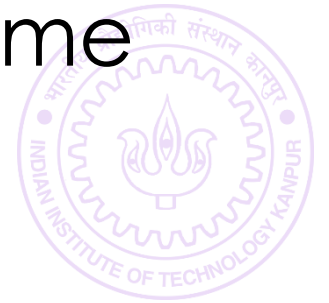
Type Hype with Mr C

ESC101: Foundations of Computing

Purushottam Kar

Announcements

- Special session on using computers
  - August 11, 2018 (coming Saturday), 5PM, NCL CC-02
  - Not a revision class – only for students who are new to computers
- Slides, tutorial sheets, lecture codes on website
  - https://tinyurl.com/esc18-19aw
  - In case the above does not work https://web.cse.iitk.ac.in/users/purushot/courses/esc/2018-19-a/
- Please bring your IITK ID card to lab – come on time



Various kinds of variables in C

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In math, we have several kinds of numbers
naturals, integers, rationals, reals, complex

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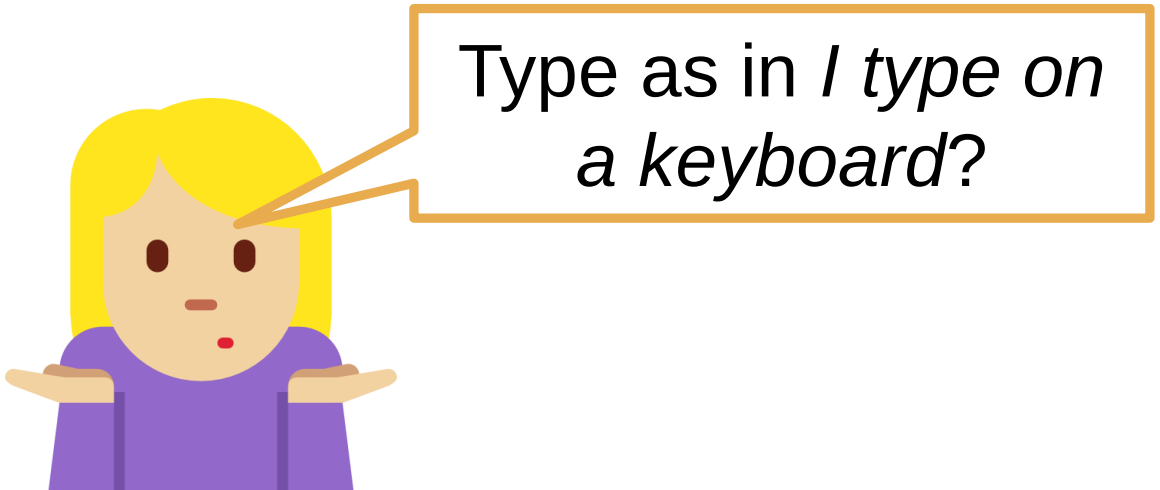

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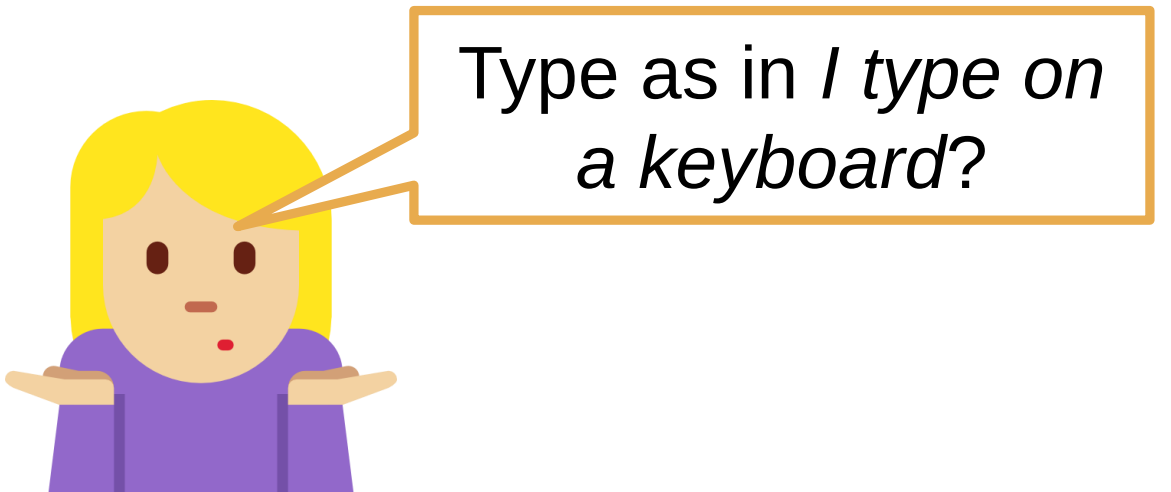

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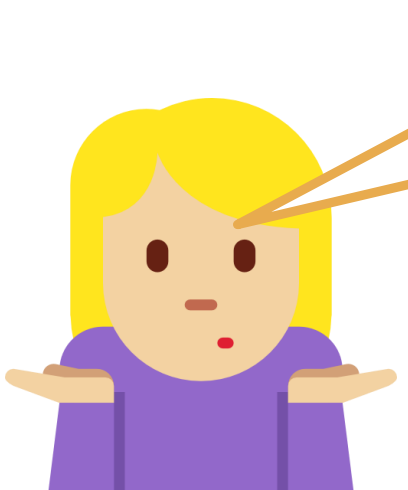

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No, as in *I saw two types of mangoes in the store today*

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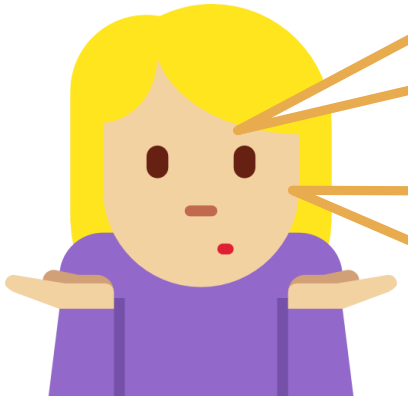

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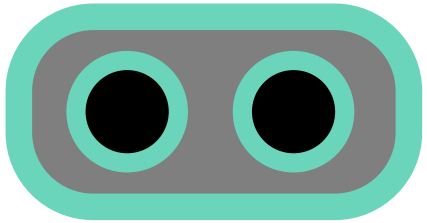

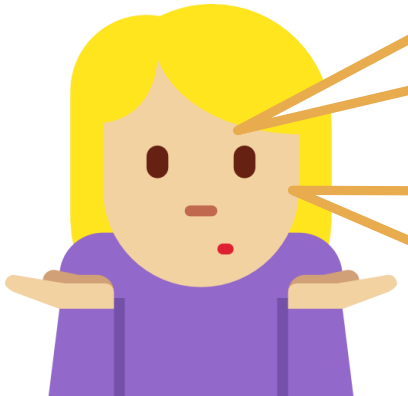

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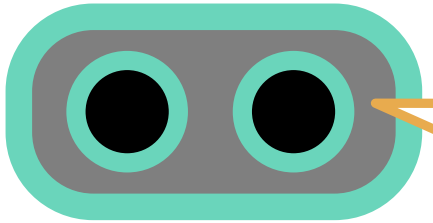
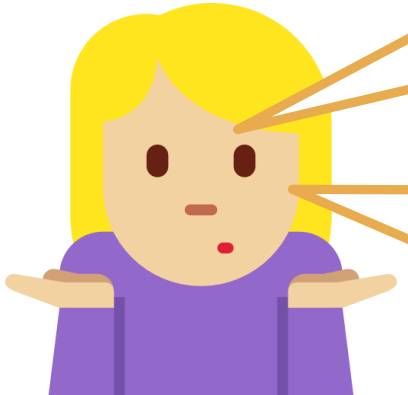


That's right. I can work with lots of kinds of variables



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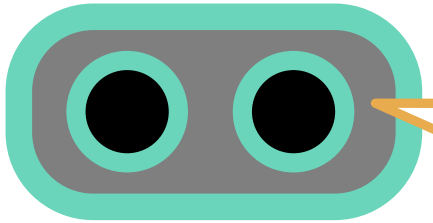

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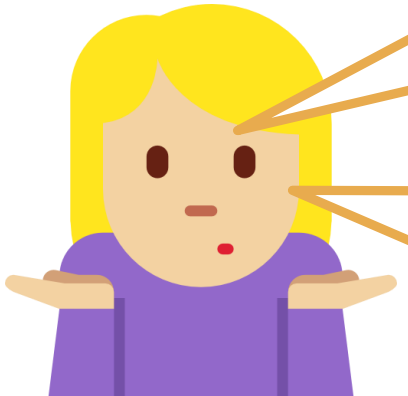

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We have already seen int, long and float types in class

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Int type

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INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Int type

Can store integers b/w -2,147,483,648 and 2,147,483,647

Int type

Shorthand for between

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#include <stdio.h>
int main(){
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int main(){
int a;
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int main(){
int a;
scanf("%d", &a);
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#include <stdio.h>
int main(){
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Integer arithmetic applies to long int as well +, -, /, *, %, ()

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Have worked with them a lot so far

Long int type

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Really long – can store integers between

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#include <stdio.h>
int main(){
long a; //long int also
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How does long work with int int + long, int * long?

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Will see today

Float type

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int, long allow us to store, do math formulae with integers

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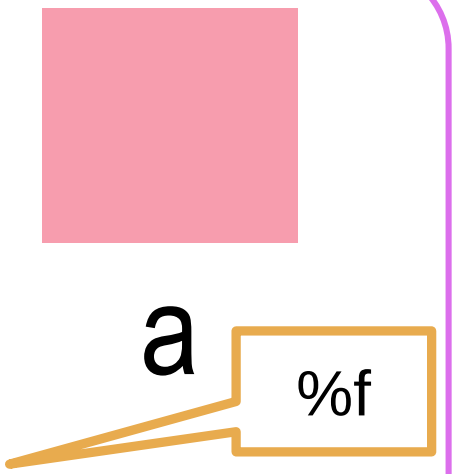

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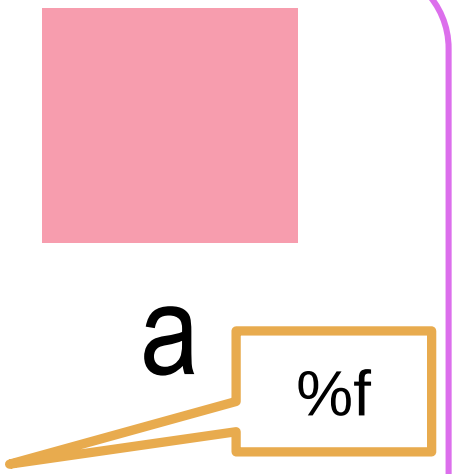

Very large range ± 3.4e+38

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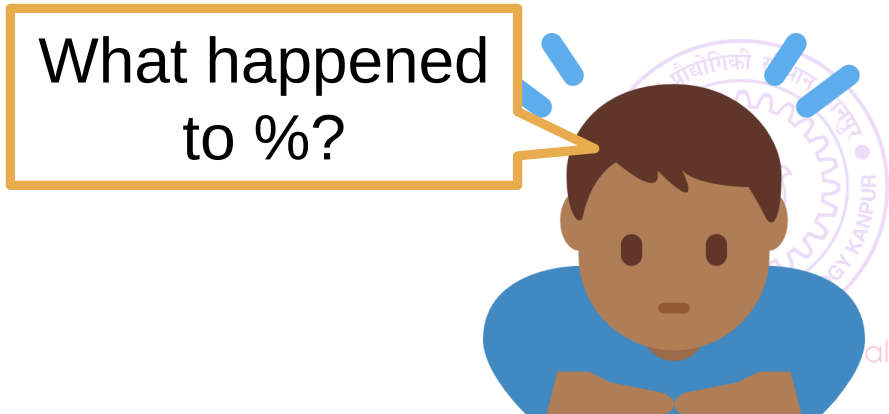

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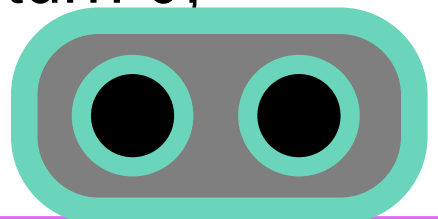

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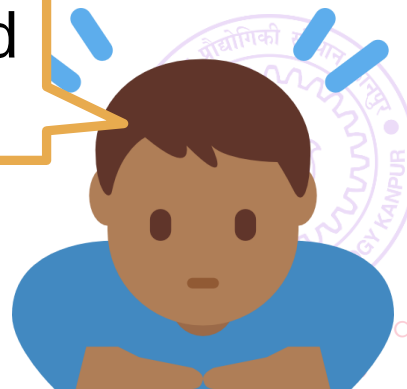
What happened to %?



