





Sorrento Bay; Freshman city; Ultimate Programming University (UPU)



Freshmen city
Main campus
building





At the end of the first week of term,
Ricky and Dany are chatting

Hey Dany, are you ok?



Hey Dany, are you ok?

Do I look ok to you?



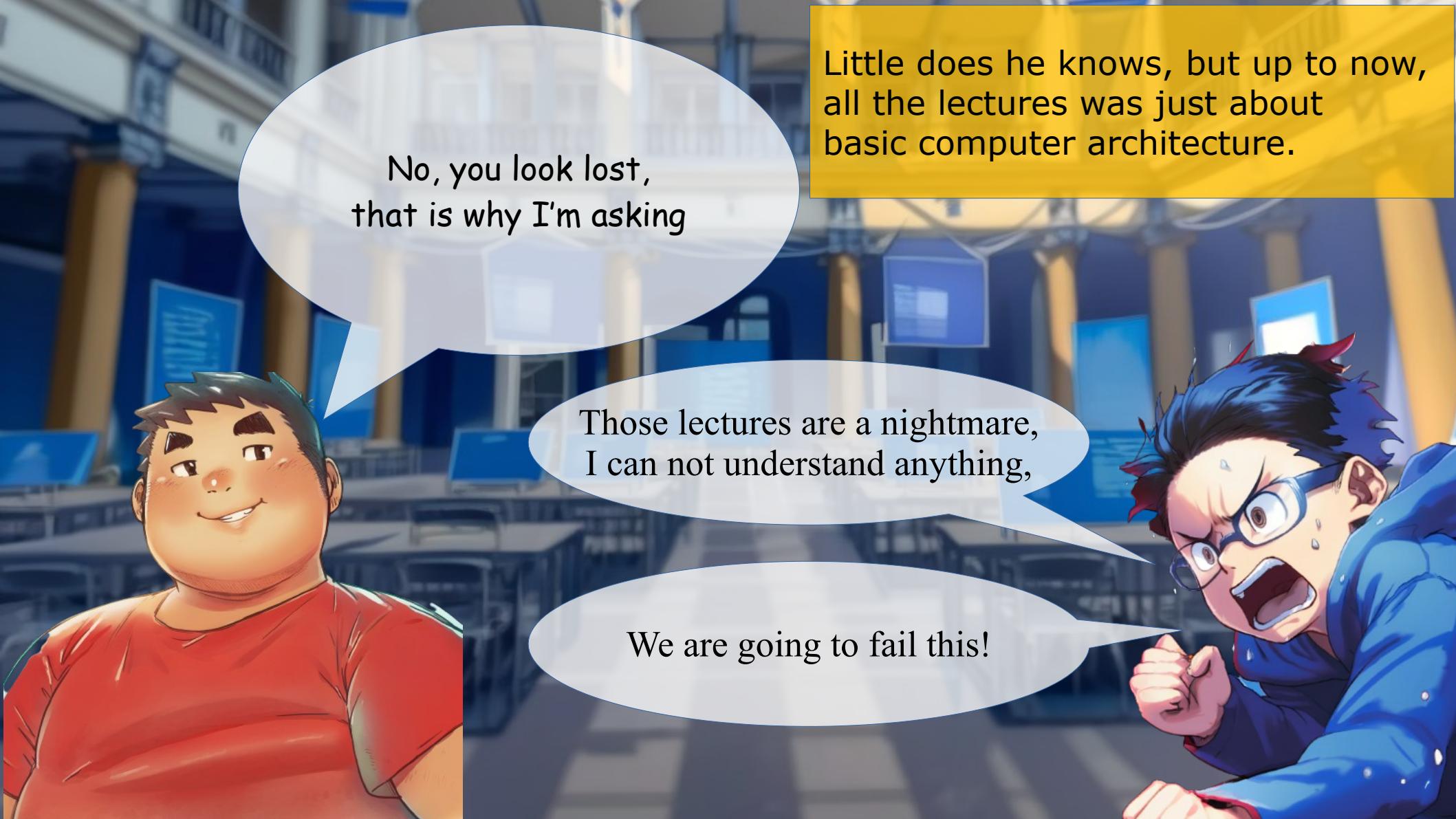
No, you look lost,
that is why I'm asking





No, you look lost,
that is why I'm asking

Those lectures are a nightmare,
I can not understand anything,



No, you look lost,
that is why I'm asking

Those lectures are a nightmare,
I can not understand anything,

We are going to fail this!

Little does he know, but up to now,
all the lectures were just about
basic computer architecture.



This university is absurd!

What's up with that giant
ivory tower?



This university is absurd!

What's up with that giant
ivory tower?



I'm not sure, but it is very cool!





That is where the second
year students live



That is where the second year students live

But do no worry about it.





Only few manage to get there,
and that is a good thing.





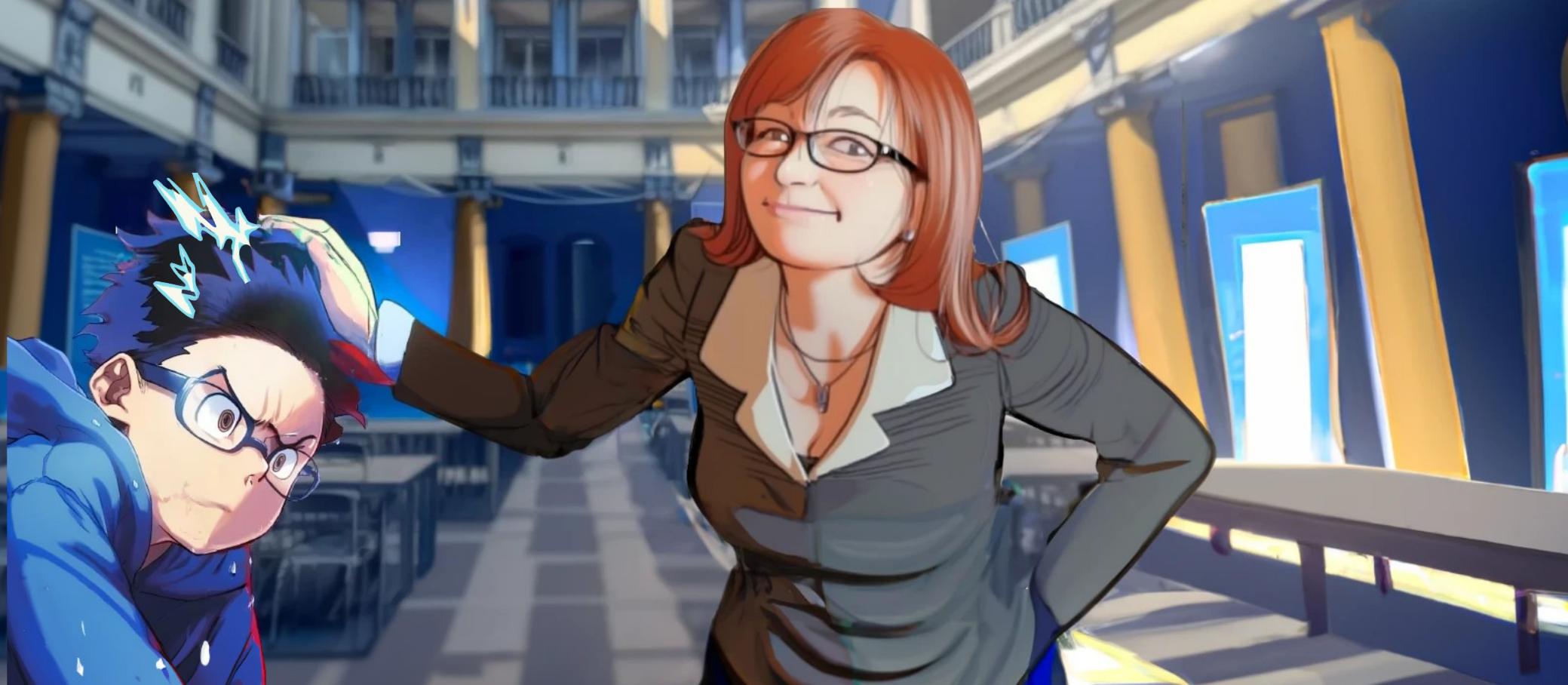
Only few manage to get there,
and that is a good thing.



This place is not good for you,
leave while you can!

An anime-style illustration of a woman with short brown hair and glasses, wearing a grey blazer over a white shirt, standing in a city street. She is looking towards the right. A man with dark blue hair and glasses, wearing a blue jacket, is leaning against a car in the background, looking up at her. The background shows a multi-story building with arched windows and a blue sky.

Poor guys,
they never listen
in time





Aaah!





Aaah!

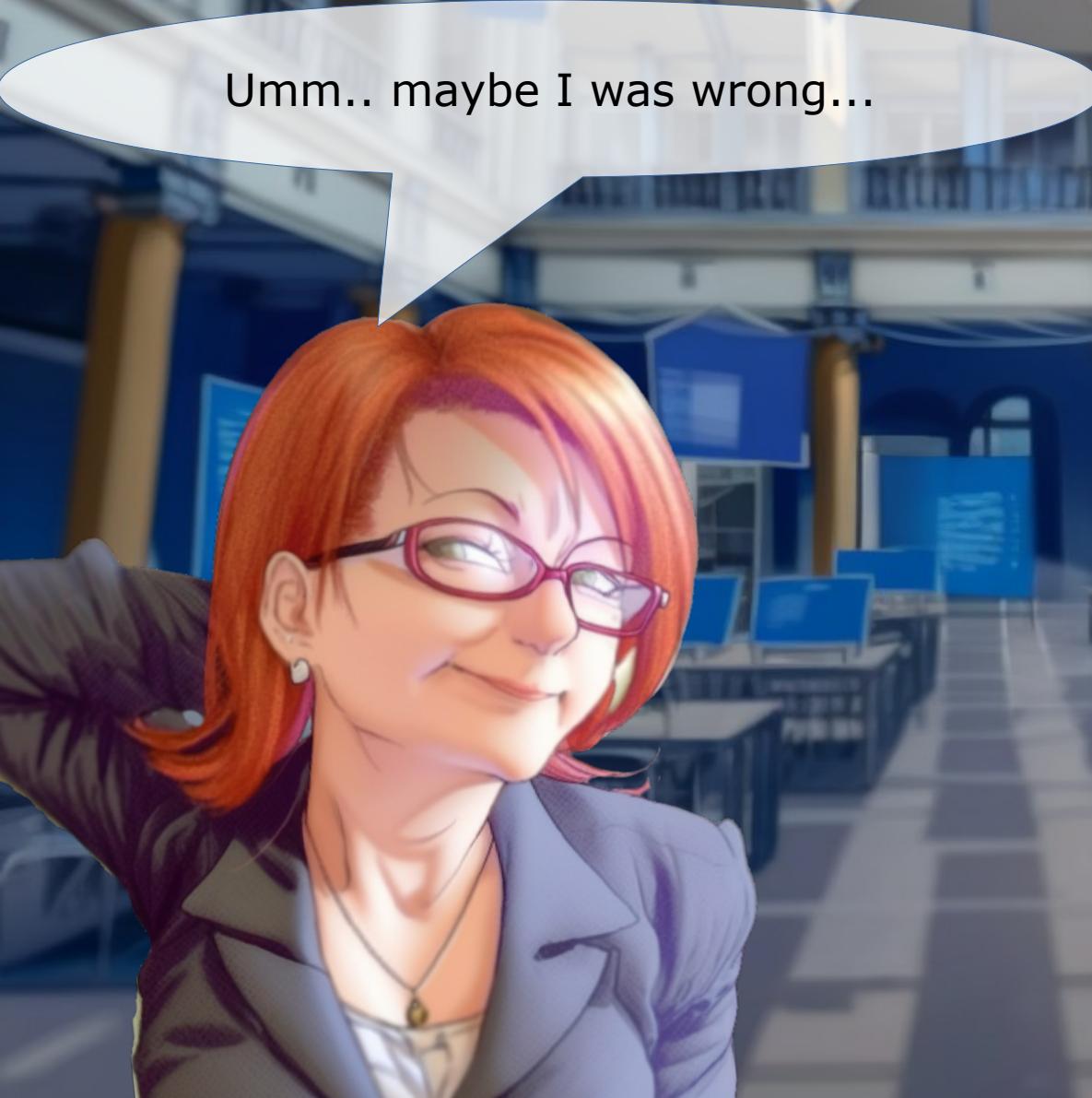


Whooops,
what was that...



What is going on?
I hate this place!





Umm.. maybe I was wrong...



What is going on?
I hate this place!



Umm.. maybe I was wrong...

What is going on?
I hate this place!

Maybe you do have what it takes
to survive here



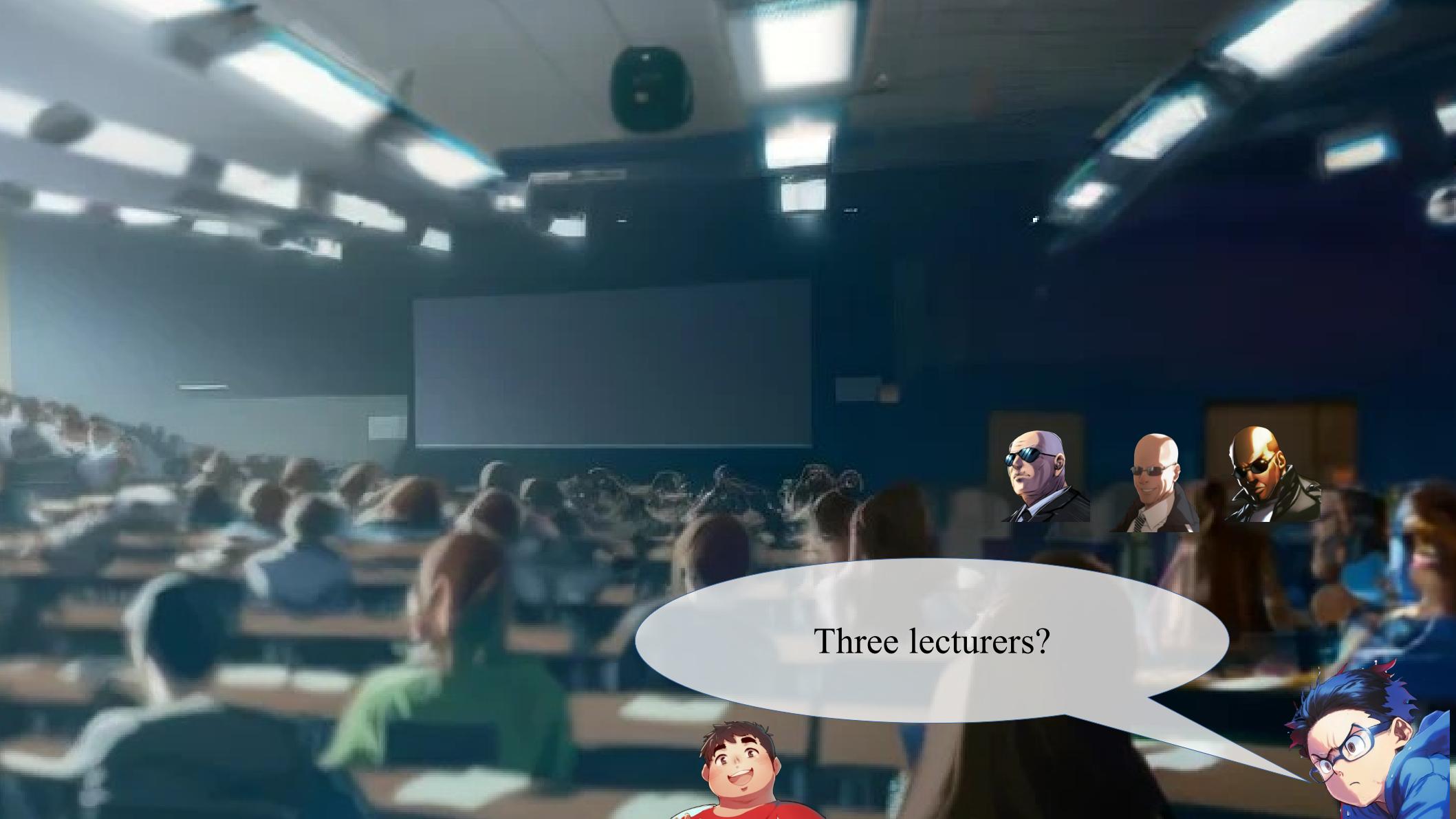
The next lecture is starting.
Maybe this is going to be easier!





