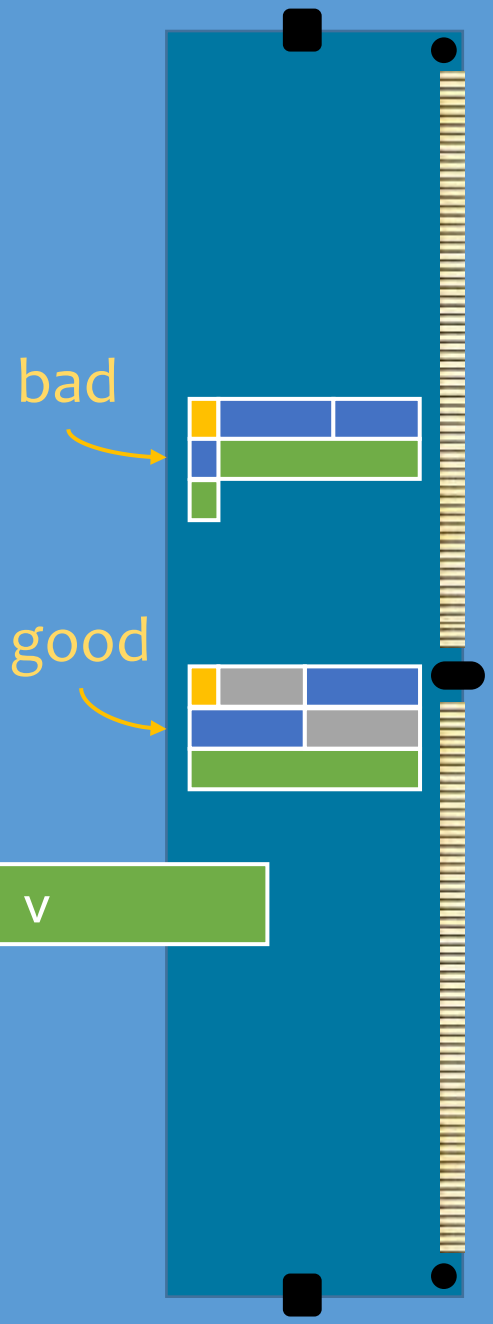
① Primitive data type requires K bytes

② Address must be multiple of K



Why?

1 byte: `char`
2 bytes: `short`
4 bytes: `int, float`
8 bytes: `double, long, char *`
16 bytes: `long double`



Example

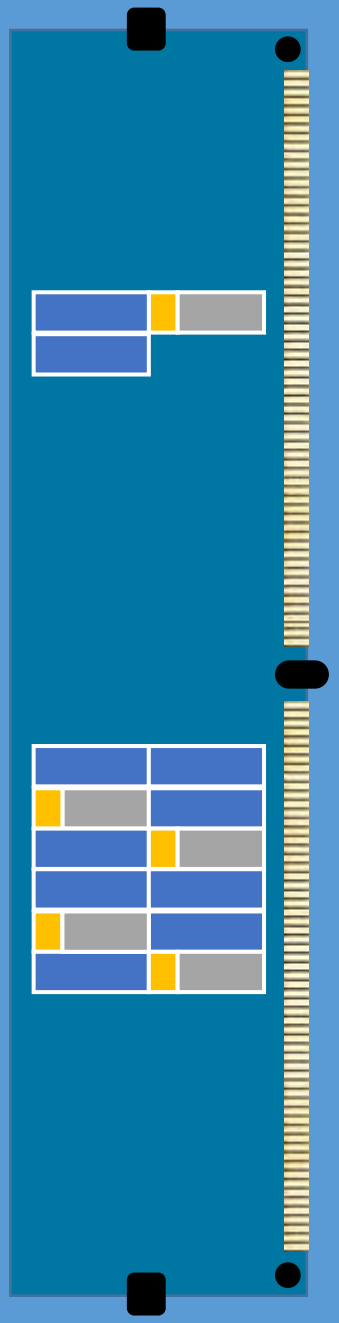
```
struct S1 {
   int i;
   char c;
   int j;
};
```

```
struct S2 {
   int i;
   int j;
   char c;
};
```

③ Overall structure must be multiple of K

④ Put large data types first

```
struct S2 d[4];
```



Saving space

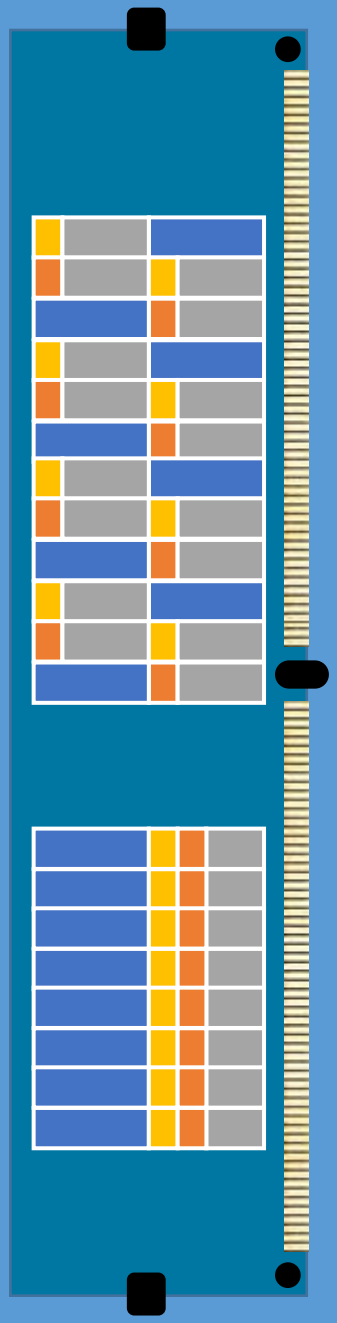
```
struct S4 {
   char c;
   int i;
   char d;
} *p;
```

```
struct S4 d[8];
```

④ Put large data types first


```
struct S5 {
   int i;
   char c;
   char d;
} *p;
```

```
struct S5 d[8];
```



Example

```
struct P1{ int i; char c; int j; char d; };

struct P2{ int i; char c; char d; long j; };

struct P3{ short w[3]; char c[3]; };

struct P4{ short w[5]; char *c[3]; };

struct P5{ struct P3 a[2]; struct P2 t };
```

Summary

- Structures
- Data Alignment

Eric Steven Raymond

Author of “The Cathedral and the Bazaar”

> “Smart data structures and dumb code works a lot better than the other way around.”