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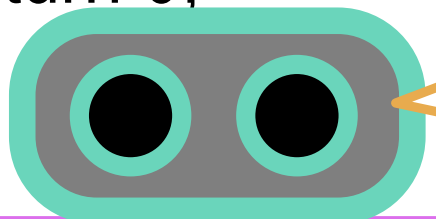

☺ Did you ever do remainders with real numbers in school?

Very large range ± 3.4e+38

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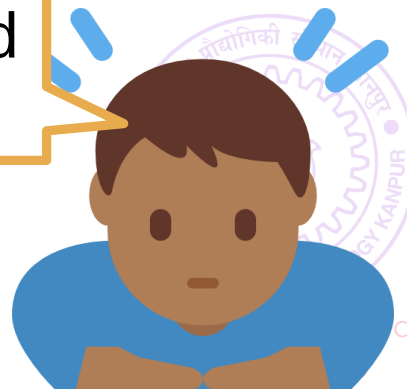

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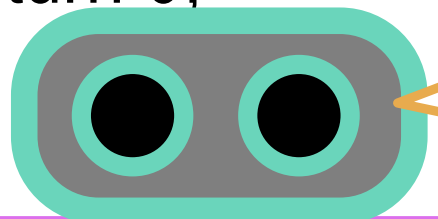

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I remember. Remainders make sense for integers, not for real numbers

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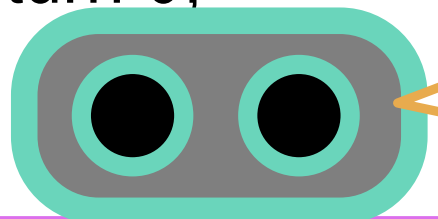
Try them out on Prutor



☺ Did you ever do remainders with real numbers in school?

I remember. Remainders make sense for integers, not for real numbers

Ints and Longs

Ints and Longs

Very good friends since both store integers

Ints and Longs

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Ints and Longs

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Ints and Longs

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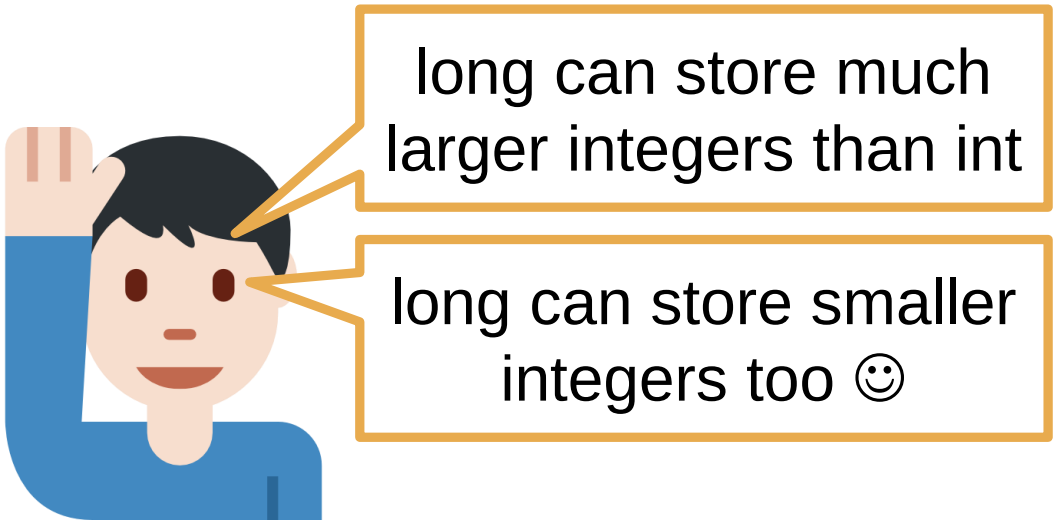
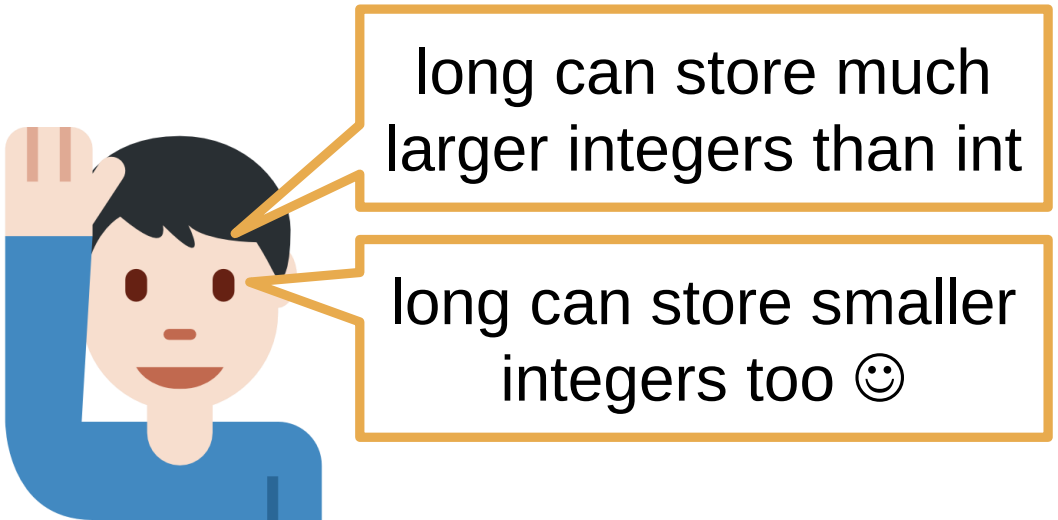


Ints and Longs

Very good friends since both store integers

Can add/subtract/multiply/divide/remainder two ints, two longs, as well as an int and a long



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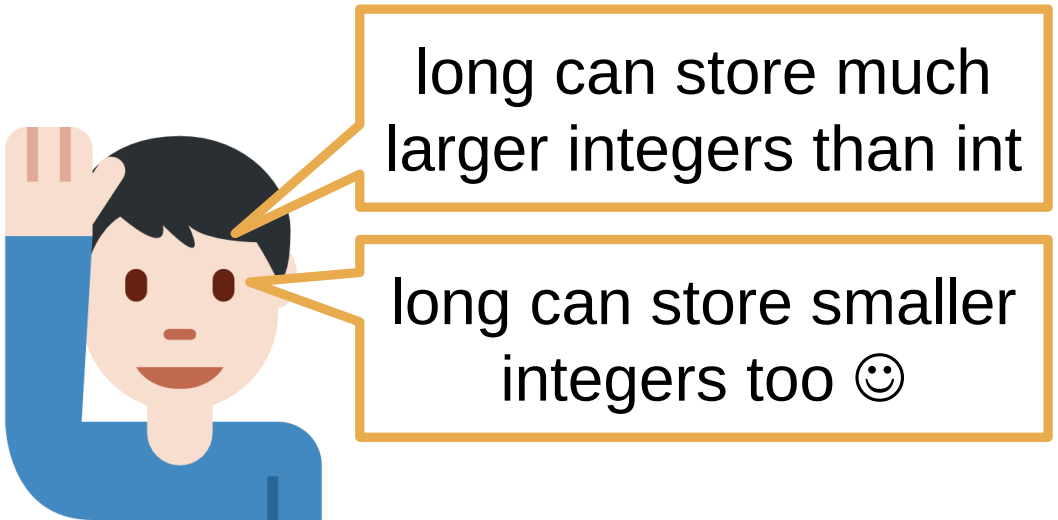
Can add/subtract/multiply/divide/remainder two ints, two longs, as well as an int and a long

In fact, even if we try to print an int using %ld or print a long using %d, Prutor will only warn us, not throw an error



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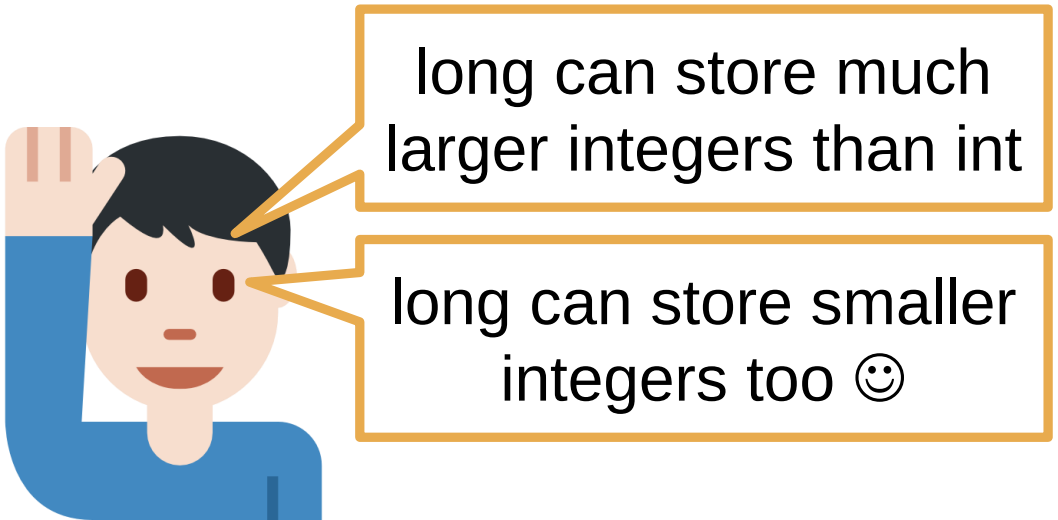

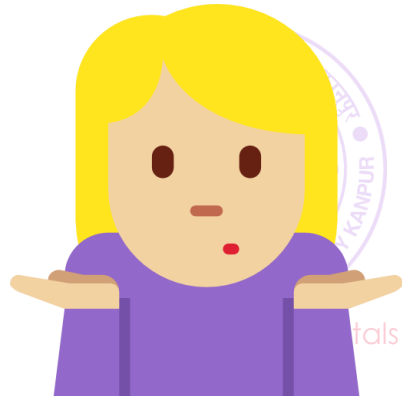

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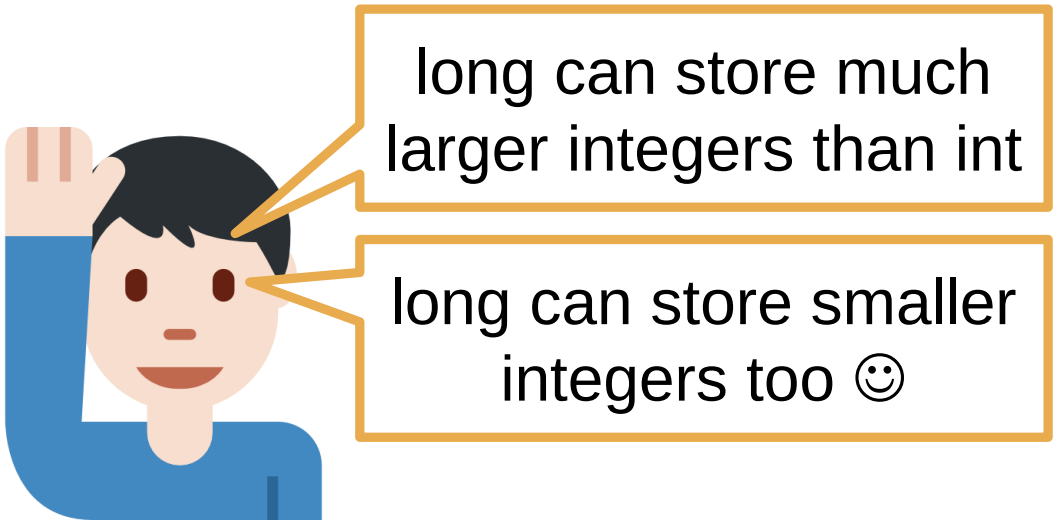