The next lecture is starting.
Maybe this is going to be easier!

Where is the lecturer?



A classroom setting with students at their desks. Three Hitman characters are visible in the background, standing near the chalkboard. A speech bubble originates from a student in the foreground.

Three lecturers?





All three are bold?





All three with sun glasses?





Welcome to the first
programming lecture





**I'm Elricho Pupon
Your Programming Professor**



**I'm Elricho Pupon
Your Programming Professor**

**Please, do not mind the
security guards**



I'm Elricho Pupon
Your Programming Professor

We had some petulant
troublemakers last year,

Please, do not mind the
security guards



I'm Elricho Pupon
Your Programming Professor

We had some petulant
troublemakers last year,

Please, do not mind the
security guards

We have to be ready, this time



Variables:

Places where the computer store information.



Variables:

Places where the computer store information.

They have names, called identifiers.



Variables:

Places where the computer store information.

They have names, called identifiers.

We can access them by their names,
and we can update the data stored in them
by using the 'equal' sign.



Variables:

Places where the computer store information.

They have names, called identifiers.

We can access them by their names, and we can update the data stored in them by using the 'equal' sign.

For example, variables can contains numbers, and we can use conventional operations on those numbers, like addition, multiplication or subtraction



We can start
with some
example code

A cartoon illustration of a man with a bald head, wearing dark sunglasses and a dark suit jacket over a white shirt. He is smiling and looking towards the right side of the frame.

**We can start
with some
example code**

**We are going to use Java, but
this would work the same in many
other languages**

```
int a = 24;  
int b = 50;
```



I'm declaring two variables, "a" and "b".

```
int a = 24;  
int b = 50;
```

A cartoon illustration of a man with a bald head, wearing blue sunglasses and a light-colored jacket over a striped shirt. He is positioned on the left side of the frame, looking towards the right where the speech bubbles are located.

I'm declaring two variables, "a" and "b".

They are both of type "int".

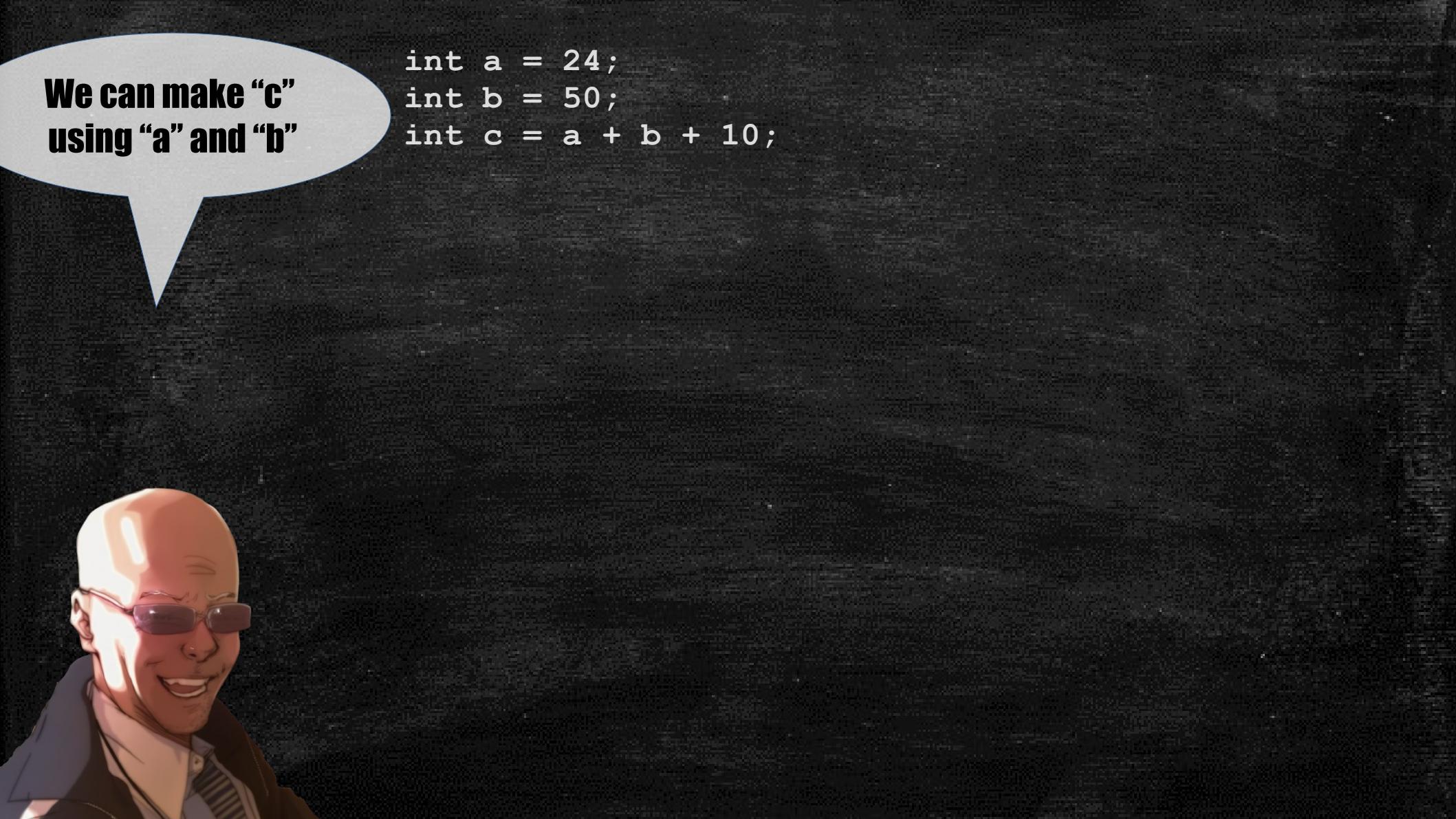
```
int a = 24;  
int b = 50;
```



I'm declaring two variables, "a" and "b".

They are both of type "int".

They are initialized with values
"24" and "50".

A cartoon illustration of a bald man wearing dark sunglasses and a light-colored shirt. He is positioned in the bottom left corner, looking towards the right. A large, light gray speech bubble originates from his mouth, containing text.

**We can make “c”
using “a” and “b”**

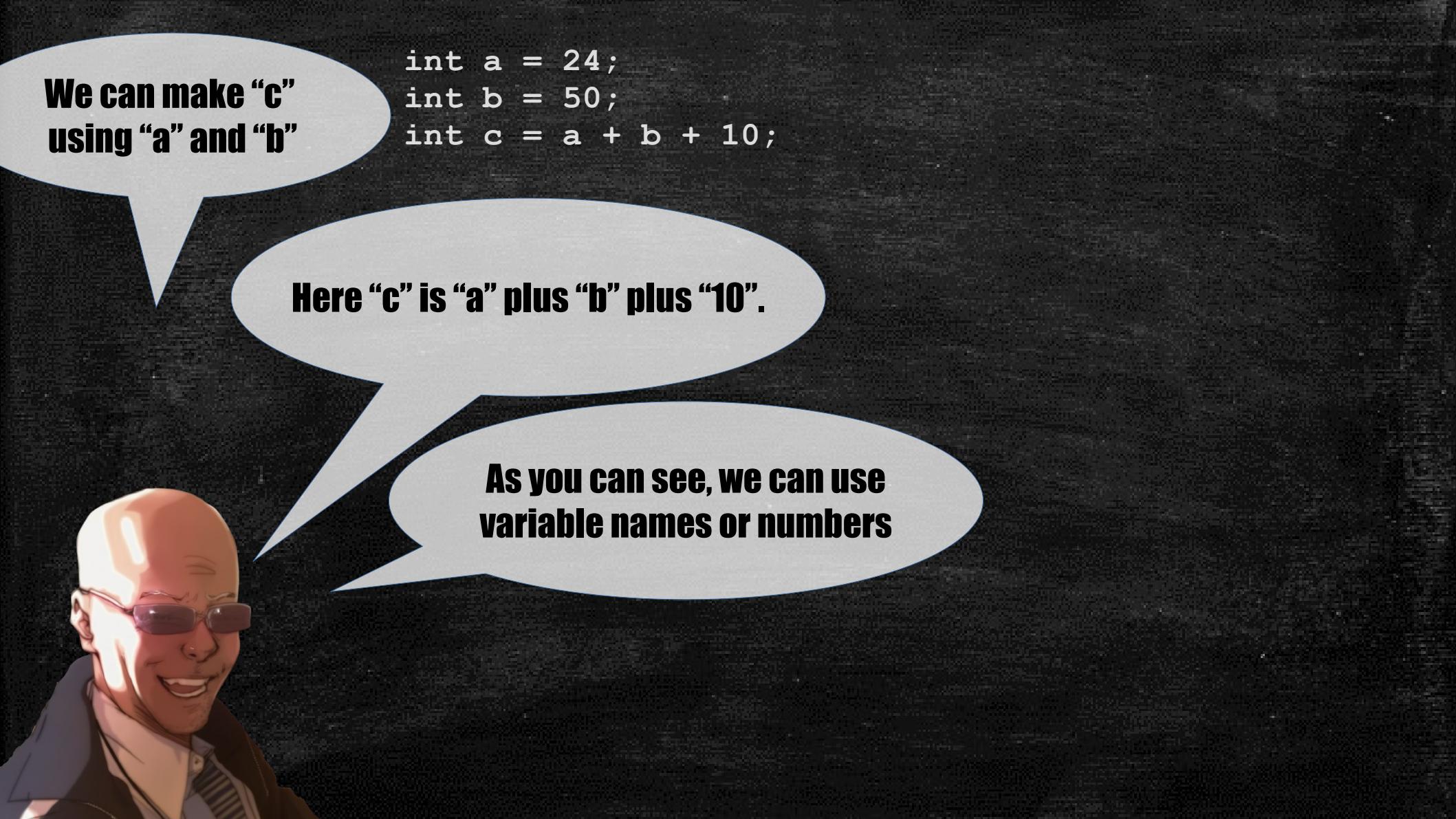
```
int a = 24;  
int b = 50;  
int c = a + b + 10;
```



We can make “c”
using “a” and “b”

```
int a = 24;  
int b = 50;  
int c = a + b + 10;
```

Here “c” is “a” plus “b” plus “10”.



We can make “c”
using “a” and “b”

```
int a = 24;  
int b = 50;  
int c = a + b + 10;
```

Here “c” is “a” plus “b” plus “10”.

As you can see, we can use
variable names or numbers



What is the value of “c”?

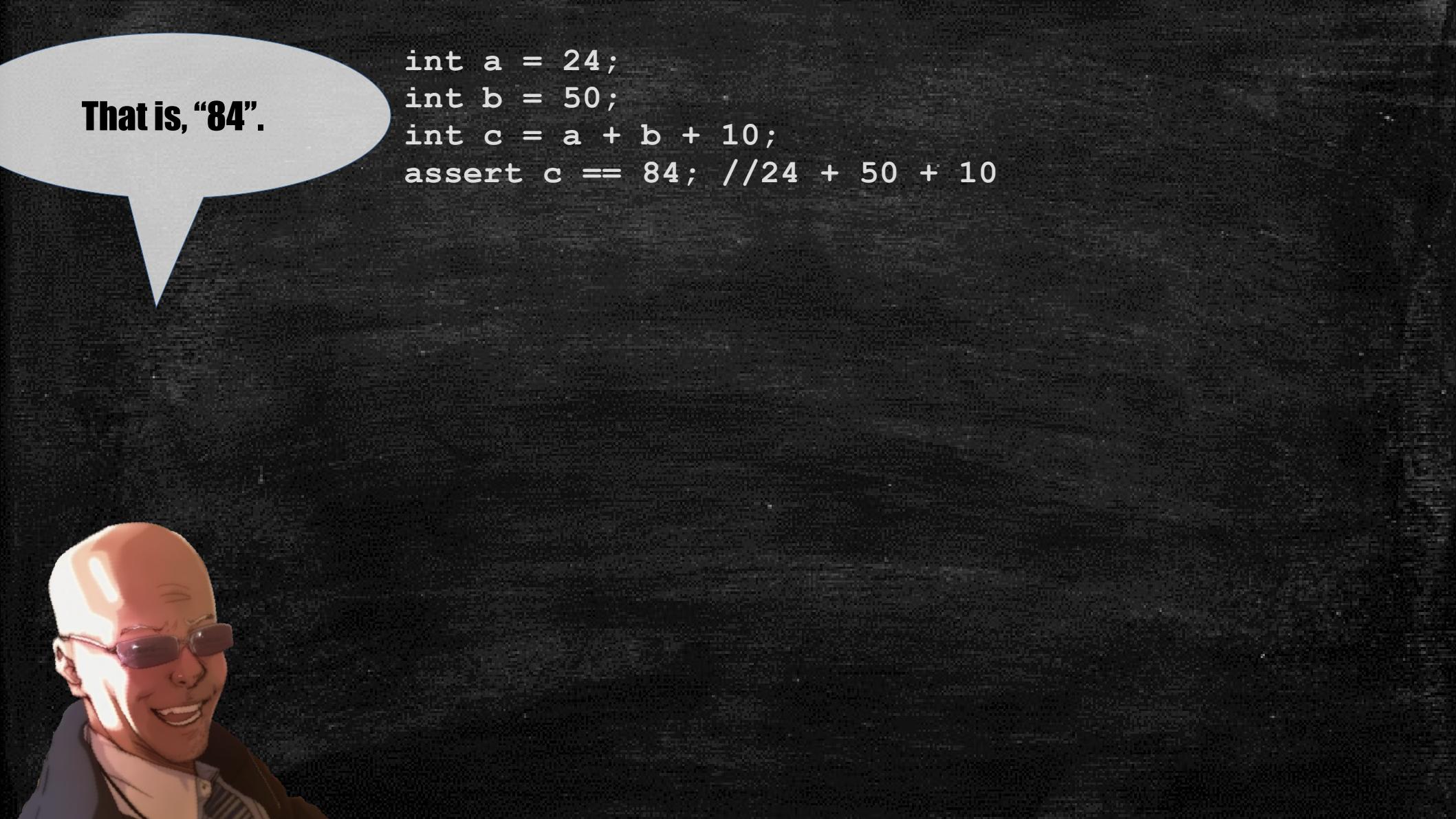
```
int a = 24;  
int b = 50;  
int c = a + b + 10;  
assert c == ??;
```



