How do languages work?

Introduction

Almost every single programming language works *generally** the same way.

> They go in (what direction)?

And they

> Evaluate things line by line, token by token

*exceptions apply

Sample

```
1   a = 5
2   b = 10
3   c = a + b * b
```

If a programming language was a person reading this code, it would do the following:

1. see `a` as the *first character in a line*,
   - this means it needs to make a **box** called `a`
2. Then it sees the `=` sign,
   - this means it needs to **put something in the box** `a`
   - and that the thing after the `=` sign is something that needs to be **evaluated**
3. Then it sees `5`

> is the number `5` an expression?

The concept of literal values

In python, and also most languages

the **symbol** `5` is separate from the **value** `5`

Because when you type `5` into the language, you are saying, place the value `5` here

so

```
a = 5
```

means

```
box a, is equal to, the value represented by the literal 5
```

because, in python, the syntax for variables is

```
identifier equals_symbol expression
```

What exactly is an expression?

An *expression* is anything that can be **evaluated** to **produce** a value

This can be:

- a literal value, like `5` or `10`
- a variable, like `a` or `b`
- a binary operation, like `a + b` or `b * b`
- a unary operation, like `-a` or `+b`
- a grouping, like `(a + b)`
- a function call, like `sum(5)`
- and basically everything else that is *replaced* by a value

Sample

the line

```
1   c = a + b * b
```

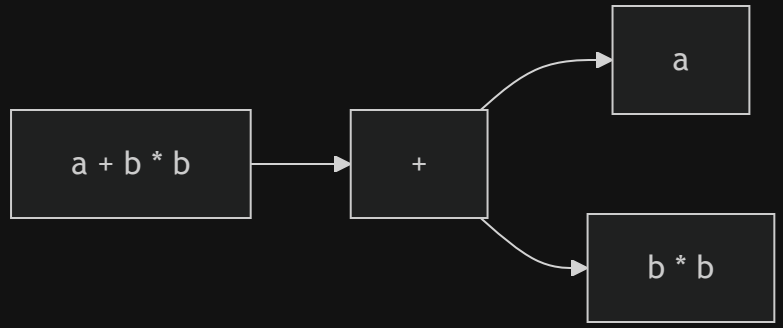
1. It sees `c` as the *first character in a line*,
   - Make **box** called `c`
2. Then it sees the `=` sign, meaning, evaluate the expression on the right side, and put the result in box `c`
3. sees that `a + b * b` is an **expression**

This expression has multiple parts, and one of the best ways to visualize it is using a **tree diagram**

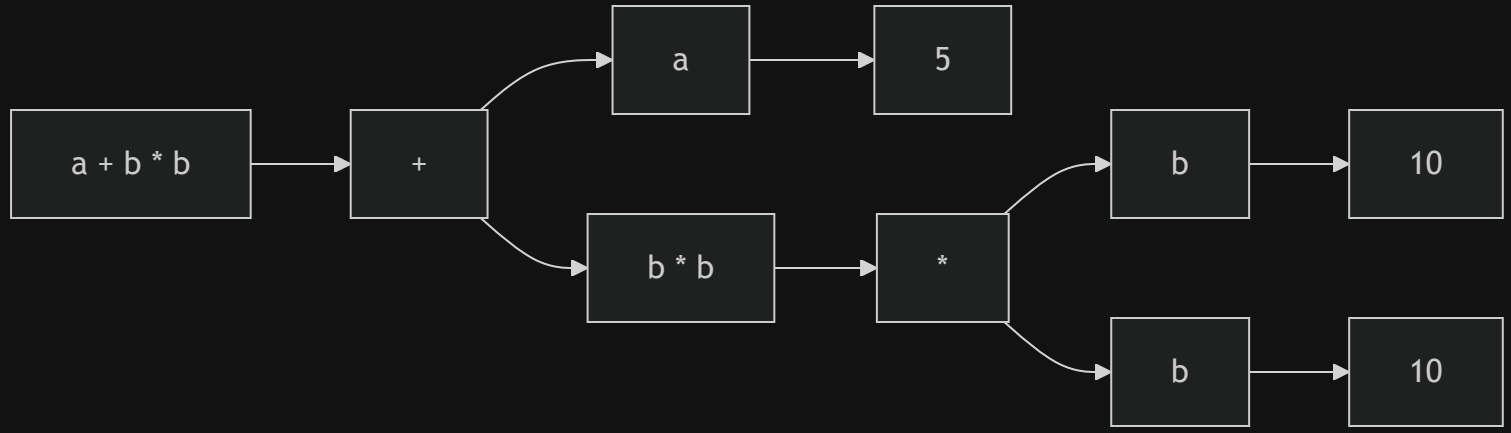
Step 1: The full expression

```
a + b * b
```