Ints and Longs

Ints and Longs

Ints and Longs


```
#include <stdio.h>
```

Ints and Longs


```
#include <stdio.h>
int main(){
```

Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
```

Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
```

Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
```

Ints and Longs


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}
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Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
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}
```


a

Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```

```
20000
00000
```

a

Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
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}
```

Ints and Longs


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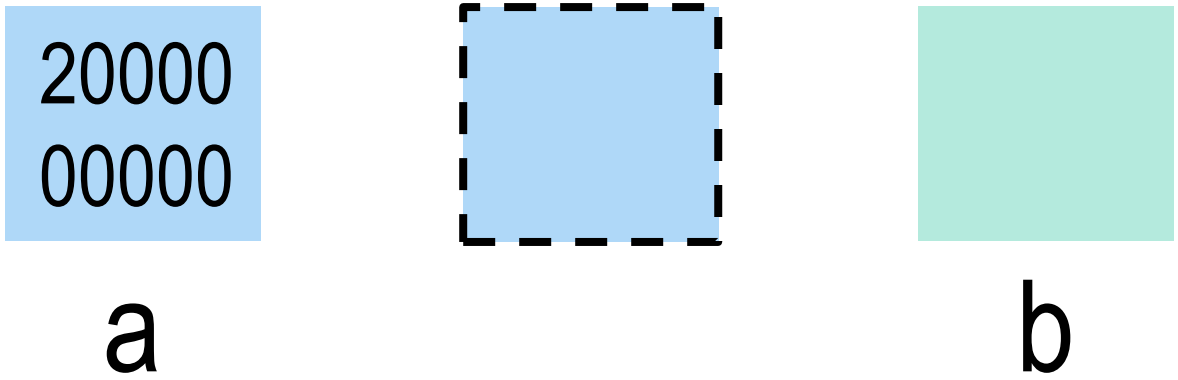

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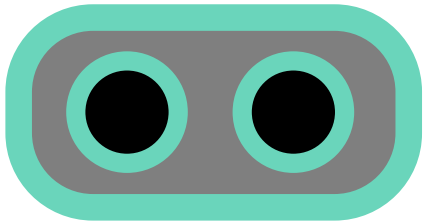
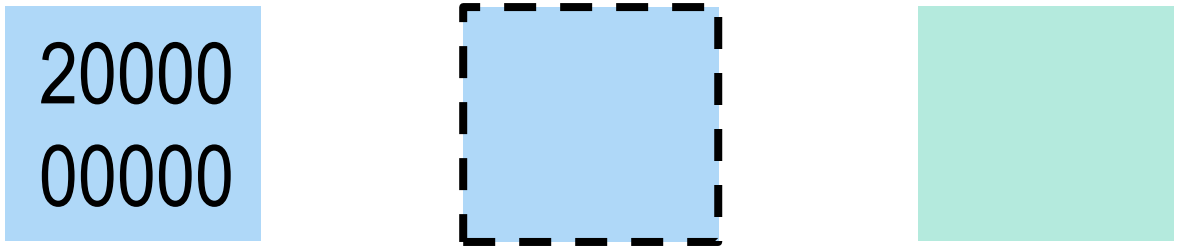
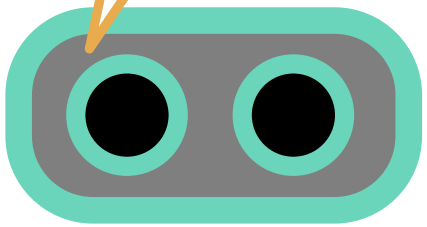


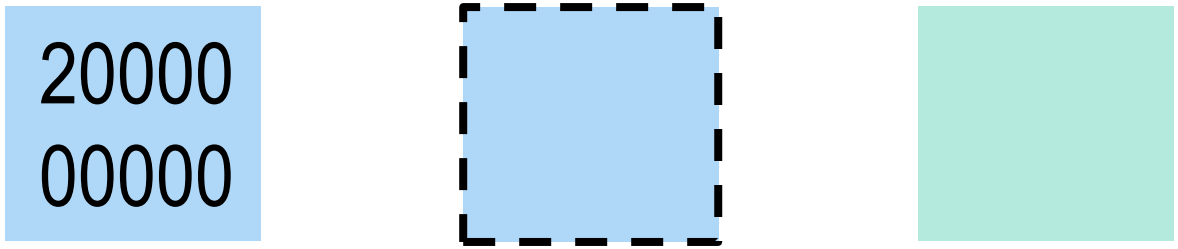


Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```

Dotted line means I create these variables myself



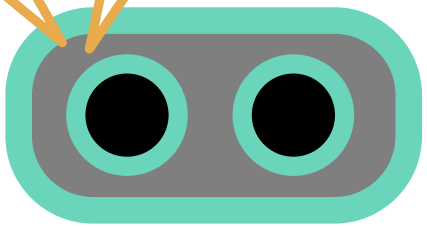


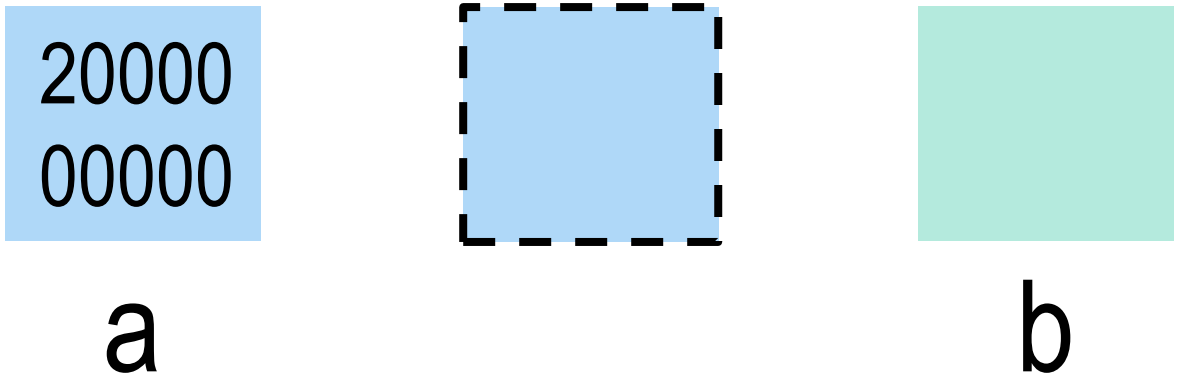
Ints and Longs


```
#include <stdio.h>
int a = 20000 00000;
long b = a + a;
printf("%ld",b);
}
```

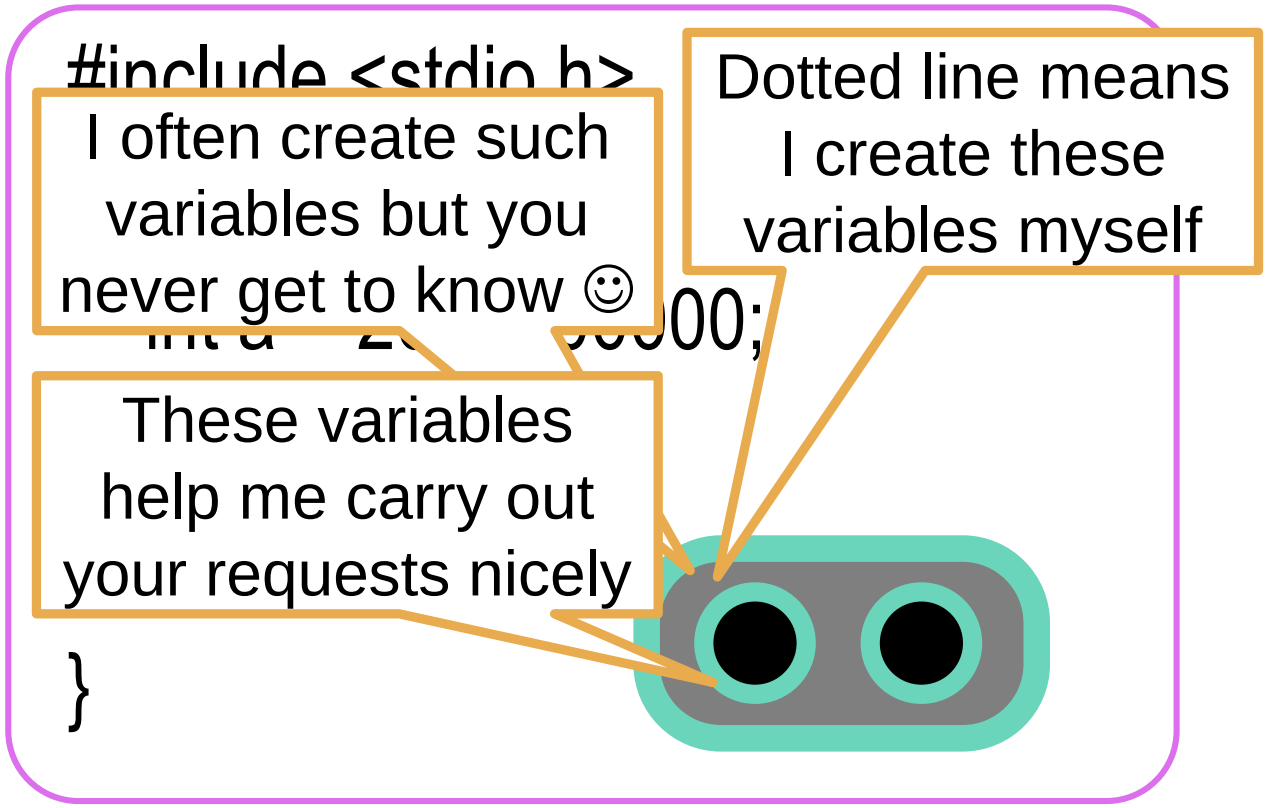
I often create such variables but you never get to know ☺

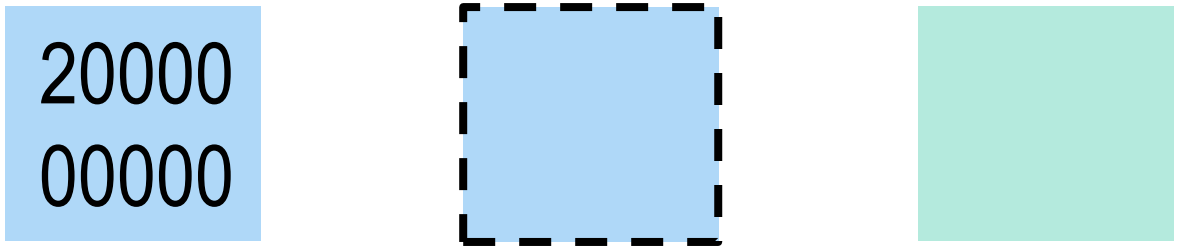
Dotted line means I create these variables myself





Ints and Longs





Ints and Longs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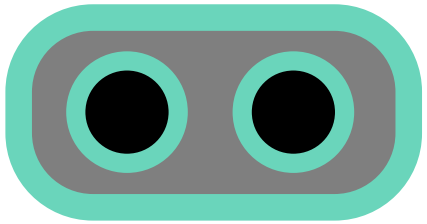

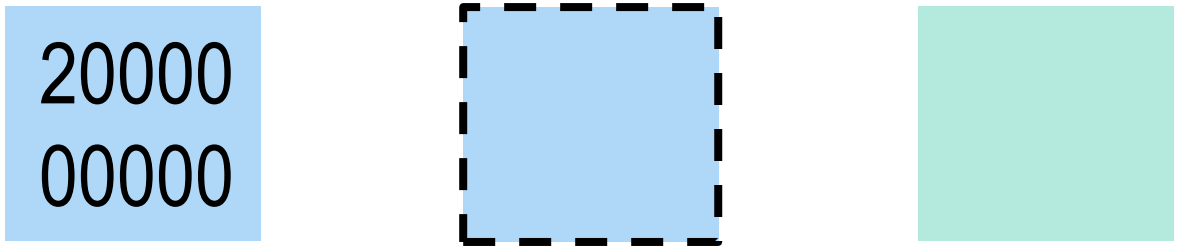

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```
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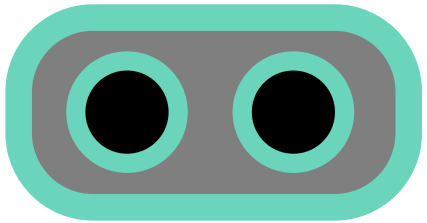
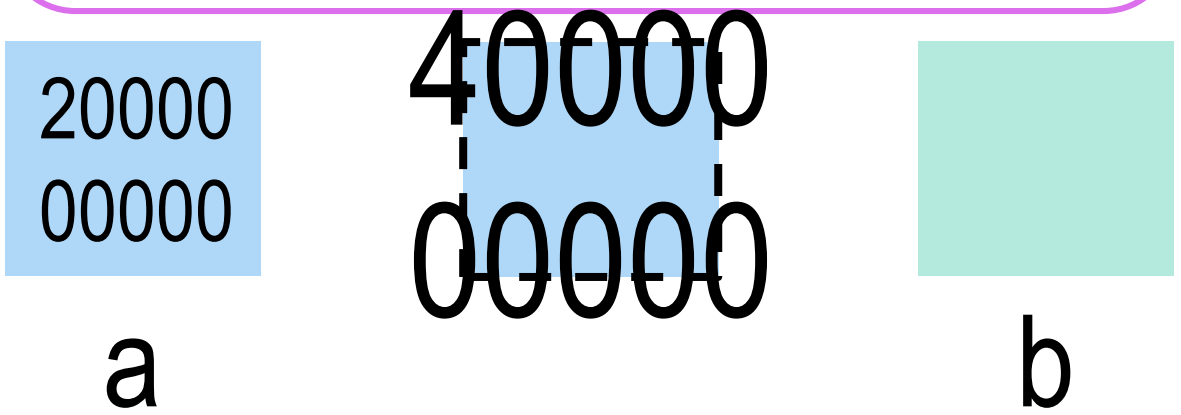
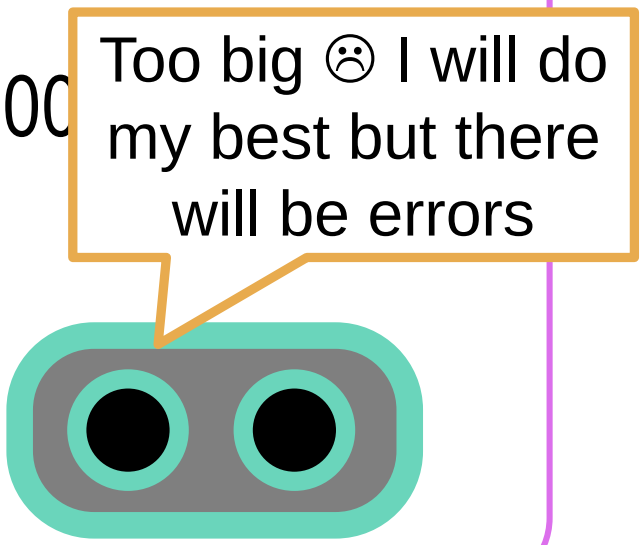
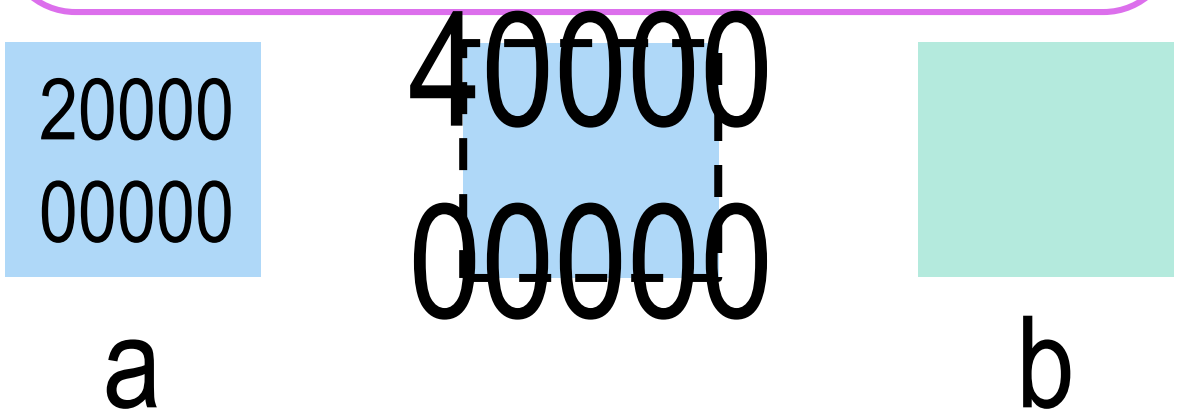




Ints and Longs

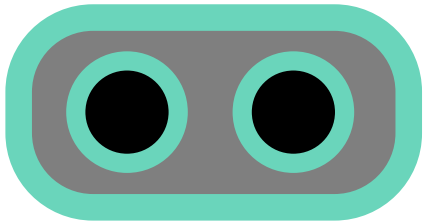