What is the value of “c”?

```
int a = 24;  
int b = 50;  
int c = a + b + 10;  
assert c == ??;
```

**It is the value of “a” plus
the value of “b” plus “10”**



That is, “84”.

```
int a = 24;  
int b = 50;  
int c = a + b + 10;  
assert c == 84; //24 + 50 + 10
```



That is, “84”.

```
int a = 24;  
int b = 50;  
int c = a + b + 10;  
assert c == 84; //24 + 50 + 10
```

**We write “assert” to mark expressions
that should hold.**



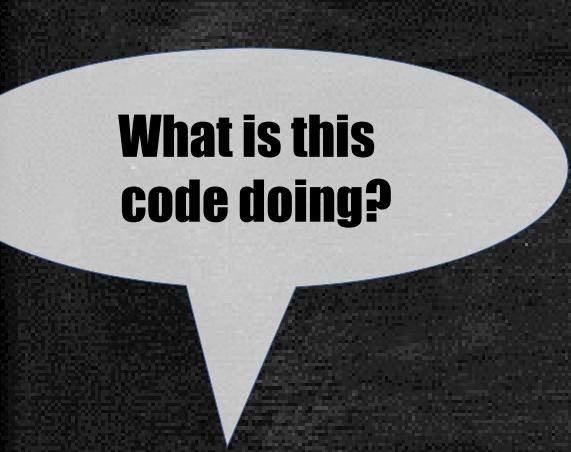
That is, “84”.

```
int a = 24;  
int b = 50;  
int c = a + b + 10;  
assert c == 84; //24 + 50 + 10
```

**We write “assert” to mark expressions
that should hold.**

**Equals equals evaluates to “true” if the
left and the right value are the same, and “false”
otherwise.**

**We can reuse a variable
instead of making a new one.**



**What is this
code doing?**

```
int a = 24;  
int b = 50;  
b = a + b + 10;
```



**What is this
code doing?**

```
int a = 24;  
int b = 50;  
b = a + b + 10;
```

**It is updating the value of “b”
using the result of the expression
on the right.**

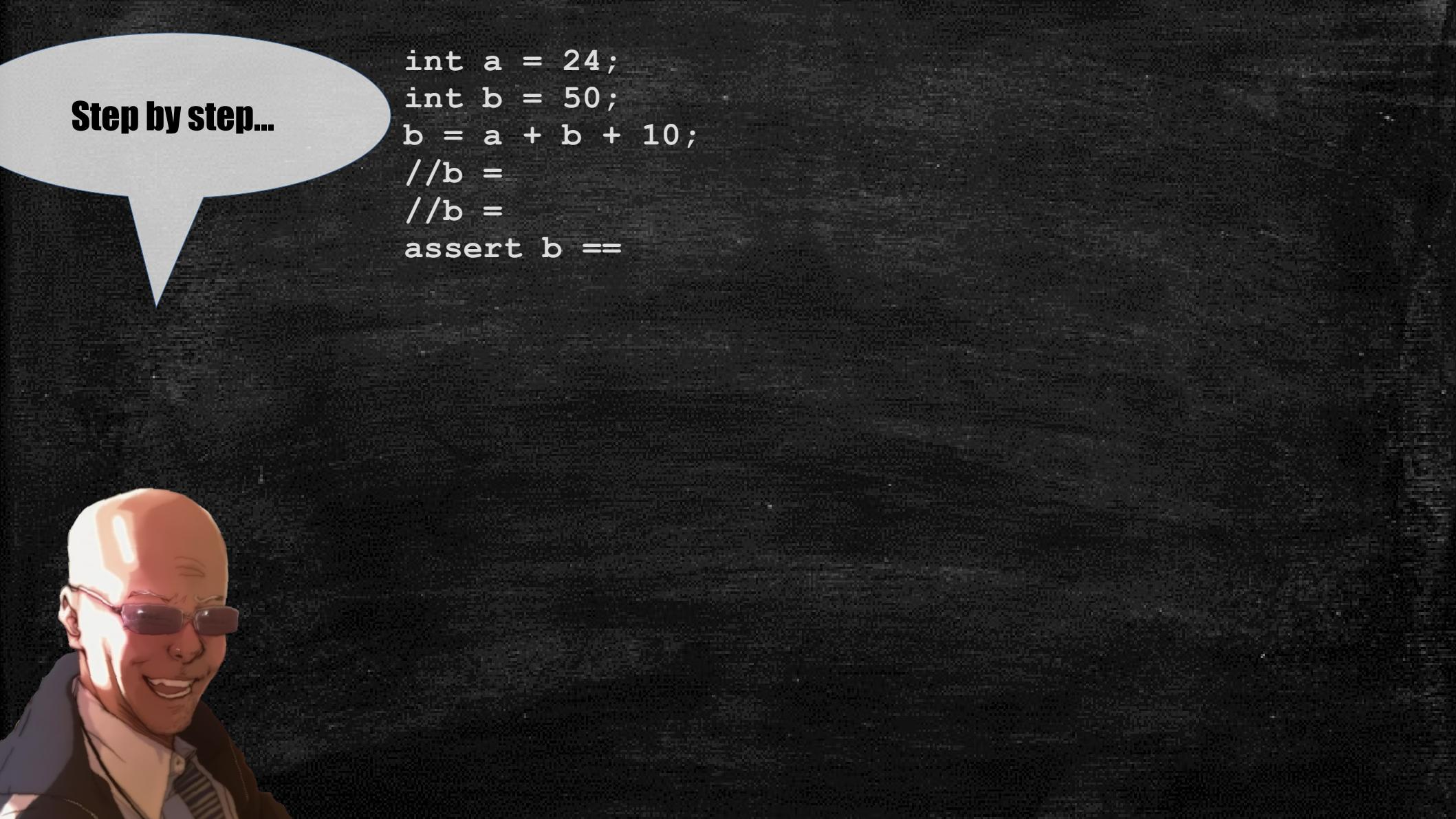


**What is this
code doing?**

```
int a = 24;  
int b = 50;  
b = a + b + 10;
```

**It is updating the value of “b”
using the result of the expression
on the right.**

**That is, the equals is not like the
math equals, where we state that two terms
have the same value**

A cartoon illustration of a bald man wearing dark sunglasses and a black hoodie. He is smiling and looking towards the right. A large white speech bubble originates from his mouth, containing the text "Step by step...".

Step by step...

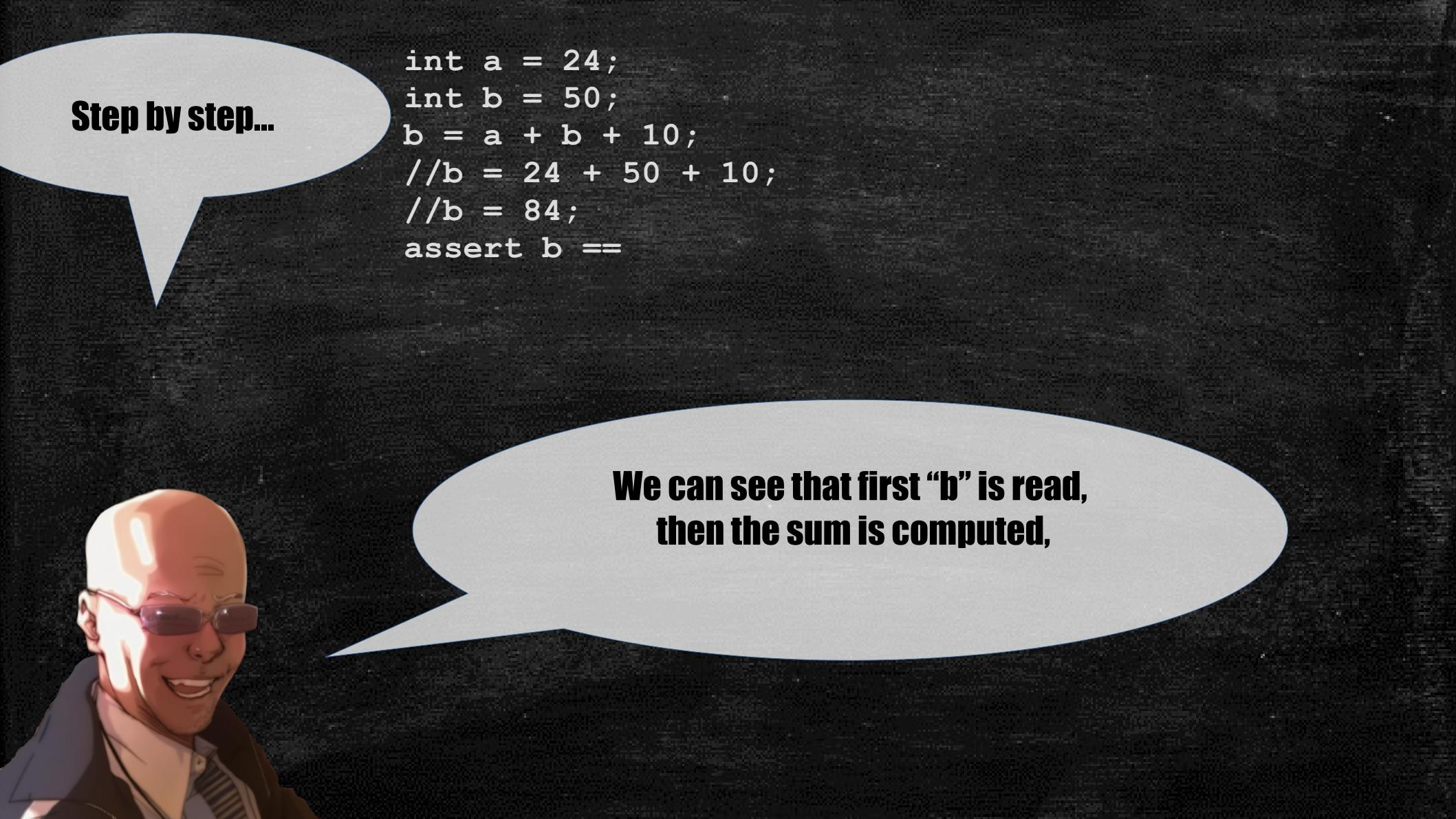
```
int a = 24;  
int b = 50;  
b = a + b + 10;  
//b =  
//b =  
assert b ==
```



Step by step...

```
int a = 24;  
int b = 50;  
b = a + b + 10;  
//b = 24 + 50 + 10;  
//b =  
assert b ==
```

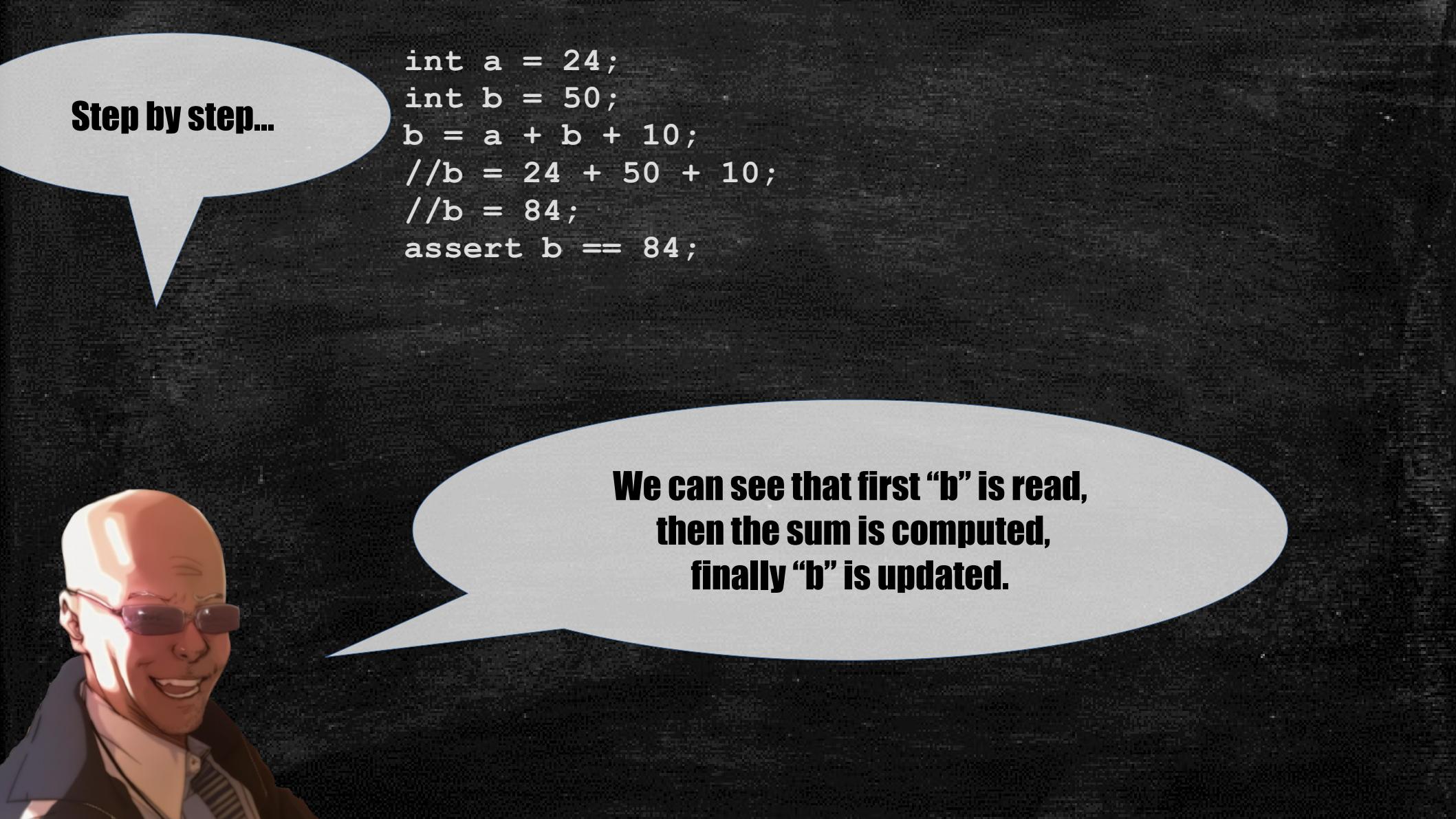
We can see that first “b” is read,

A cartoon illustration of a bald man wearing dark sunglasses and a light-colored shirt. He is positioned on the left side of the frame, looking towards the right. A large, light gray speech bubble originates from his mouth and extends towards the center of the image.