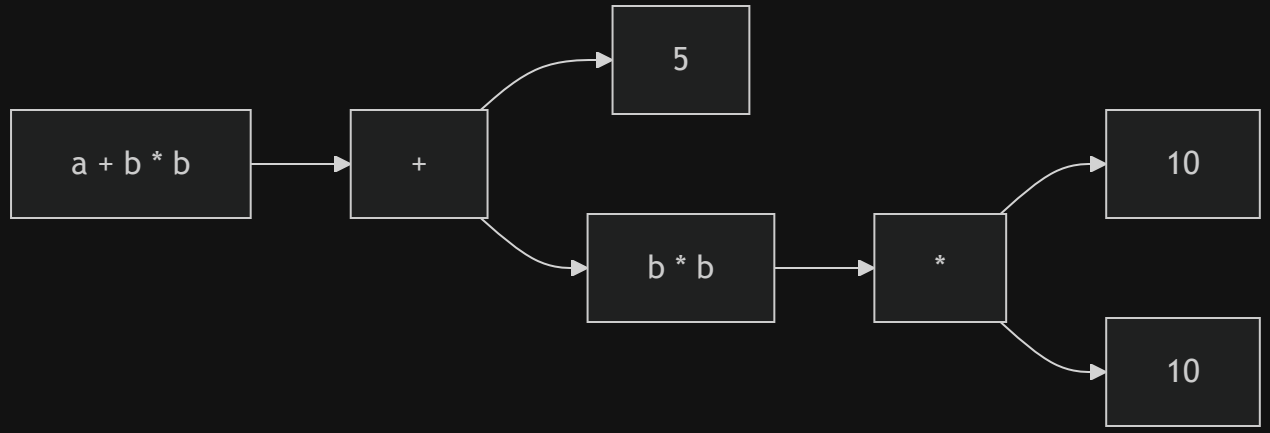
Step 2: implicit groupings



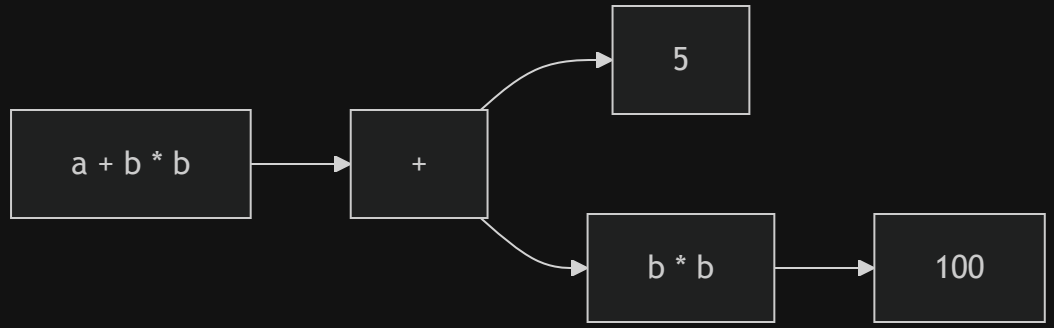
Step 3: further breakdown



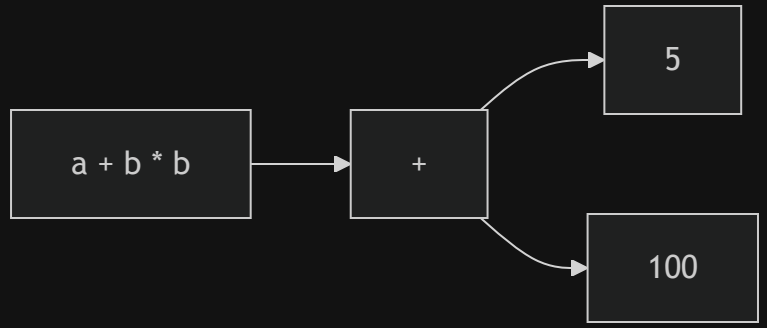
Step 4: collapsing down



Step 4: continue



Step 4: continue



Step 4: continue

Step 5: final value

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and so the line

```
1   c = a + b * b
```

results in what value being assigned to variable `c`?

In the context of more complex structures

Like functions

```
1  def is_even(n):
2      if n % 2 == 0:
3          return True
4      else:
5          return False
```

When the language sees the string of characters `def`,

- it knows it needs to make a **box**
- that box is called `is_even` that holds code that can be run later

Functions

and if you call the function later

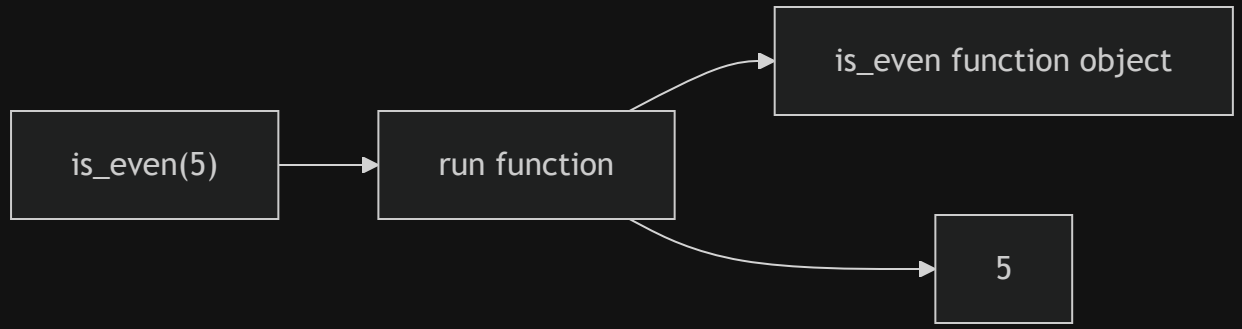
```
1   result = is_even(5)
```

It simply evaluates the *name* `is_even`, which returns whatever was in the box called `is_even`

in our case, it returns the `function object`, a blob of code

Then it sees the `(` symbol, meaning it needs to **run** the code from the blob

with whatever is **in-between** the parentheses as inputs



Demo