```
#include <stdio.h>
int main(){
    int a = 200000000
    long b = a + a;
    printf("%ld",b);
}
```

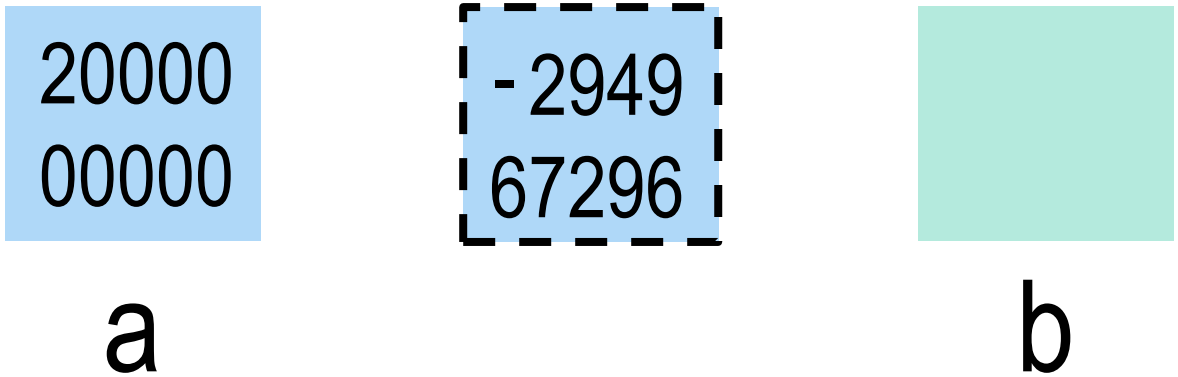




Ints and Longs


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```





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    printf("%ld",b);
}
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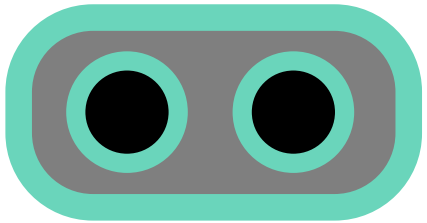

20000 00000	-2949 67296	-2949 67296
a		b

Ints and Longs


```
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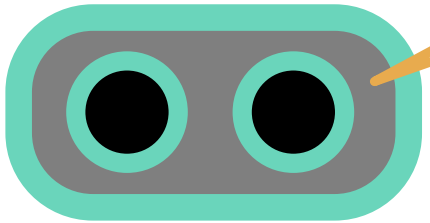
    printf("%ld",b);
}
```



-294967296

20000 00000	-2949 67296	-2949 67296
a		b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
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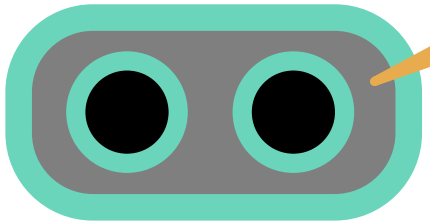
```



-294967296

20000 00000	-2949 67296	-2949 67296
a		b

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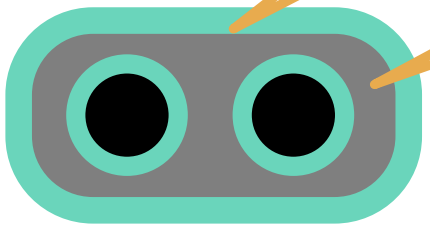

Typecasting is an instruction to me to interpret an int as a long

-294967296

20000 00000	-2949 67296	-2949 67296
a		b

Ints and Longs - Typecasting


```
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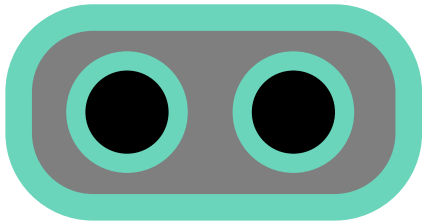

20000 00000	-2949 67296	-2949 67296
a		b

Ints and Longs - Typecasting


```
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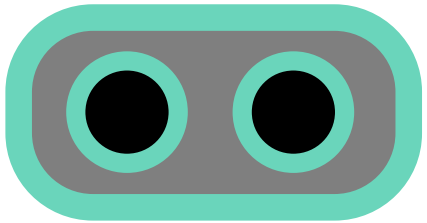

20000
00000

a

-2949
67296

-2949
67296

b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
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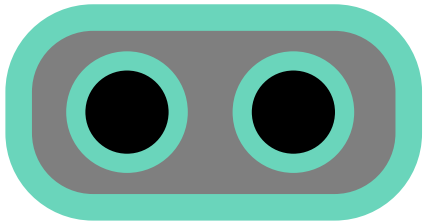
}
```



```
#include <stdio.h>
```

20000 00000	-2949 67296	-2949 67296
a		b

Ints and Longs - Typecasting


```
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    int a = 2000000000;
    long b = a + a;
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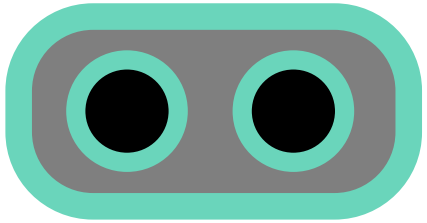

```
#include <stdio.h>
int main(){
```

20000
00000

a

-2949
67296

-2949
67296

b

Ints and Longs - Typecasting


```
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    int a = 2000000000;
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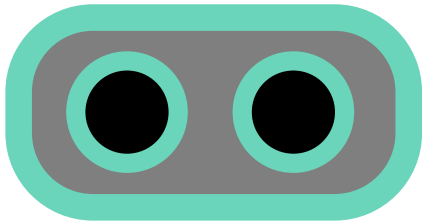

```
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```

20000
00000

a

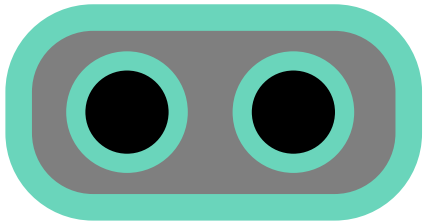
-2949
67296

-2949
67296

b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```

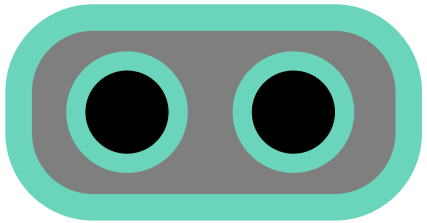


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
```

20000 00000	-2949 67296	-2949 67296
a		b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```



```
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int main(){
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    printf("%ld",b);
```

20000
00000

a

-2949
67296

-2949
67296

b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
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    long b = a + a;
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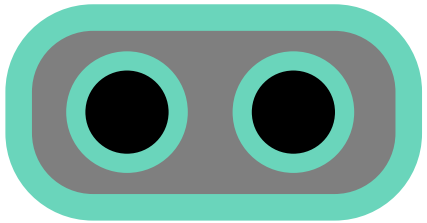
}
```