Step by step...

```
int a = 24;  
int b = 50;  
b = a + b + 10;  
//b = 24 + 50 + 10;  
//b = 84;  
assert b ==
```

**We can see that first “b” is read,
then the sum is computed,**

A cartoon illustration of a bald man wearing dark sunglasses and a black jacket over a striped shirt. He is positioned on the left side of the frame, looking towards the right. A large, light gray speech bubble originates from his mouth and extends towards the center of the slide.

Step by step...

```
int a = 24;  
int b = 50;  
b = a + b + 10;  
//b = 24 + 50 + 10;  
//b = 84;  
assert b == 84;
```

**We can see that first “b” is read,
then the sum is computed,
finally “b” is updated.**



**What if wanted to swap the
content of two variables?**



**We can see our two variables
as our two hands,
holding one ball each.**



**We can see our two variables
as our two hands,
holding one ball each.**

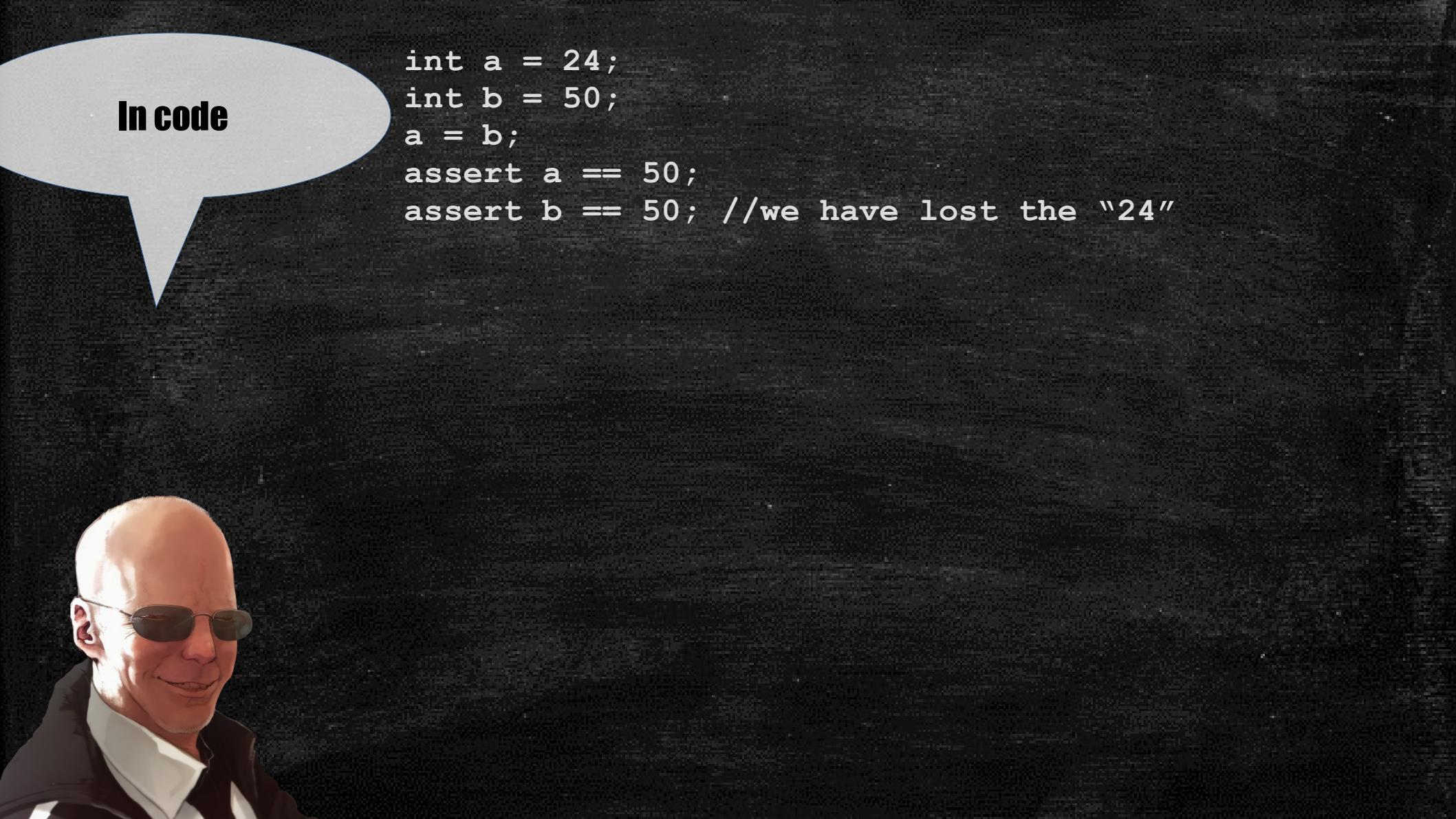
A hand only hold one ball;



**We can see our two variables
as our two hands,
holding one ball each.**

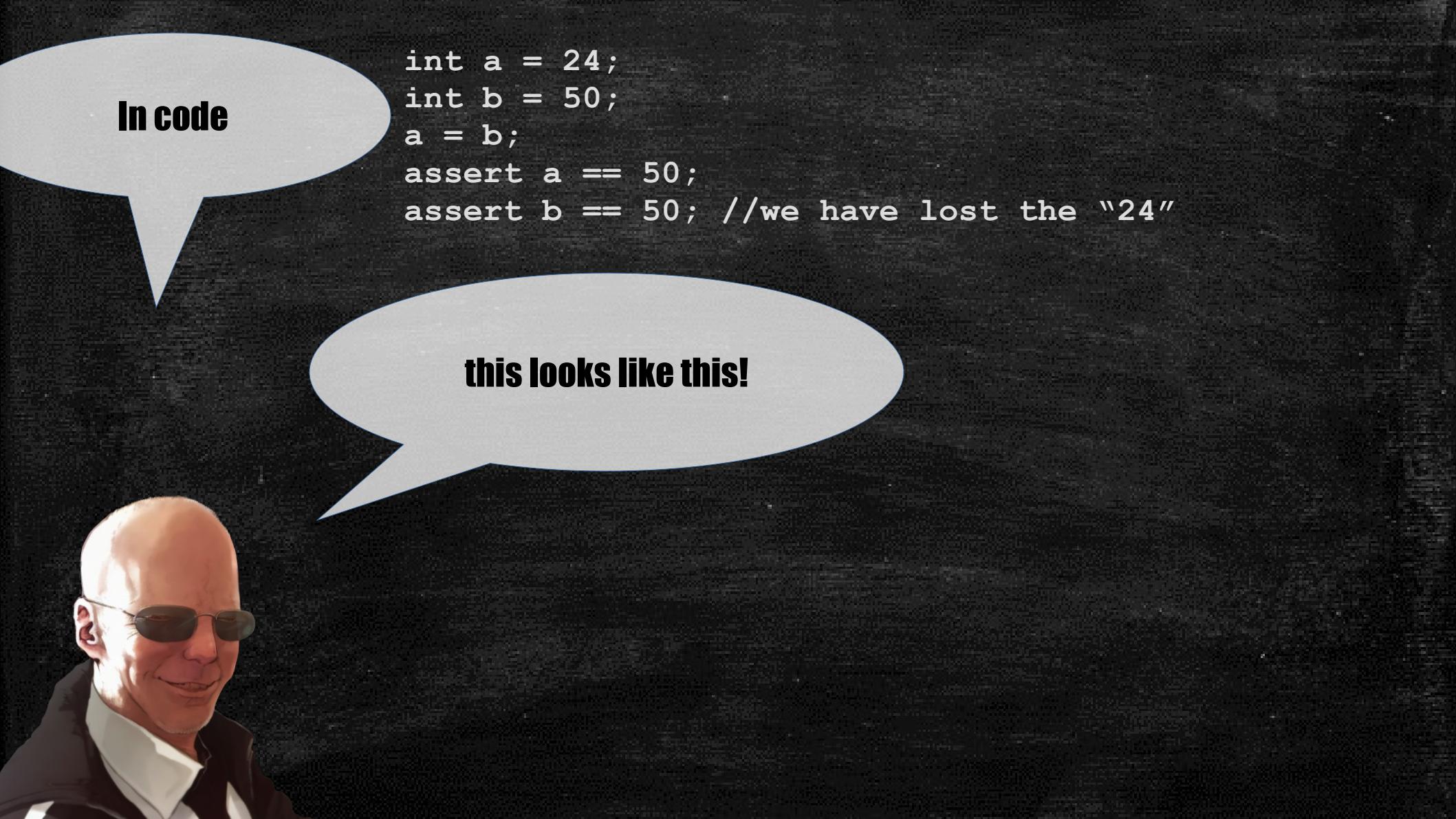
A hand only hold one ball;

**taking the other ball, we have to
abandon the current ball, that
would fall down, out of reach.**



In code

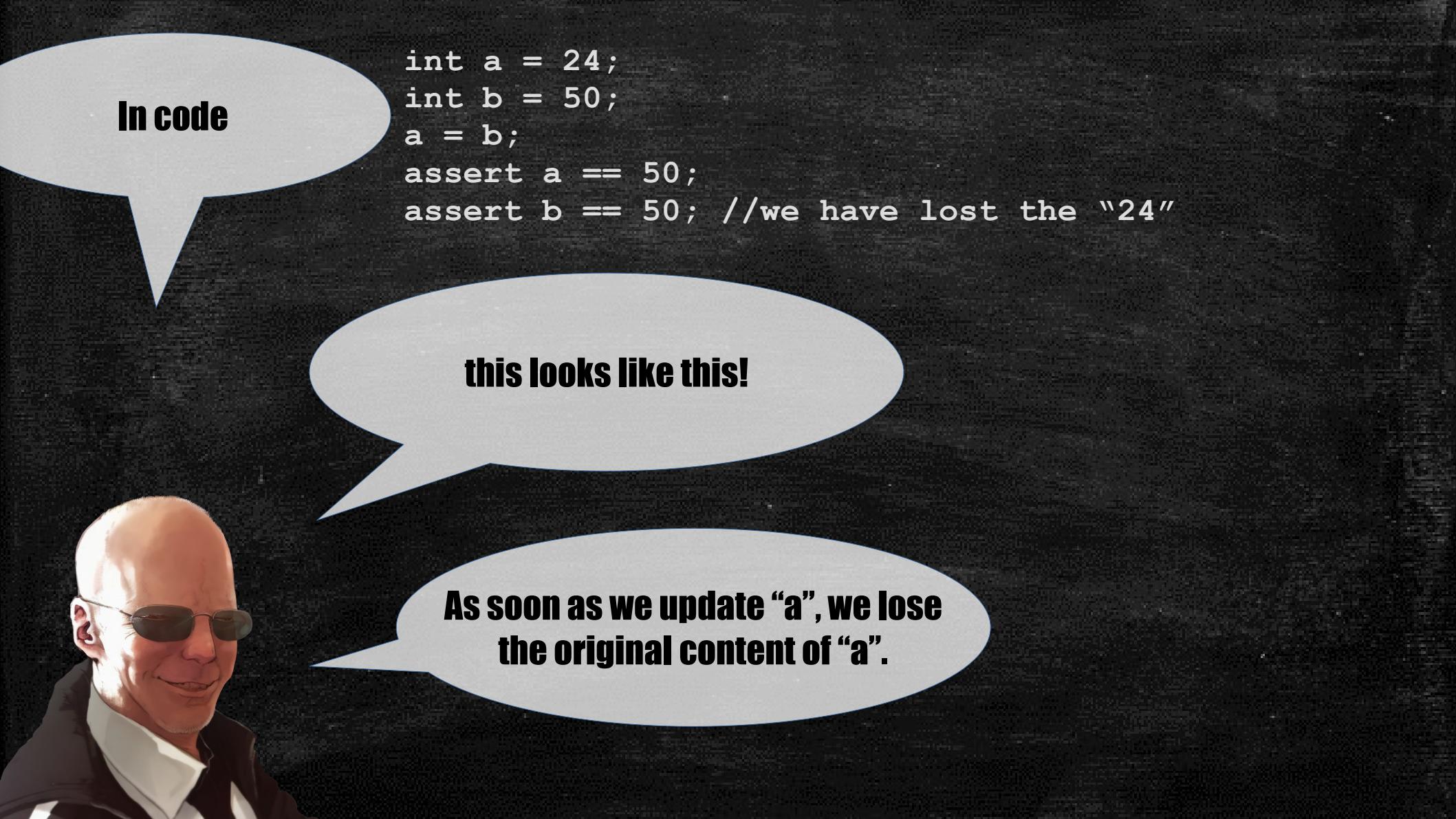
```
int a = 24;  
int b = 50;  
a = b;  
assert a == 50;  
assert b == 50; //we have lost the "24"
```



In code

```
int a = 24;  
int b = 50;  
a = b;  
assert a == 50;  
assert b == 50; //we have lost the "24"
```

this looks like this!



In code

```
int a = 24;  
int b = 50;  
a = b;  
assert a == 50;  
assert b == 50; //we have lost the "24"
```

this looks like this!

As soon as we update “a”, we lose
the original content of “a”.

A cartoon illustration of Mr. Incredible from the Pixar movie "The Incredibles". He is shown from the waist up, wearing his signature black suit, white shirt, and striped tie. He has a wide, mischievous smile and is wearing dark sunglasses. He is holding two shiny, reflective sports balls: a basketball in his left hand and a soccer ball in his right hand. He is standing in front of a chalkboard with a wooden frame. To his right is a wooden desk with a small green plaque on it. A large, light-colored speech bubble originates from Mr. Incredible's mouth, containing the text.

As you can see, we can not do it!



As you can see, we can not do it!