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}
```

a		b
20000 00000	-2949 67296	-2949 67296

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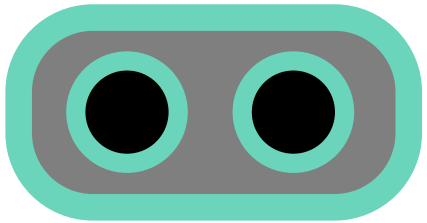

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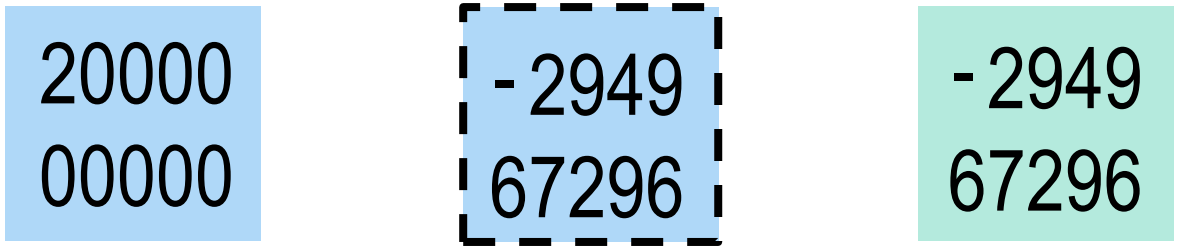

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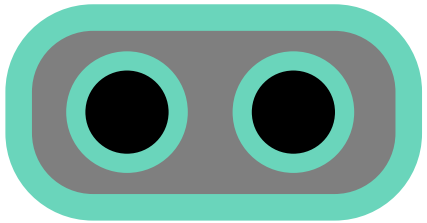

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```

20000 00000	-2949 67296	-2949 67296	20000 00000
a		b	a

Ints and Longs - Typecasting


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}
```
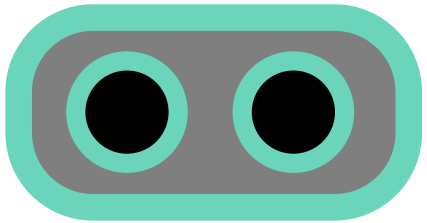



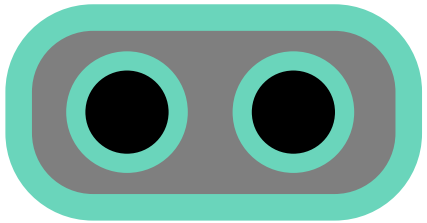
```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

20000 00000	-2949 67296	-2949 67296	20000 00000
a		b	a

b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```



a		b
20000 00000	-2949 67296	-2949 67296

```
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}
```

a		b
20000 00000		

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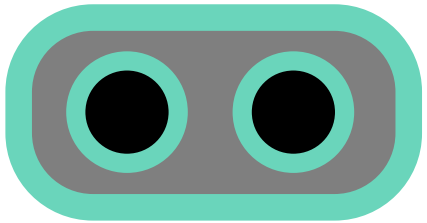

20000 00000	-2949 67296	-2949 67296
a		b

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a	b

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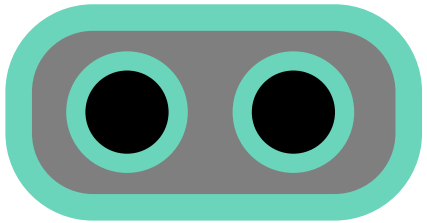

20000 00000	-2949 67296	-2949 67296
a		b

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}
```

20000 00000	20000 00000	
a		b

Ints and Longs - Typecasting


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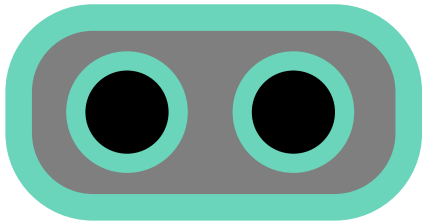

20000 00000	-2949 67296	-2949 67296
a		b

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}
```

20000 00000	20000 00000	20000 00000
a		b

Ints and Longs - Typecasting


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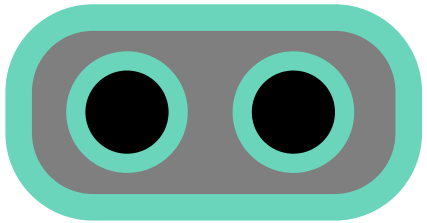
```



20000 00000	-2949 67296	-2949 67296
a		b

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```

20000 00000	20000 00000	20000 00000
a		b

Ints and Longs - Typecasting


```
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}
```
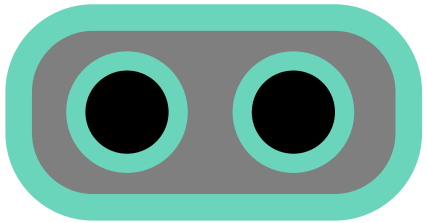



a		b
20000 00000	-2949 67296	-2949 67296

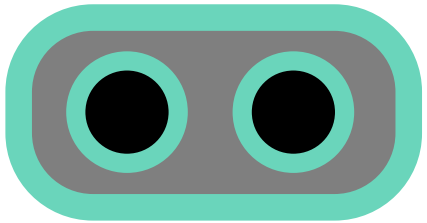
```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

40000
00000

a			b
20000 00000	20000 00000	20000 00000	

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```



20000
00000

a

-2949
67296

-2949
67296

b

```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

40000
00000

20000
00000

a

20000
00000

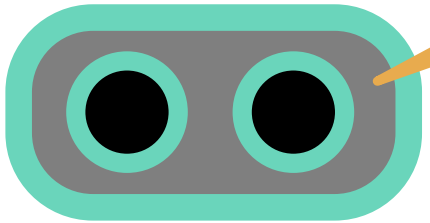
20000
00000

40000
00000

b

Ints and Longs - Typecasting


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```



4000000000

```
#include <stdio.h>
int main(){
    int a = 2000000000;
    b = (long)a + (long)a;
    printf("%ld",b);
}
```

40000
00000

20000
00000

-2949
67296

-2949
67296

20000
00000

20000
00000

20000
00000

40000
00000

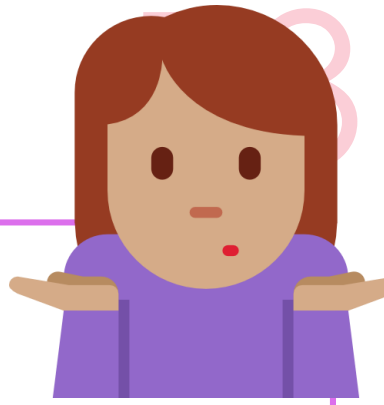
a

b

a

b

Ints and Longs - Typecasting



```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```

4000000000

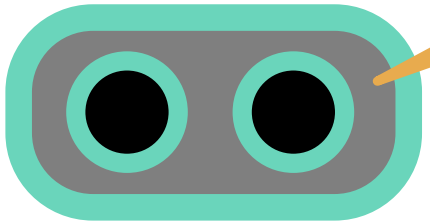
```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

a		b
20000 00000	-2949 67296	-2949 67296

a			b
20000 00000	20000 00000	20000 00000	40000 00000

Ints and Longs - Typec

```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = a + a;
    printf("%ld",b);
}
```



4000000000

20000 00000 — a

-2949 67296

-2949 67296 — b

Why not just define a long variable? No need for typecasting!

```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

40000 00000

20000 00000 — a

20000 00000

20000 00000 — b

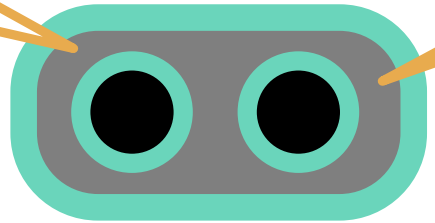
40000 00000

Ints and Longs - Typec

Why not just define a long variable? No need for typecasting!

```
#include <stdio.h>
...00;
    printf("%ld",b);
}
```

Often, you don't have control over the kind of data you receive. Typecasting helps convert data to a form your like to work with



4000000000

```
#include <stdio.h>
int main(){
    int a = 2000000000;
    ... b = (long)a + (long)a;
    printf("%ld",b);
}
```

40000
00000

20000 00000	-2949 67296	-2949 67296	20000 00000	20000 00000	20000 00000	40000 00000
a		b	a			b

A handy shorthand

A handy shorthand

A handy shorthand


```
#include <stdio.h>
```

A handy shorthand


```
#include <stdio.h>
int main(){
```

A handy shorthand


```
#include <stdio.h>
int main(){
    int a = 2000000000;
```

A handy shorthand


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
```

A handy shorthand


```
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int main(){
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```

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```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

```
#include <stdio.h>
int main(){
    int a = 2000000000;
```

A handy shorthand


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

```
#include <stdio.h>
int main(){
    int a = 2000000000;
    printf("%ld", (long)a + (long)a);
```

A handy shorthand


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
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#include <stdio.h>
int main(){
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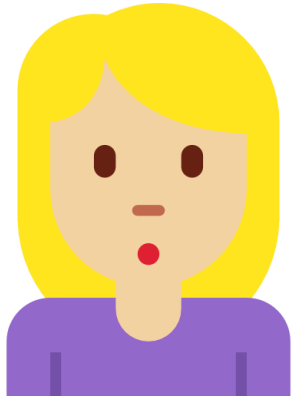

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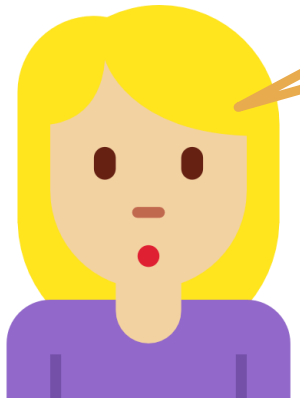
That means I really have to be careful



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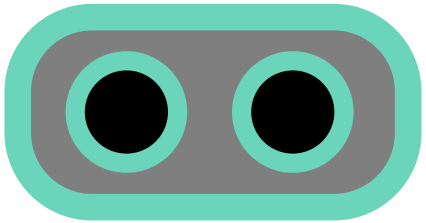

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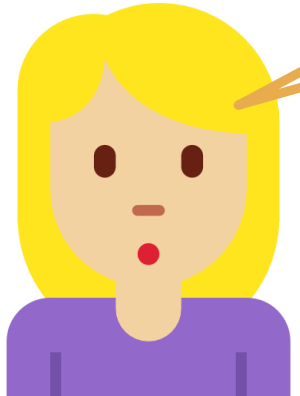

```
#include <stdio.h>
int main(){
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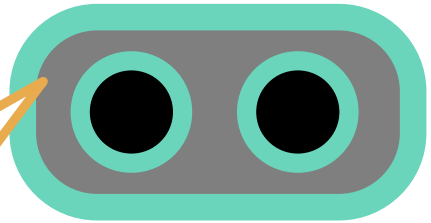
}
```

Yes, when in doubt, try typecasting to see if error vanishes



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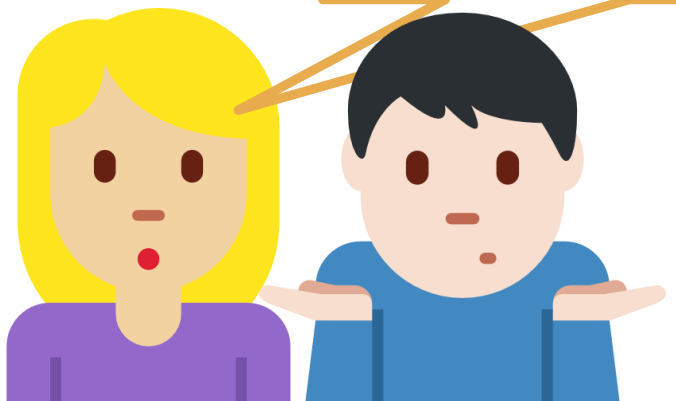

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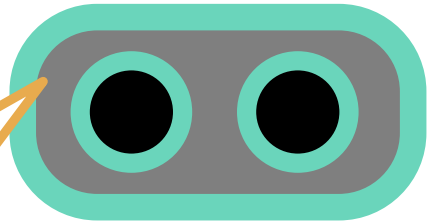

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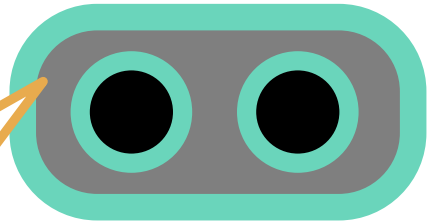

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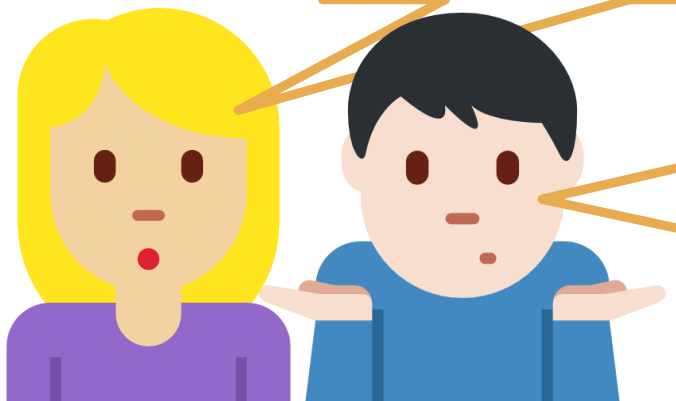

But Mr. C, why didn't you tell us about these errors when we compiled?

A handy shorthand


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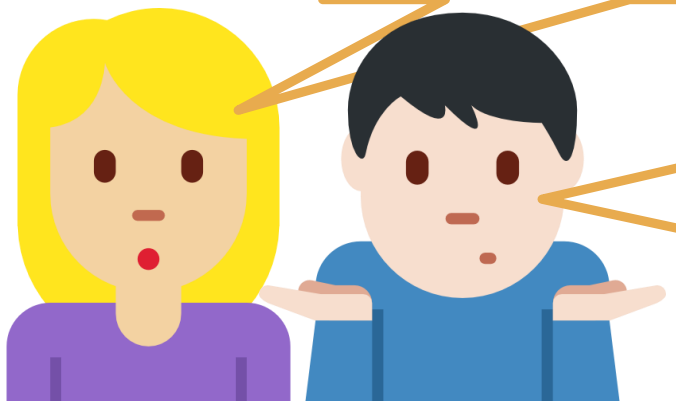

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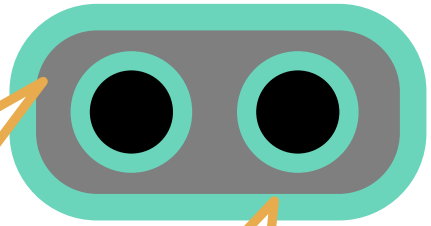


Yes, when in doubt, try typecasting to see if error vanishes

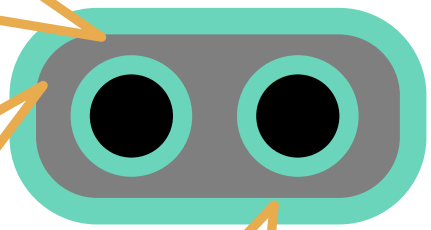
During compilation I only check if your grammar is correct

A handy shorthand


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    long b = (long)a + (long)a;
    printf("%ld",b);
}
```

```
#include <stdio.h>
int main(){
                                00;
                               )a + (long)a);
```

The errors we just saw are called *type errors*. These are a kind of *runtime error*



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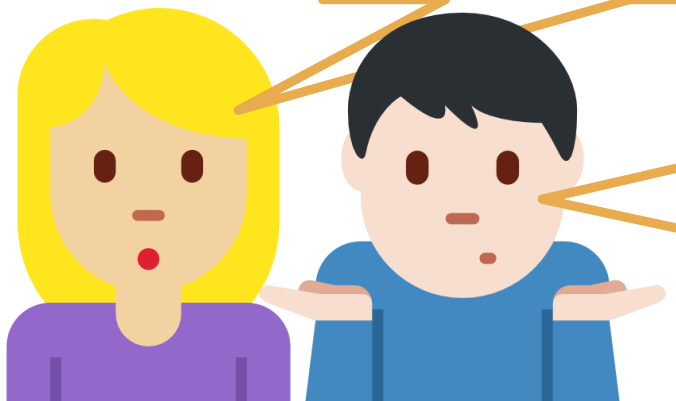
That means I really have to be careful



But Mr. C, why didn't you tell us about these errors when we compiled?

During compilation I only check if your grammar is correct

A handy shorthand


```
#include <stdio.h>
int main(){
    int a = 2000000000;
    lo                  ;
    p
}
```

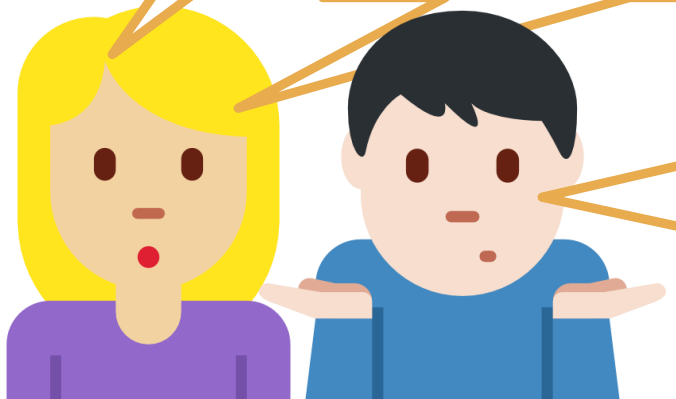
```
#include <stdio.h>
int main(){
                        00;
                        )a + (long)a);
```

Hmm. We see runtime errors only when we execute our code

That means I really have to be careful

The errors we just saw are called *type errors*. These are a kind of *runtime error*

Yes, when in doubt, try typecasting to see if error vanishes



But Mr. C, why didn't you tell us about these errors when we compiled?

During compilation I only check if your grammar is correct

Mixed type operations

Mixed type operations


```
int a = 2;
long c, b = 5;
```

Mixed type operations

What if we have mixed types in a formula?

```
int a = 2;
long c, b = 5;
```

Mixed type operations

What if we have mixed types in a formula?

```
c = a * b;
```

```
int a = 2;
long c, b = 5;
```

Mixed type operations

What if we have mixed types in a formula?

```
c = a * b;
```

```
int a = 2;
long c, b = 5;
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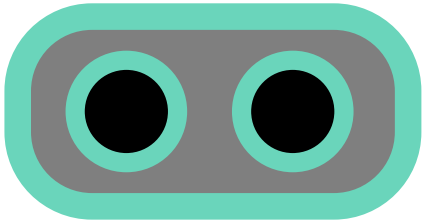


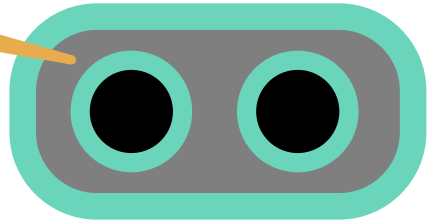
Mixed type operations

What if we ha

```
c = a * b;
```

Hmm … An int being multiplied to a long. Let me take care to convert the int to a long before performing the operation ☺

```
int a = 2;
long c, b = 5;
```



Mixed type operations

What if we ha

```
c = a * b;
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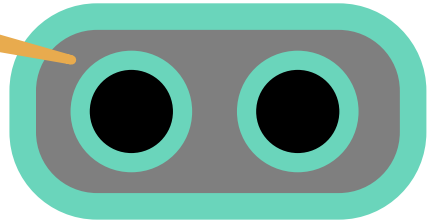
```
int a = 2;
long c, b = 5;
```



2

a

Mixed type operations

What if we ha

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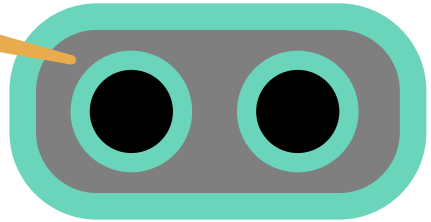

2

a

c

Mixed type operations

What if we ha

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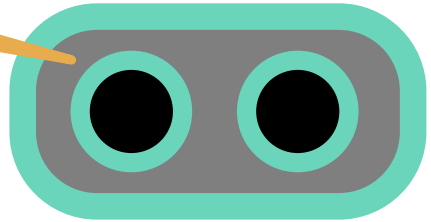

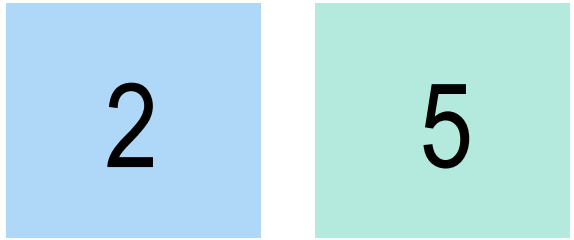

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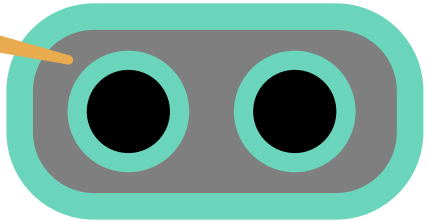

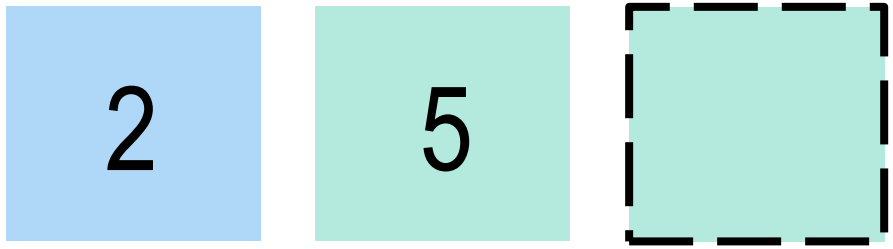

c

Mixed type operations

What if we ha

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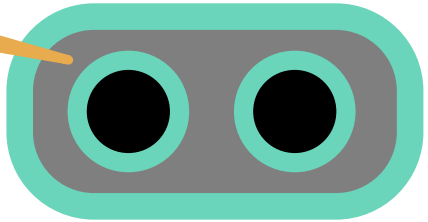

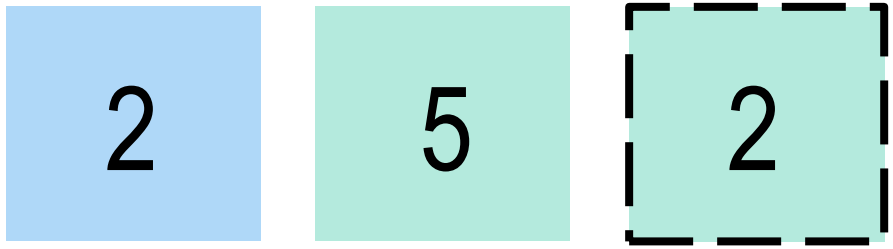

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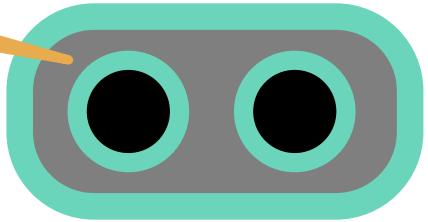

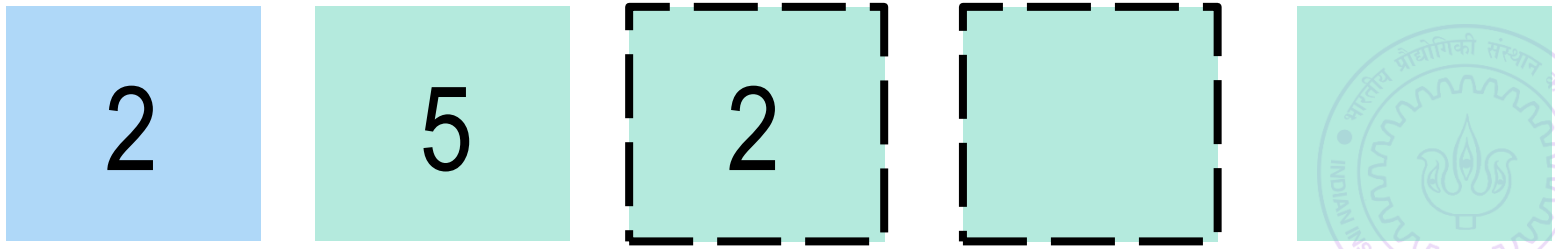

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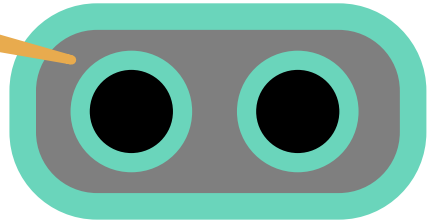