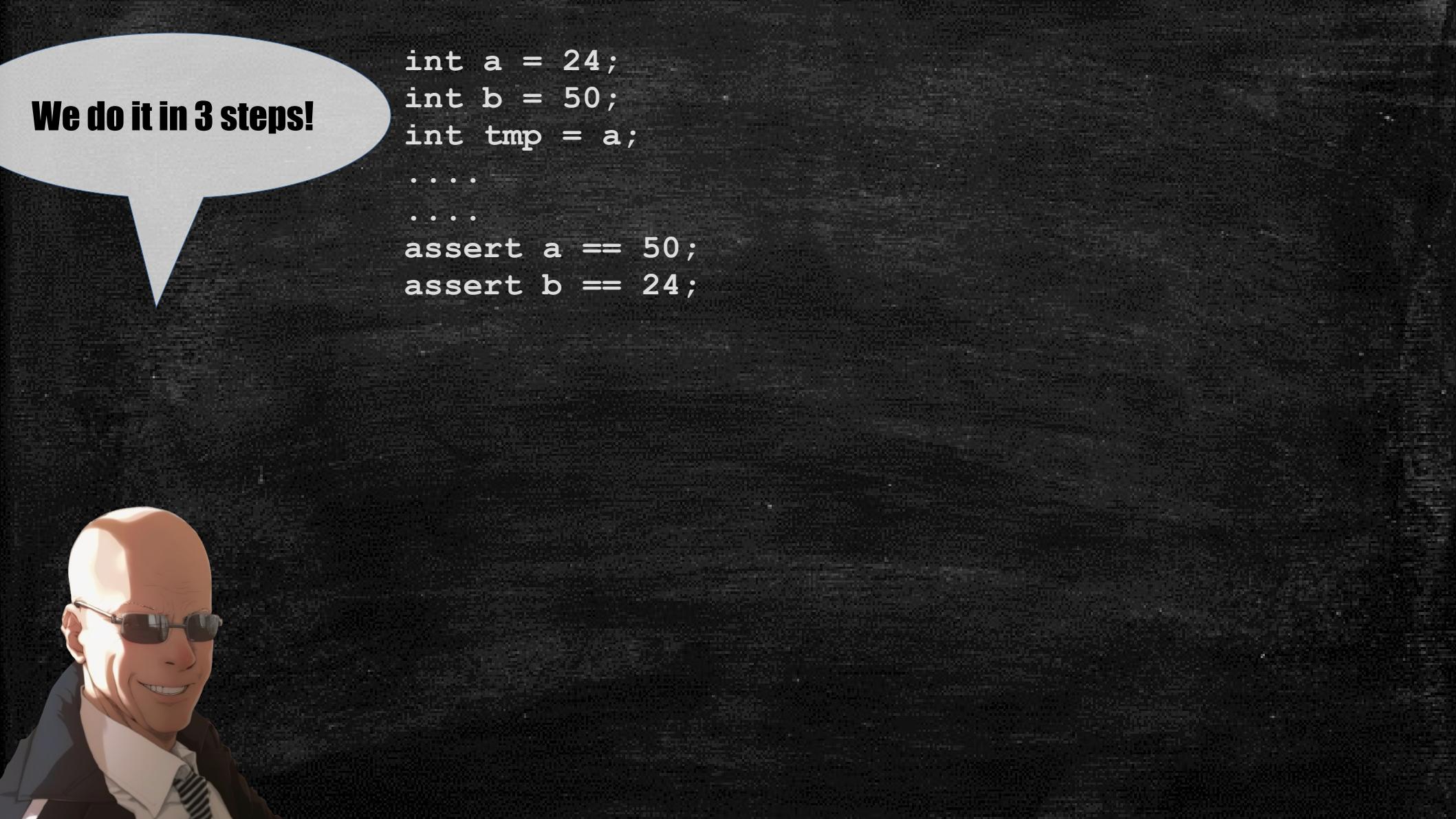
Not with only two variables!



As you can see, we can not do it!

Not with only two variables!

We need a third variable to help us!

A cartoon illustration of a bald man wearing dark sunglasses and a suit, smiling slightly. He has his right hand near his face. A large white speech bubble originates from his mouth, containing the text "We do it in 3 steps!".

We do it in 3 steps!

```
int a = 24;  
int b = 50;  
int tmp = a;  
....  
....  
assert a == 50;  
assert b == 24;
```



We do it in 3 steps!

```
int a = 24;  
int b = 50;  
int tmp = a; //step 1  
....  
....  
assert a == 50;  
assert b == 24;
```

First we save the original value of “a”
in a new temporary local variable

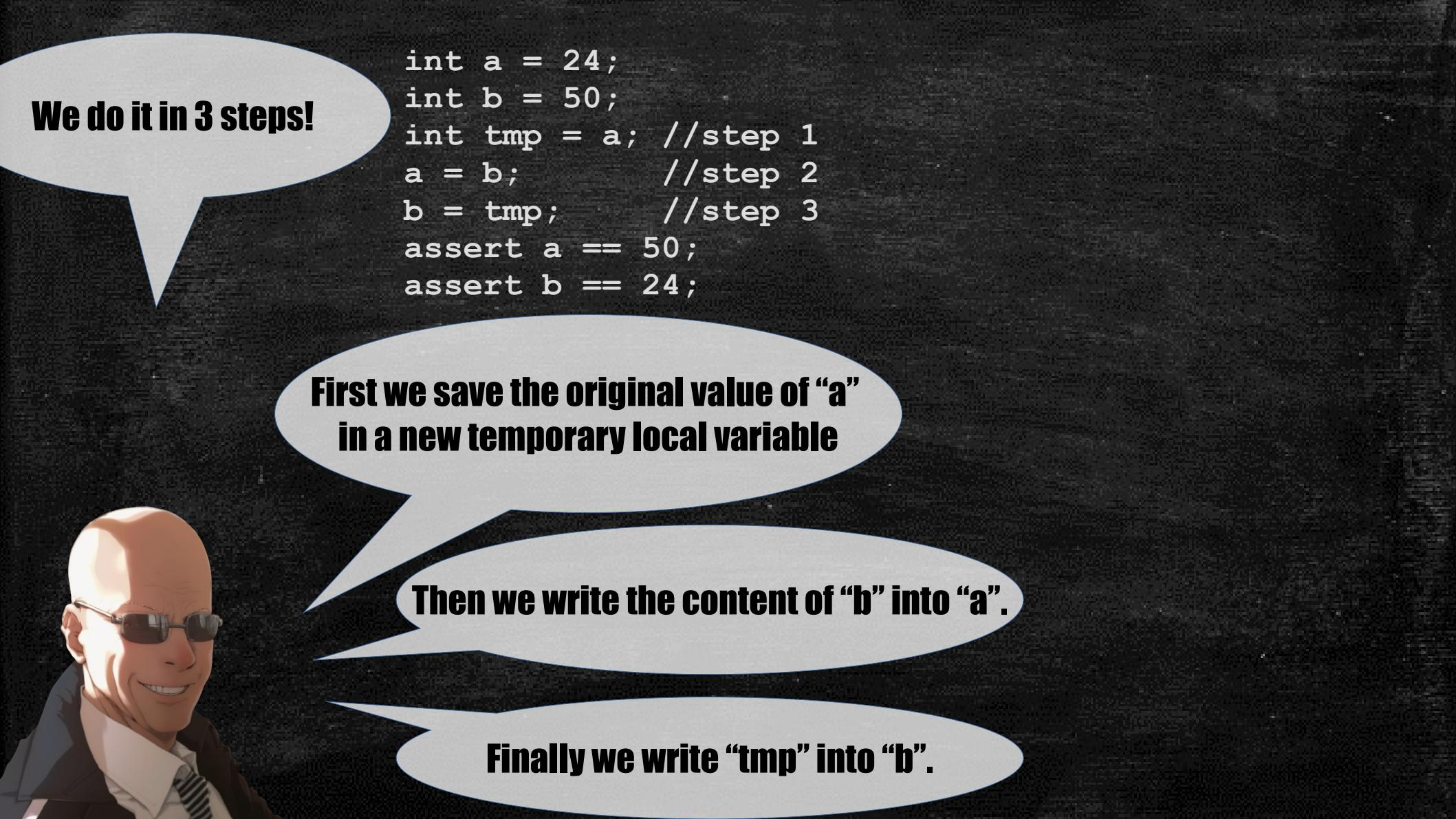


We do it in 3 steps!

```
int a = 24;  
int b = 50;  
int tmp = a; //step 1  
a = b; //step 2  
....  
assert a == 50;  
assert b == 24;
```

**First we save the original value of “a”
in a new temporary local variable**

Then we write the content of “b” into “a”.

A cartoon illustration of a bald man wearing dark sunglasses and a dark suit jacket over a white shirt. He is smiling and looking towards the text.

We do it in 3 steps!

```
int a = 24;  
int b = 50;  
int tmp = a; //step 1  
a = b; //step 2  
b = tmp; //step 3  
assert a == 50;  
assert b == 24;
```

First we save the original value of “a”
in a new temporary local variable

Then we write the content of “b” into “a”.

Finally we write “tmp” into “b”.



We do it in 3 steps!

```
int a = 24;  
int b = 50;  
int tmp = a; //step 1  
a = b; //step 2  
b = tmp; //step 3  
assert a == 50;  
assert b == 24;
```

As you can see, it can not be done
with only two variables,
it is mathematically proven

You need a third variable!

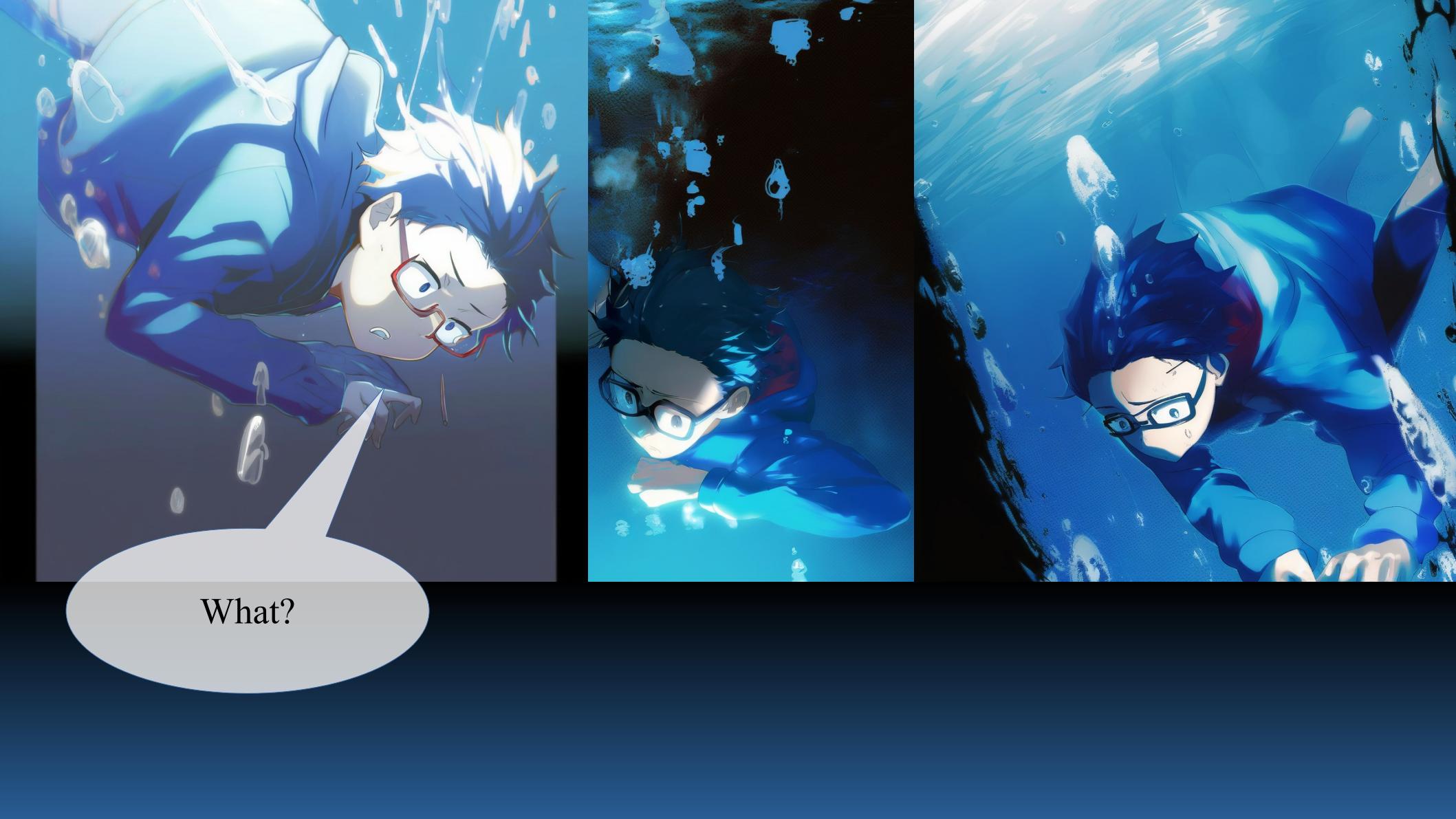


Something is wrong here



Something is wrong here

I'm seeing stuff

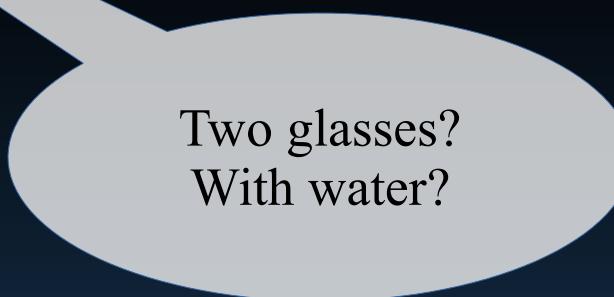


What?









Two glasses?
With water?





Two glasses?
With water?

But I'm already
underwater...



Two glasses?
With water?

But I'm already
underwater...

I must be dreaming

Anyway, can I swap
the content



Anyway, can I swap
the content

without
a third glass?





```
int a = 24;  
int b = 50;  
a = a + b;
```



If I add the two glasses in
the first one,

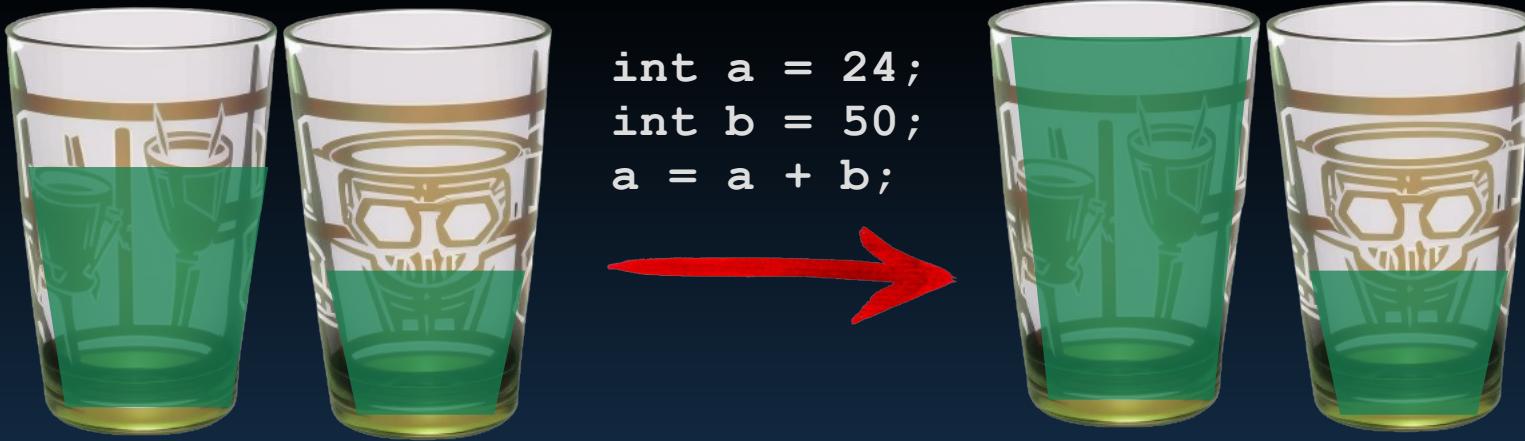


```
int a = 24;  
int b = 50;  
a = a + b;
```



If I add the two glasses in
the first one,

would the second
glass get empty?



```
int a = 24;  
int b = 50;  
a = a + b;
```



No! this does not
update b.





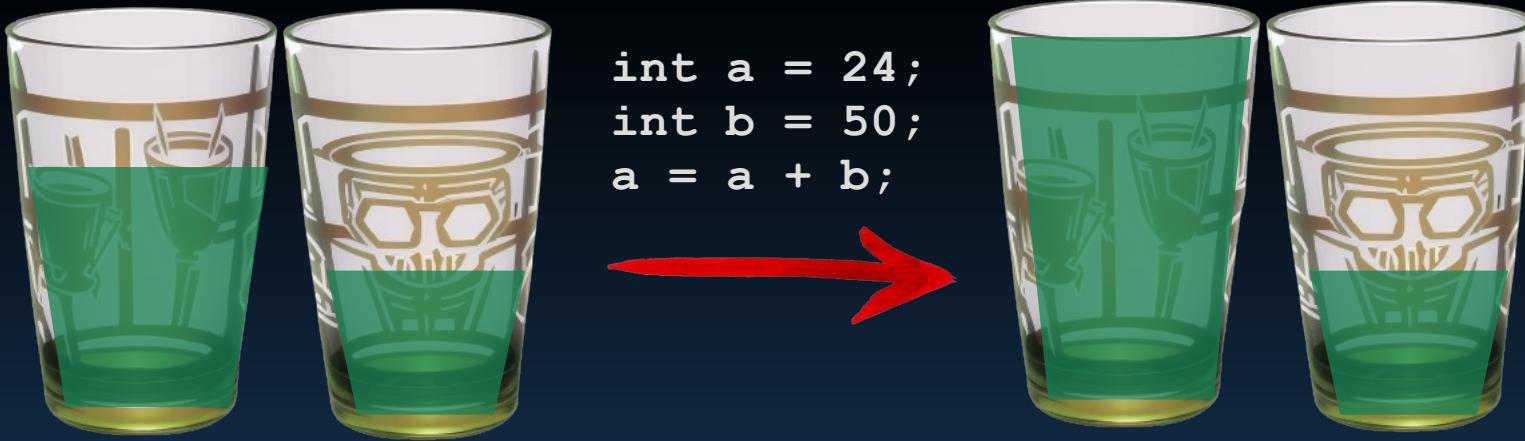
```
int a = 24;  
int b = 50;  
a = a + b;
```



No! this does not
update b.

Values are not shuffled
around, but duplicated





```
int a = 24;  
int b = 50;  
a = a + b;
```



That is, even after
adding a and b



```
int a = 24;  
int b = 50;  
a = a + b;
```



That is, even after
adding a and b

All the information
is still in the system.



```
int a = 24;  
int b = 50;  
a = a + b;
```



That is, even after
adding a and b

All the information
is still in the system.

b is still in b, and
the original a is just
the current a minus b

```
int a = 24;  
int b = 50;
```



a = a + b;



b = a - b;



a = a - b;



So, in 3 steps,
I can swap them







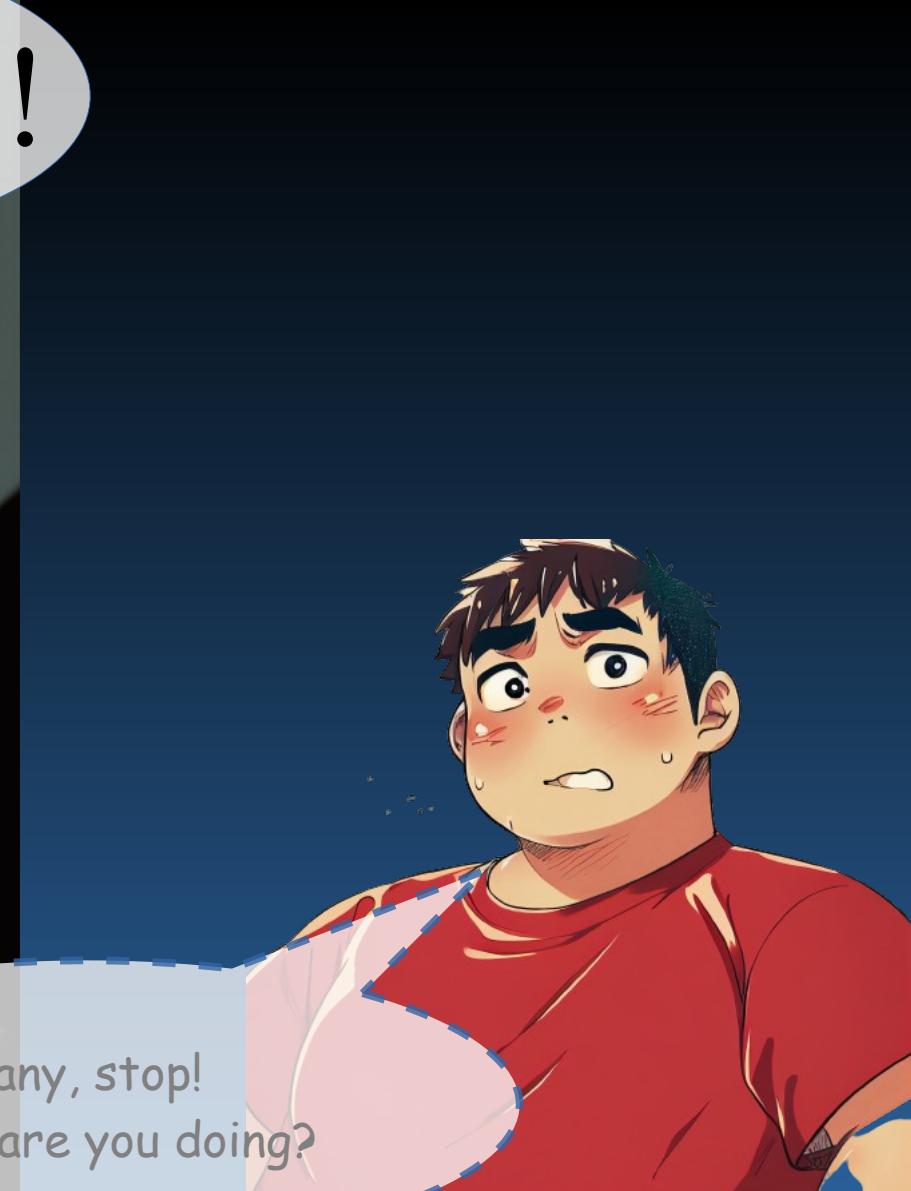
! Sorry !







! Hey, ... !



Dany, stop!
What are you doing?



Yes?

**Do you have a question on
this basic material?**





I CAN do it!



So you 'CAN' do..

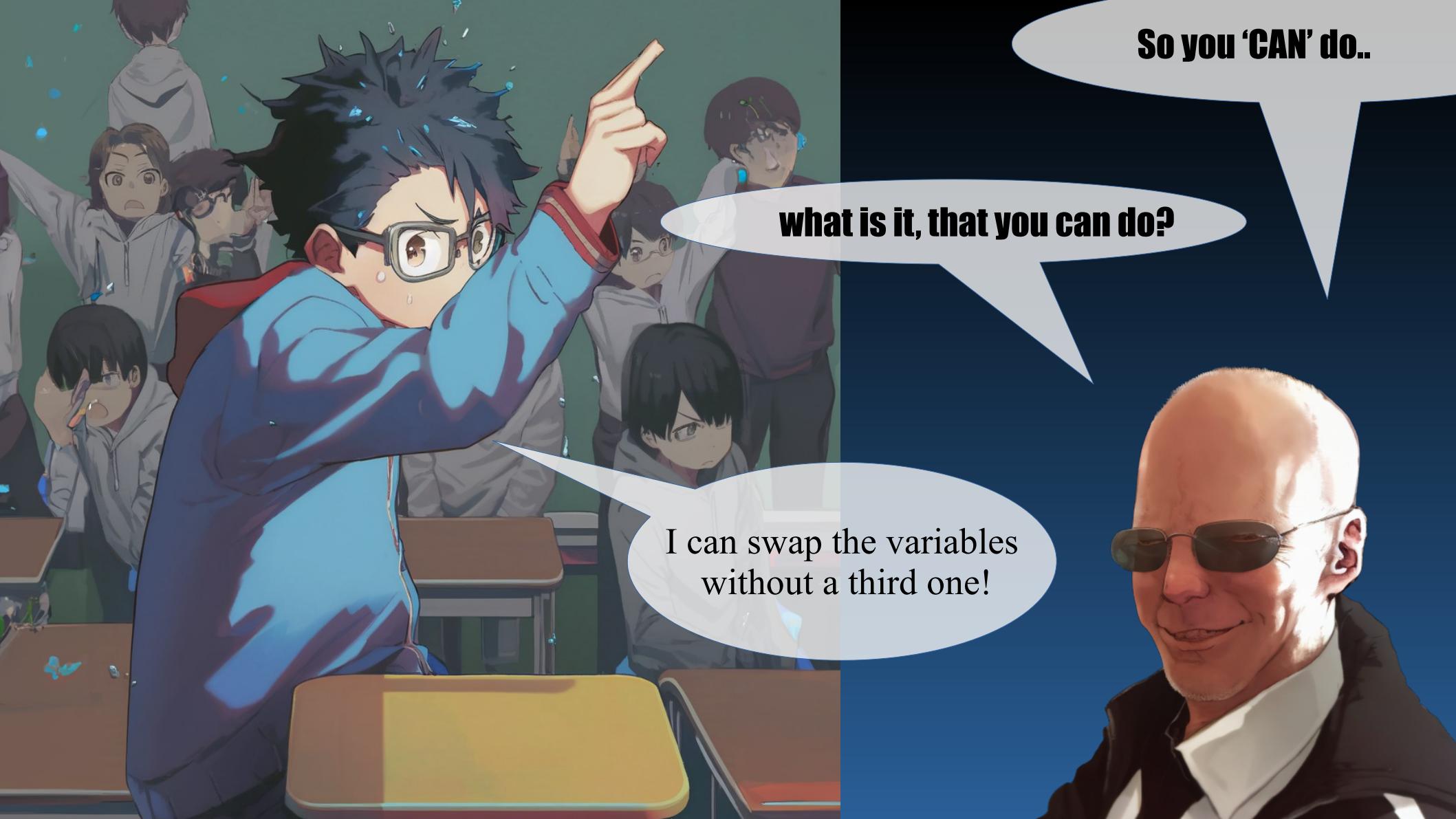




So you 'CAN' do..

what is it, that you can do?





So you 'CAN' do..

what is it, that you can do?

I can swap the variables
without a third one!

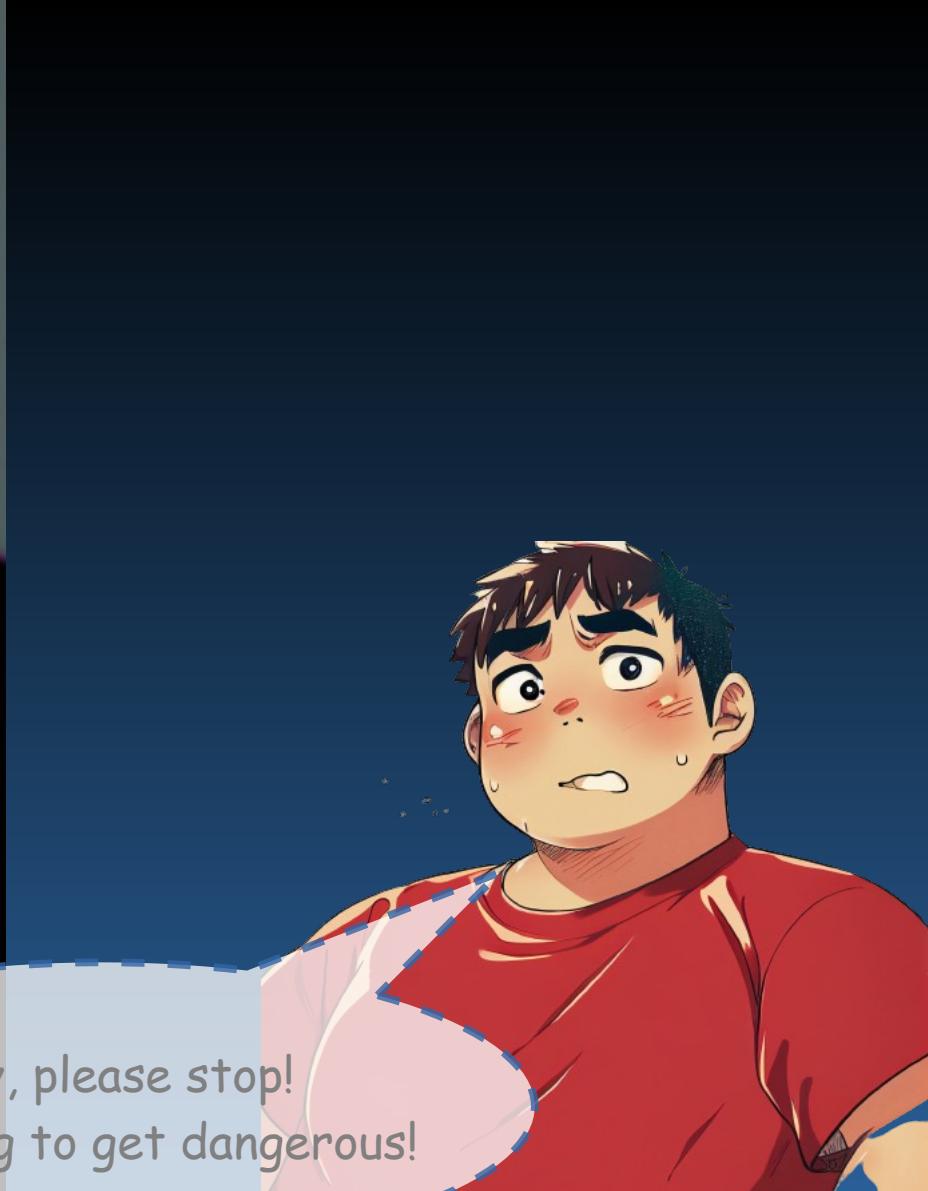


**Really?
Do not make us laugh,
It is mathematically proved,
It can not be done!**

A cartoon illustration of a balding man with glasses, wearing a white shirt and a dark blazer, standing in front of a chalkboard. He is smiling and holding a piece of chalk. The background shows a classroom setting with desks and chairs.