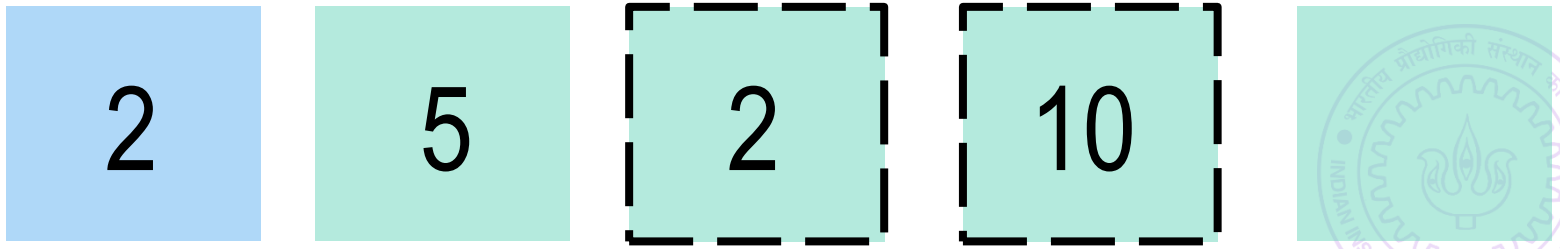

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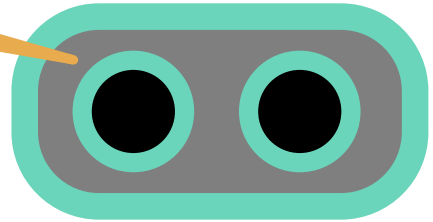

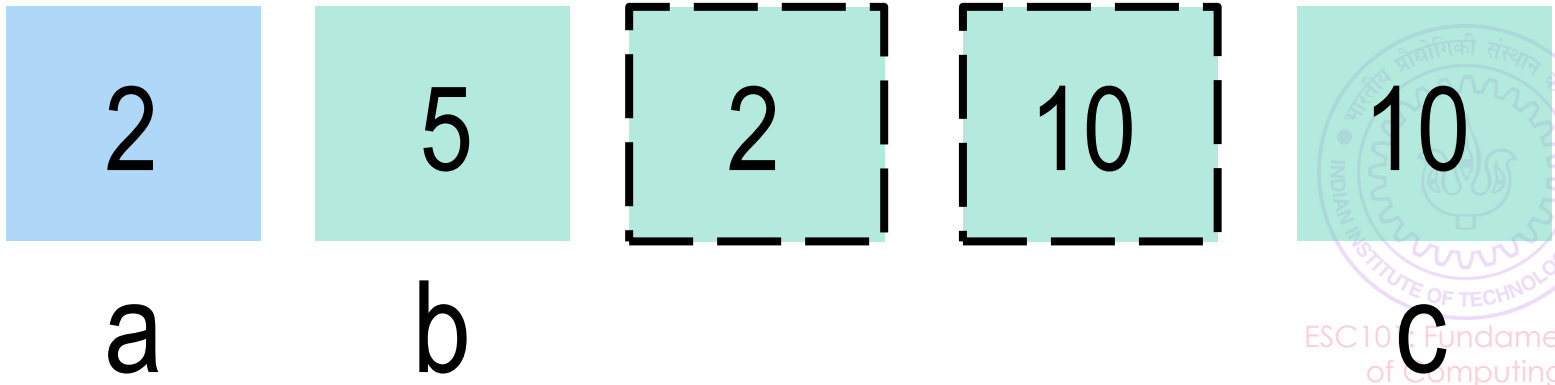

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Can typecast int to long

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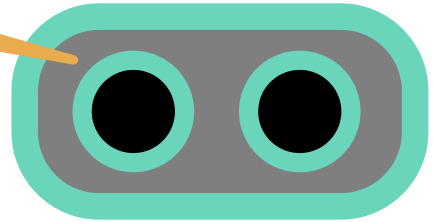

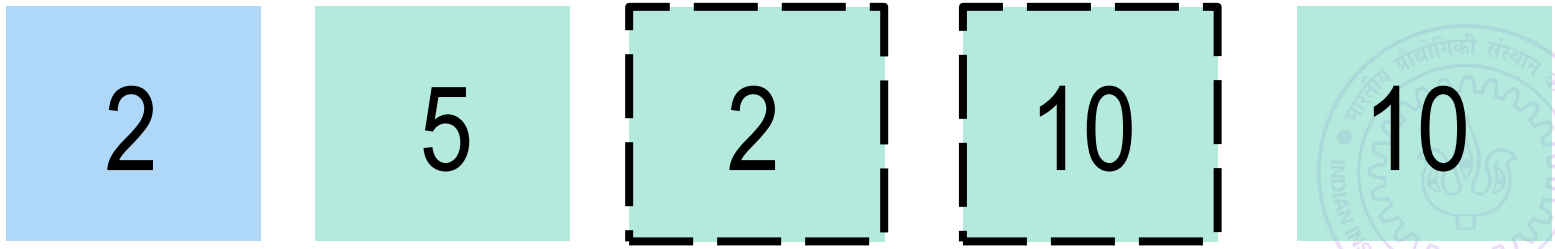

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Can typecast int to long

```
b = (long) a;
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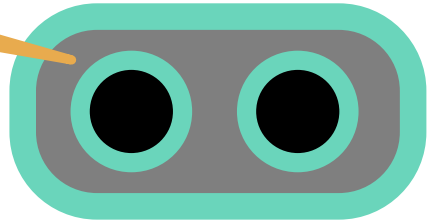

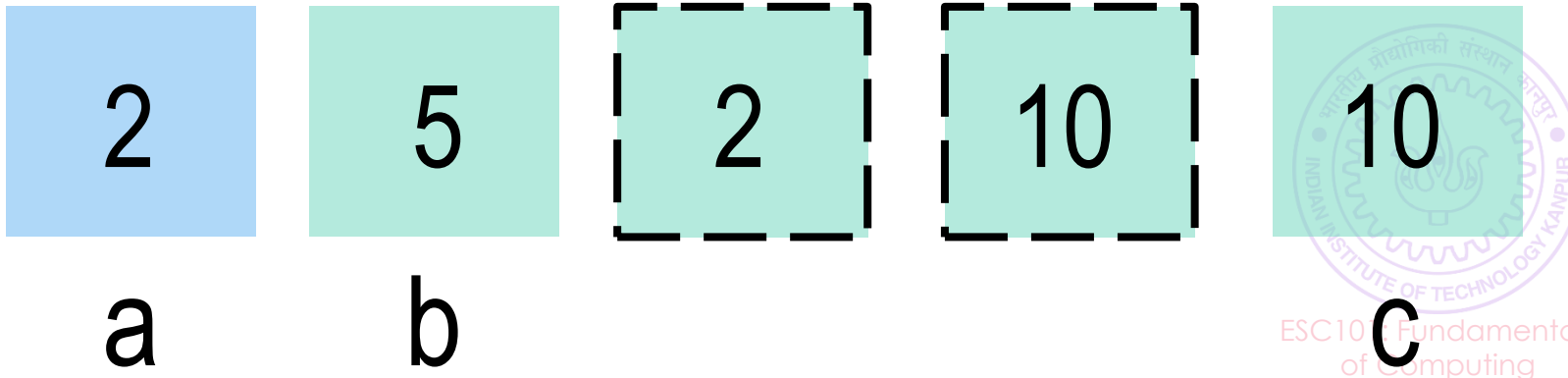

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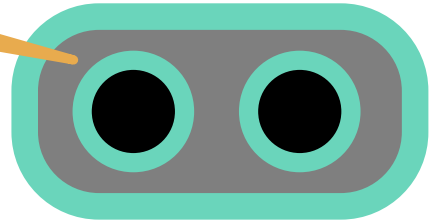
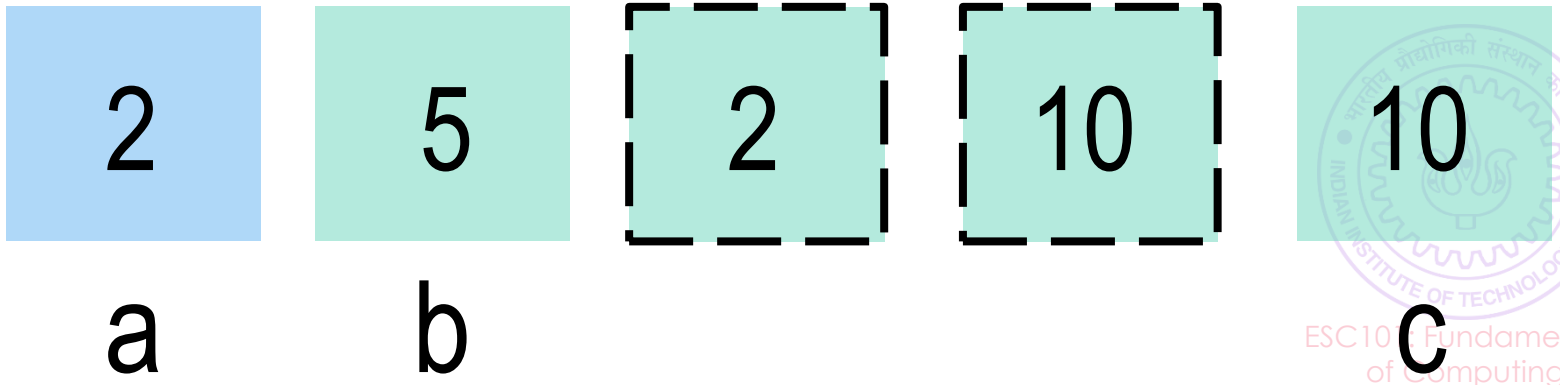


Can typecast int to long

```
b = (long) a;
```

Can typecast long to int



Mixed type operations

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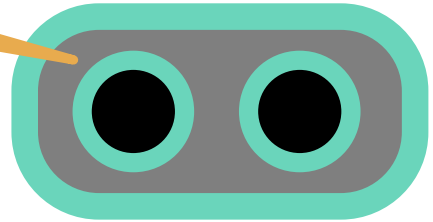

Can typecast int to long

```
b = (long) a;
```

Can typecast long to int

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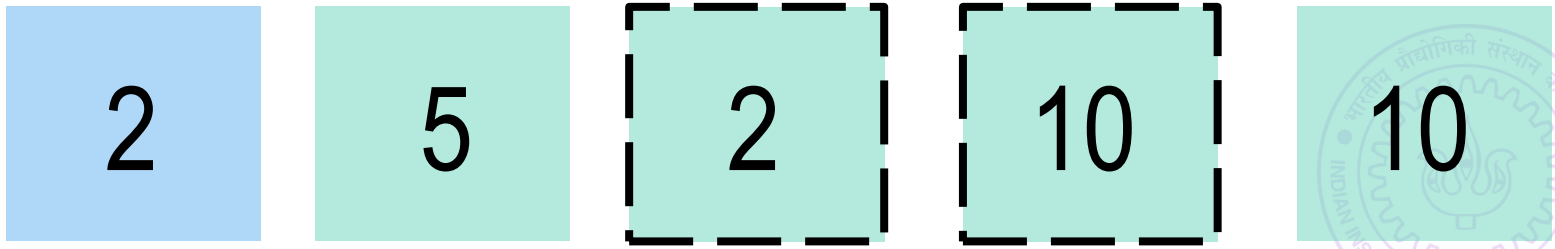

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Can typecast int to long

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b = (long) a;
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Can typecast long to int

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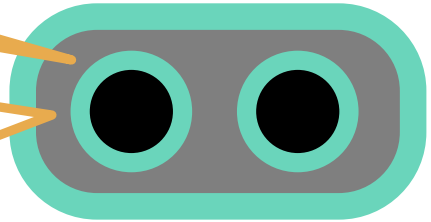
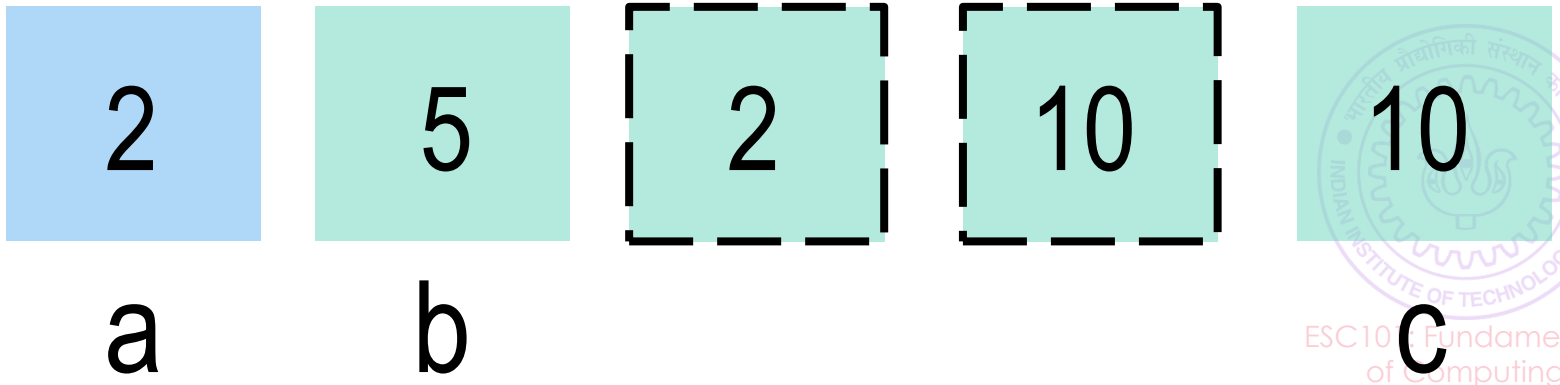
a = (int) b;
```