**Really?
Do not make us laugh,
It is mathematically proved,
It can not be done!**

**Now, let's move one
with the lecture..**



Dany, please stop!
It is going to get dangerous!



WRITE IT DOWN!



WRITE IT DOWN!

$a = a + b;$



WRITE IT DOWN!

$a = a + b;$



$b = a - b;$

$a = a - b;$



A 3D animated scene featuring Mr. Incredible from the Pixar movie "The Incredibles". He is standing in a classroom, leaning against a chalkboard with his right hand. He is wearing his signature superhero suit, which is white with a grey vest over a striped shirt and yellow pants. He has a wide, mischievous smile and is wearing sunglasses. To his right is a wooden teacher's desk with a single sheet of paper on it. A large, light blue speech bubble originates from Mr. Incredible's mouth, containing the text "P.. are you...". The background shows a dark wall and a chalkboard.

?.. are you...



A 3D animated scene featuring Mr. Incredible from the Pixar movie "The Incredibles". He is standing in a classroom, leaning against a chalkboard with his right hand. He is wearing his signature superhero suit, which is white with a grey vest over a striped shirt and yellow pants. He has a wide, mischievous smile and is wearing sunglasses. A speech bubble originates from him, containing the text "?. are you... for real.. ?" in a bold, black font. To his right, there is a wooden desk with a single sheet of paper on it. The floor is dark, and the overall lighting is dramatic, highlighting Mr. Incredible's face and suit.

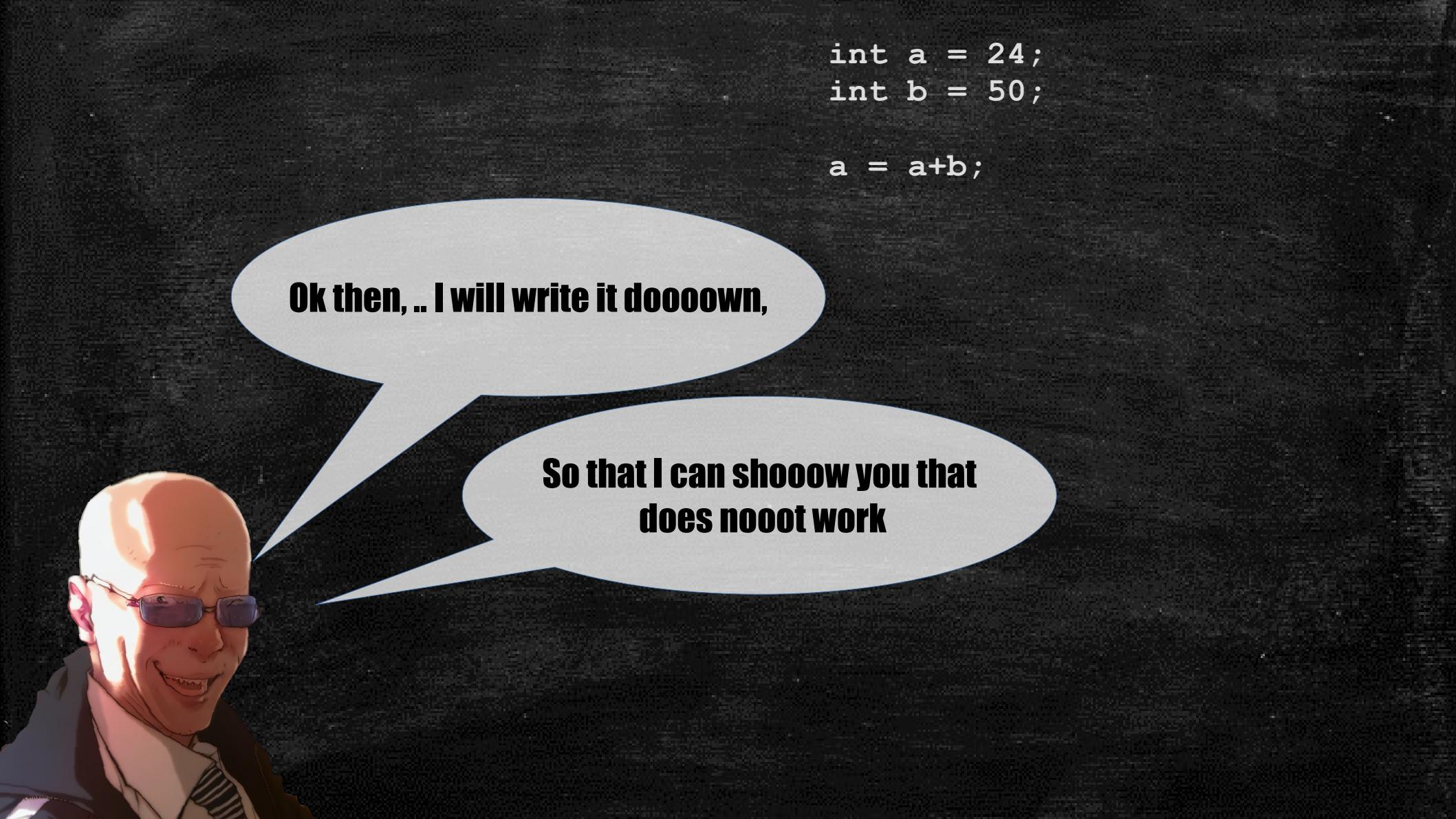
?.. are you... for real.. ?

```
int a = 24;  
int b = 50;
```



Ok then, .. I will write it doooown,

```
int a = 24;  
int b = 50;  
  
a = a+b;
```

A cartoon illustration of a bald man wearing dark sunglasses and a light-colored shirt. He is positioned on the left side of the frame, looking towards the right. Two large, white, speech-bubble-like shapes extend from his head, one above and one below, containing text.

Ok then, .. I will write it doooown,

So that I can shooow you that
does nooot work



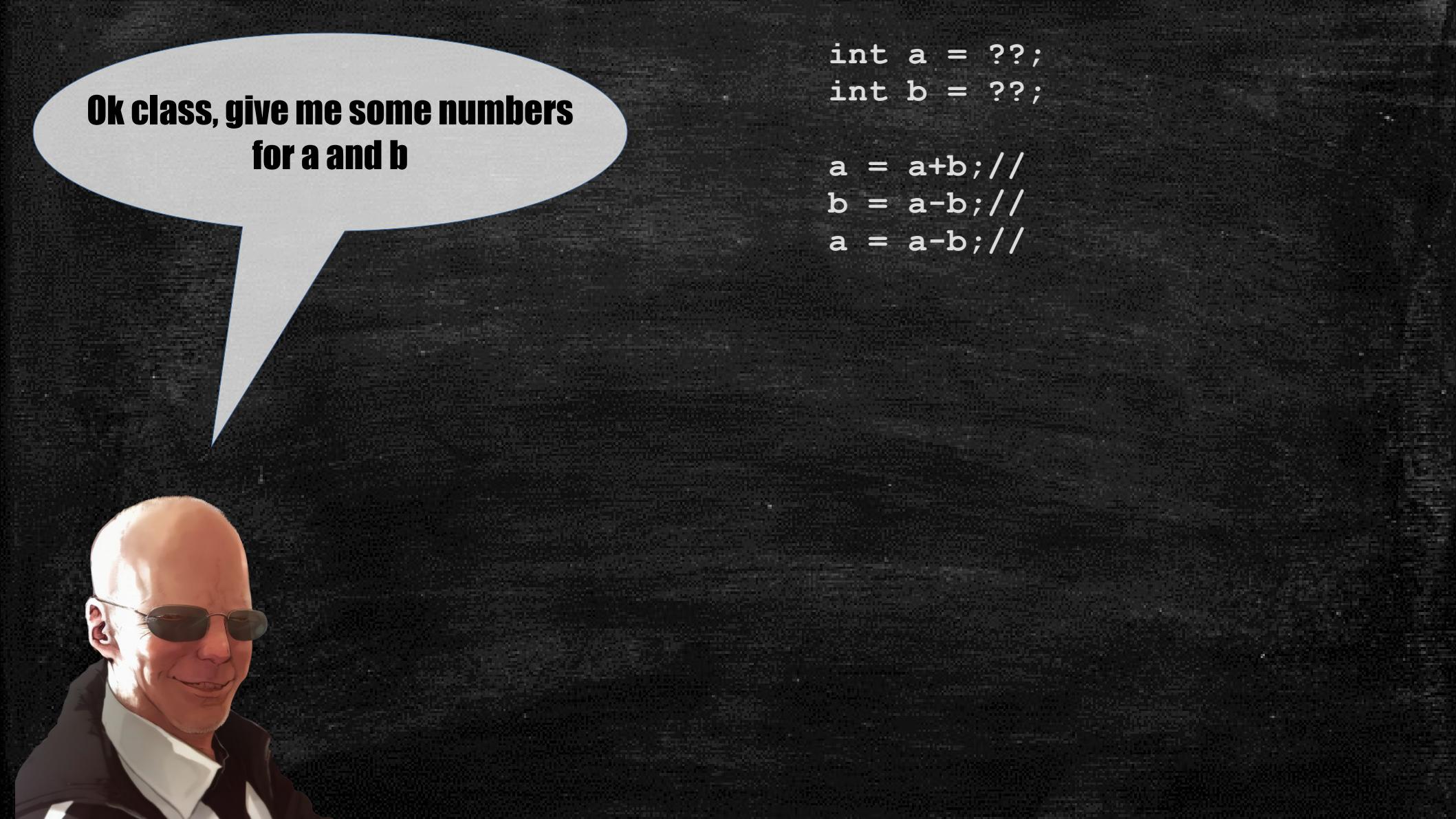
```
int a = 24;  
int b = 50;
```

```
a = a+b;  
b = a-b;  
a = a-b;
```

Ok then, .. I will write it doooown,

**So that I can shooow you that
does nooot work**

**And then we will all laughs at you
and your dumb arrogance!**



**Ok class, give me some numbers
for a and b**

```
int a = ??;  
int b = ??;  
  
a = a+b;//  
b = a-b;//  
a = a-b;//
```



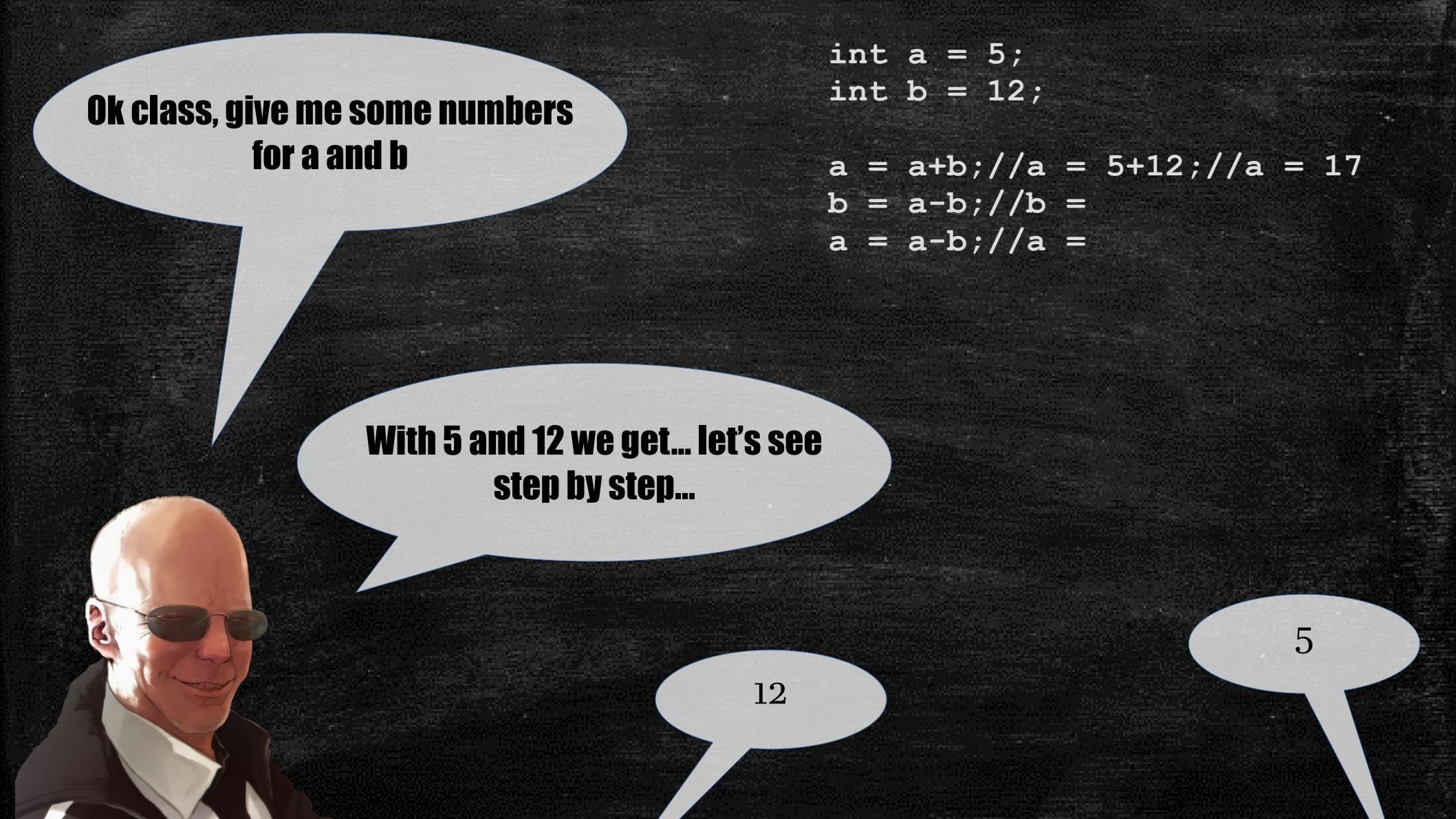
**Ok class, give me some numbers
for a and b**

```
int a = 5;  
int b = 12;
```

```
a = a+b;//  
b = a-b;//  
a = a-b;//
```

12

5



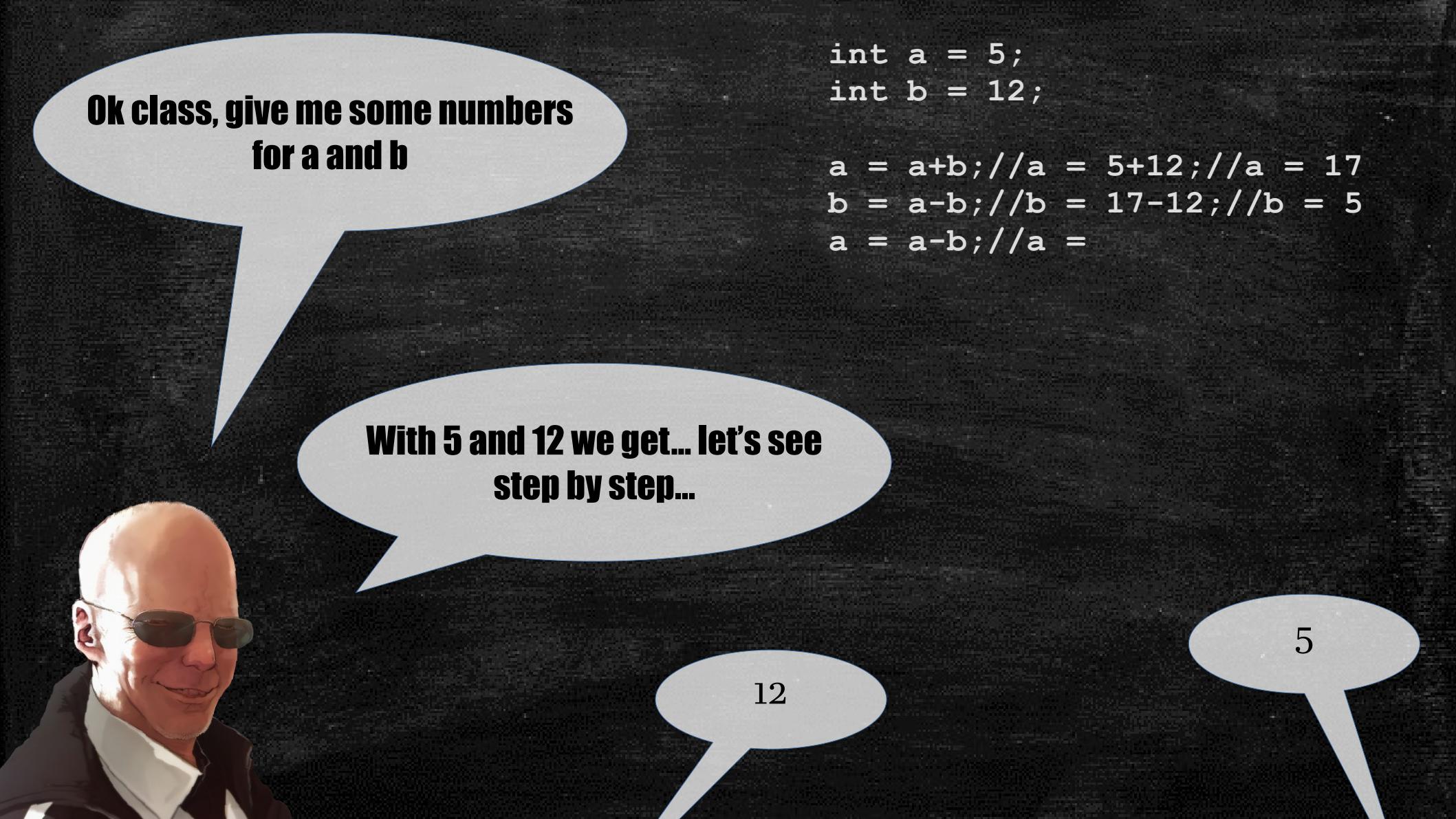
**Ok class, give me some numbers
for a and b**

```
int a = 5;  
int b = 12;  
  
a = a+b;//a = 5+12;//a = 17  
b = a-b;//b =  
a = a-b;//a =
```

**With 5 and 12 we get... let's see
step by step...**

12

5



**Ok class, give me some numbers
for a and b**

```
int a = 5;  
int b = 12;  
  
a = a+b;//a = 5+12;//a = 17  
b = a-b;//b = 17-12;//b = 5  
a = a-b;//a =
```

**With 5 and 12 we get... let's see
step by step...**

12

5



....

```
int a = 5;  
int b = 12;
```

```
a = a+b;//a = 5+12;//a = 17  
b = a-b;//b = 17-12;//b = 5  
a = a-b;//a = 17-5;// a = 12
```

hahah



....

```
int a = 5;  
int b = 12;
```

```
a = a+b;//a = 5+12;//a = 17  
b = a-b;//b = 17-12;//b = 5  
a = a-b;//a = 17-5;// a = 12
```

What, it worked?

hahah

A cartoon illustration of Steve Jobs, showing his head and shoulders. He has a shaved head, wears dark sunglasses, and has a warm, smiling expression. He is wearing a light-colored collared shirt.

**Relax, it must be that those
two numbers are somehow special**

```
int a = 5;  
int b = 12;  
  
a = a+b;//a = 5+12;//a = 17  
b = a-b;//b = 17-12;//b = 5  
a = a-b;//a = 17-5;// a = 12
```



**Relax, it must be that those
two numbers are somehow special**

```
int a = 5;  
int b = 12;
```

```
a = a+b;//a = 5+12;//a = 17  
b = a-b;//b = 17-12;//b = 5  
a = a-b;//a = 17-5;// a = 12
```

**Give me two other numbers,
this time one positive
and one negative**



Please, stop this
and just solve
it symbolically

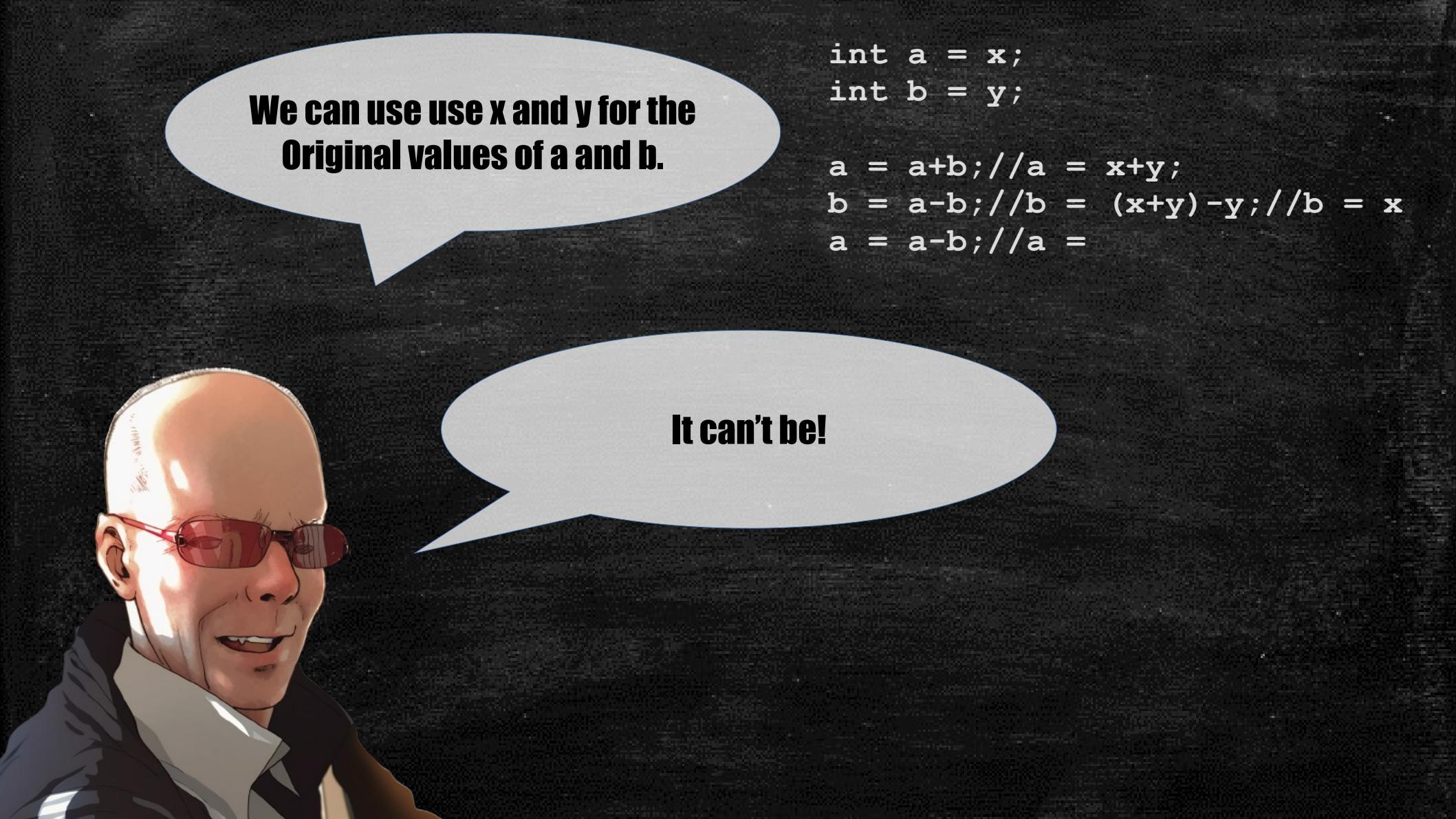
A 3D animated scene featuring Mr. Incredible from the Pixar movie "The Incredibles". He is standing in a classroom, leaning against a chalkboard with his right hand. He is wearing his signature superhero suit, which is white with a grey vest and yellow pants. He has a wide, smiling expression and is wearing sunglasses. A speech bubble originates from him, containing the text "Such a good idea, you must be very smart." The classroom setting includes a wooden desk with a book on it in the background.

**Such a good idea,
you must be very smart.**



We can use use x and y for the
Original values of a and b.

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b =  
a = a-b;//a =
```



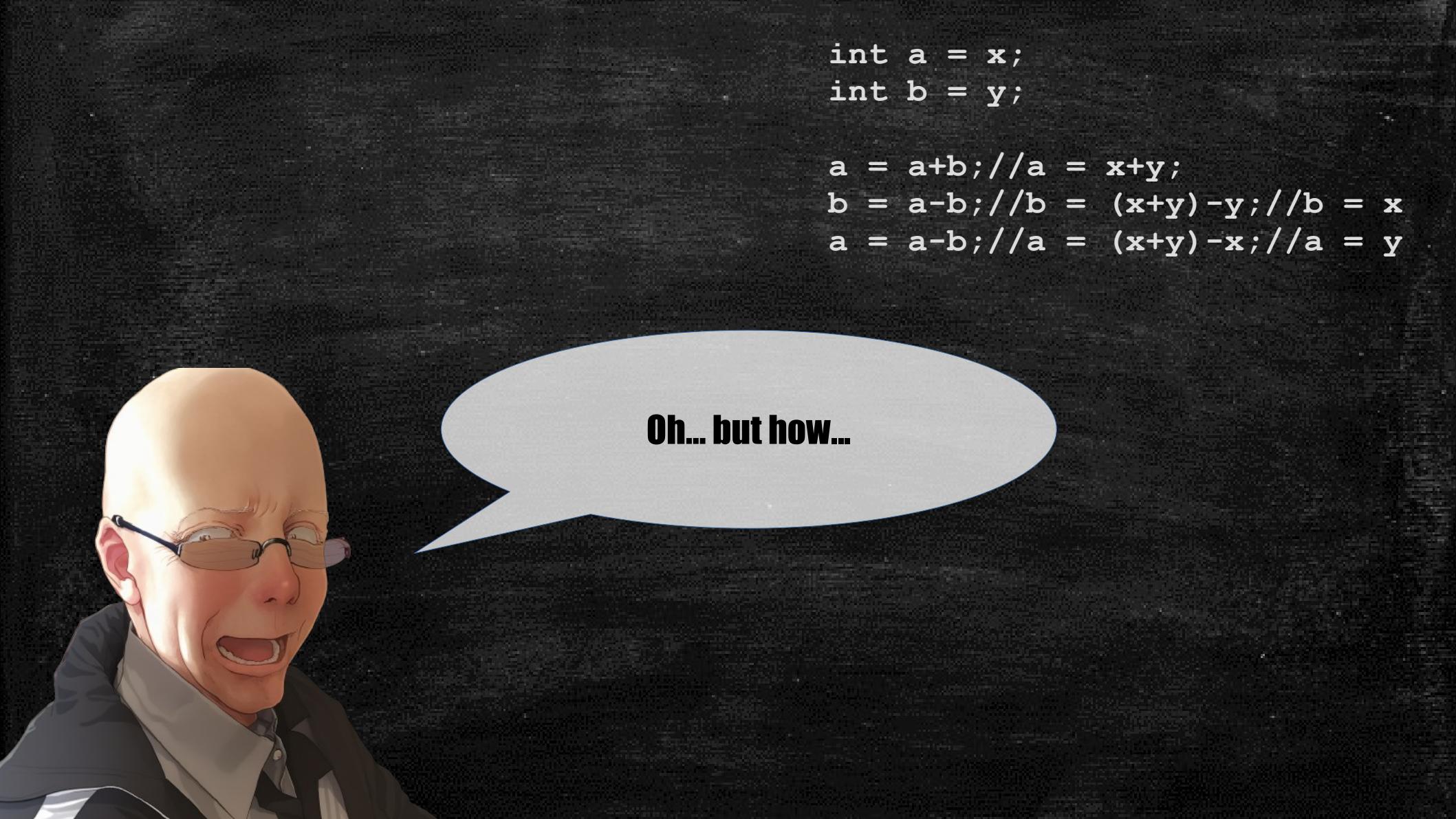
We can use use x and y for the
Original values of a and b.

int a = x;
int b = y;

a = a+b;//a = x+y;
b = a-b;//b = (x+y)-y;//b = x
a = a-b;//a =

It can't be!

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b = (x+y)-y;//b = x  
a = a-b;//a = (x+y)-x;//a = y
```



Oh... but how...

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b = (x+y)-y;//b = x  
a = a-b;//a = (x+y)-x;//a = y
```



**It does not make sense,
there is even a repeated
“a” minus “b”...**

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b = (x+y)-y;//b = x  
a = a-b;//a = (x+y)-x;//a = y
```



**It does not make sense,
there is even a repeated
“a” minus “b”...**

Ah?
so it is
working!

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b = (x+y)-y;//b = x  
a = a-b;//a = (x+y)-x;//a = y
```



**It does not make sense,
there is even a repeated
“a” minus “b”...**

LOL, I'm
never forgetting
this

Ah?
so it is
working!

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b = (x+y)-y;//b = x  
a = a-b;//a = (x+y)-x;//a = y
```

A cartoon illustration of Steve Jobs, showing his head and shoulders. He has a bald head, wears glasses, and has a surprised or confused expression with his mouth open. He is positioned on the left side of the frame.

**It does not make sense,
there is even a repeated
“a” minus “b”...**

**How can the same expression
make two different results...**

```
int a = x;  
int b = y;  
  
a = a+b;//a = x+y;  
b = a-b;//b = (x+y)-y;//b = x  
a = a-b;//a = (x+y)-x;//a = y
```

A cartoon caricature of Steve Jobs, showing him from the chest up. He has a bald head, wears glasses, and has a wide, open-mouthed smile. He is wearing a dark jacket over a light-colored shirt.

No, wait, there must be some other...

The bell rings in this crucial moment.
It is the end of the lecture





No, NO!





What have I done!



It is over!





It is over!

All the class was
laughing at him,
he is going to hate me!





It is over!

All the class was
laughing at him,
he is going to hate me!



He is going to make
my life a nightmare!



This is the end of
the first chapter.

What waits in the future
of our cowardly hero?