Be careful! If b was storing a very large integer that won't fit into int, this typecast will cause errors





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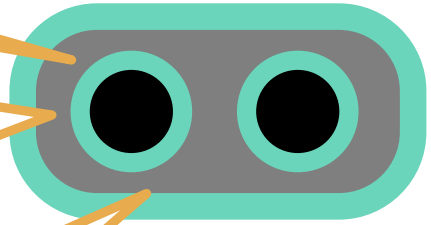
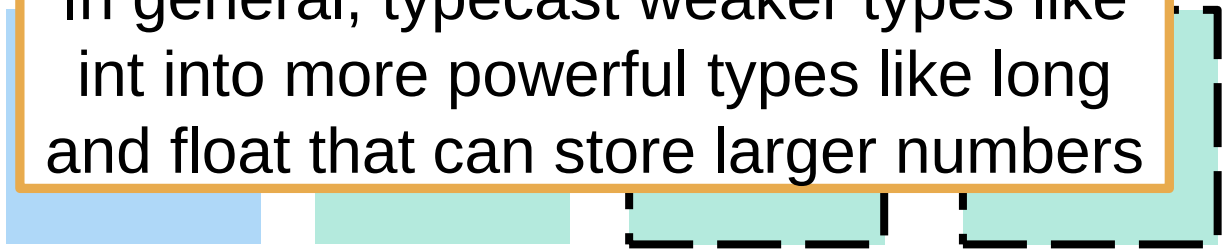


In general, typecast weaker types like int into more powerful types like long and float that can store larger numbers



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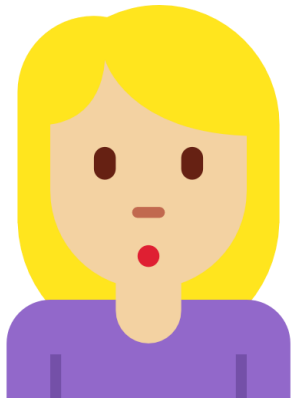

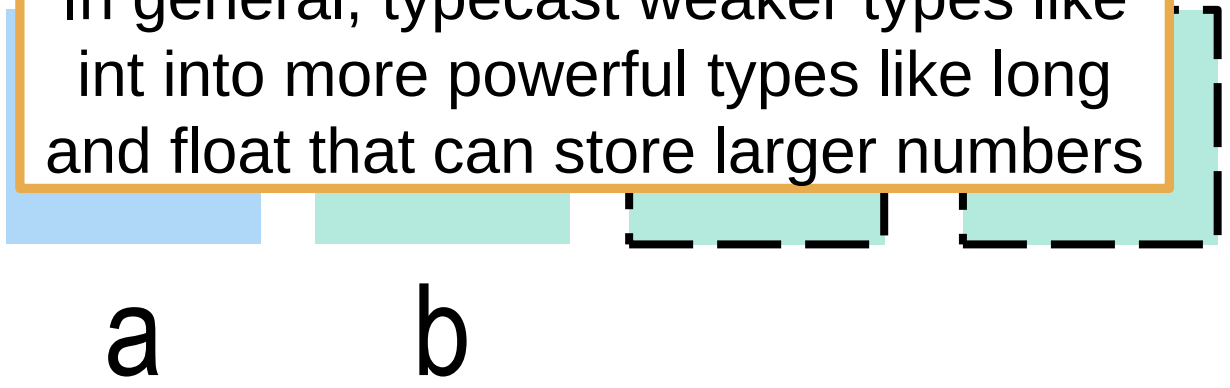

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Can typecast long to int

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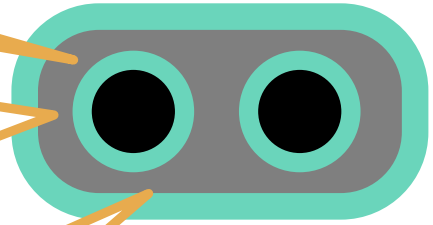

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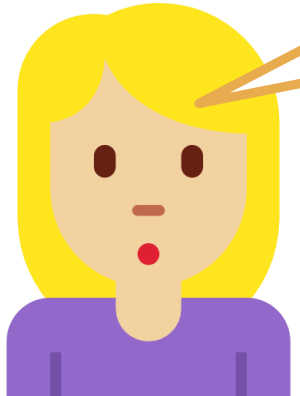
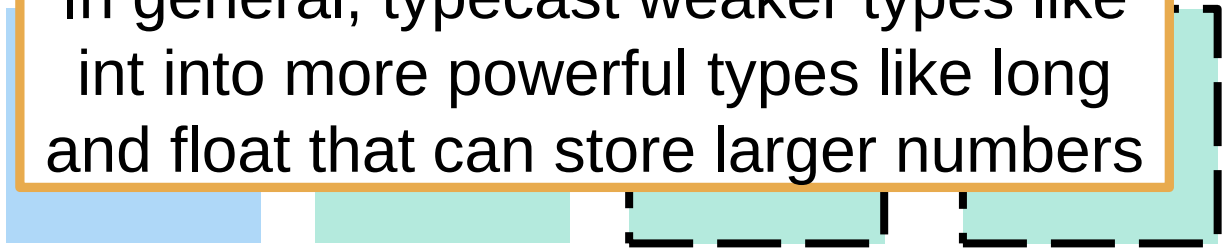


We can typecast int to float too?

In general, typecast weaker types like int into more powerful types like long and float that can store larger numbers



a b

c

Mixed type operations

What if we ha

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```

Hmm … An int being multiplied to a long. Let me take care to convert the int to a long before performing the operation ☺

```
int a = 2;
long c, b = 5;
```

Can typecast int to long

```
b = (long) a;
```

Can typecast long to int

```
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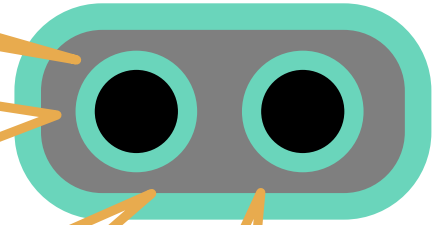
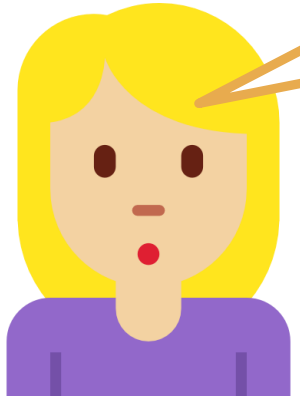
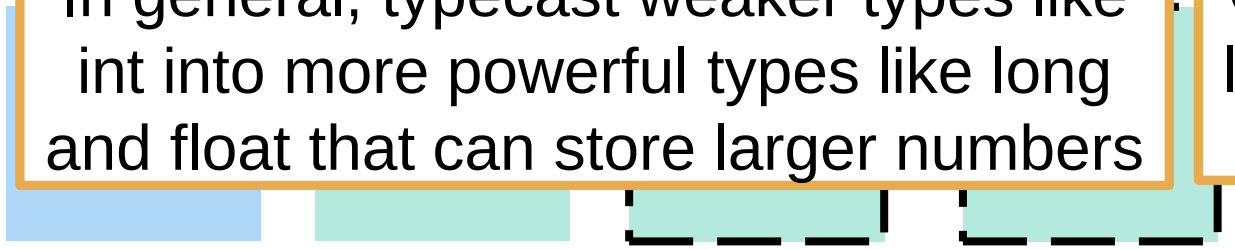


We can typecast int to float too?



In general, typecast weaker types like int into more powerful types like long and float that can store larger numbers

Of course – let me show you ☺



Is 2.0 the same as 2? (JEE 2018)

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#include <stdio.h>
int main(){
    float a = 2.5;
    printf("%f", a);
    return 0;
}
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int main(){
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    printf("%d", (int) a);
    return 0;
}
```

```
float c = 2/3;
```

Is 2.0 the same as 2? (JEE 2018)


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float c = 2/3;

float c = 2/3.0;

Is 2.0 the same as 2? (JEE 2018)


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```
float c = 2/3;
```

```
float c = 2/3.0;
```

```
float c = 2/(float)3;
```

Is 2.0 the same as 2? (JEE 2018)


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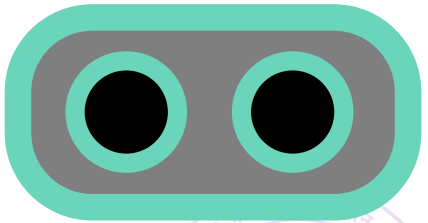

```
float c = 2/3;
```

```
float c = 2/3.0;
```

```
float c = 2/(float)3;
```

Is 2.0 the same as 2? (JEE 2018)


```
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int main(){
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    return 0;
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    return 0;
}
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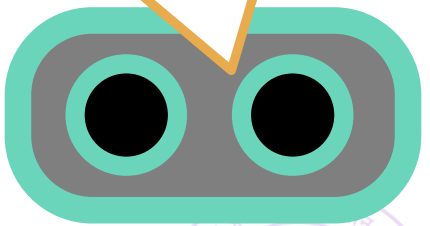
If float and int are present in a formula together, I will take care to convert the int to float before performing the operation since float is more powerful



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float c = 2/3;
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    return 0;
}
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#include <stdio.h>
int main(){
    float a = 2.5;
    printf("%d", (int) a);
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}
```
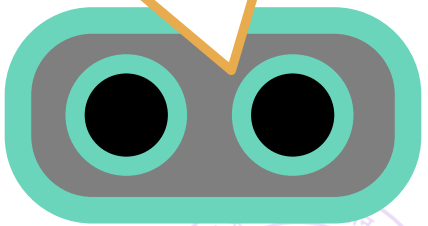

However, in this case, 2 and 3 are both are int so I will not bother converting them to float since int divided by int is just int

If float and int are present in a formula together, I will take care to convert the int to float before performing the operation since float is more powerful



```
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```

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float c = 2/(float)3;
```

Is 2.0 the same as 2? (JEE 2018)


```
#include <stdio.h>
int main(){
    float a = 2.5;
    printf("%d", (int) a);
    return 0;
}
```

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```
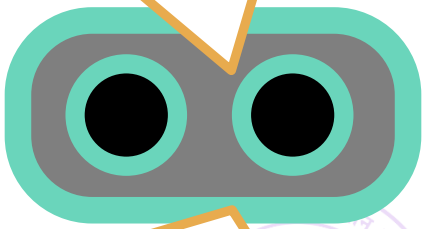

However, in this case, 2 and 3 are both are int so I will not bother converting them to float since int divided by int is just int

If float and int are present in a formula together, I will take care to convert the int to float before performing the operation since float is more powerful



```
float c = 2/3;
```

```
float c = 2/3.0;
```

```
float c = 2/(float)3;
```

Be careful, float can store much larger numbers (± 3.4e+38) than int can (± 2.1e+9)