ETH zürich

# Introduction to Scientific Computation
# Lecture 0
# Fall 2018

## The rules of the game
## Intro

Mikhail Usvyatsov September 19, 2018

## General course info

Lectures can be downloaded and viewed on Github:
https://github.com/Aelphy/ISC2018
There you can find information on how to prepare the environment, launch the code, submit assignments, communicate with staff etc.

## Team & TAs:

Mikhail Usvyatsov

## Communication system

Communication with staff (questions, suggestions, etc) could be done via emails mikhailu@ethz.ch. Please make sure that the subject in your email is [ISC2018].
Telegram chatroom for ETHZ students is here: https://t.me/icsfall18

## Plagiarism

Students are encouraged to discuss the material, but all the assignments should be done individually. Assignments will be checked for plagiarism. If noticed, can be punished in various ways from zeroing out some parts of a specific assignment to unsatisfactory grade for the course.

## Assignments

This course uses Github for submitting assignments. You should create a dedicated **private!** repository with name **ICS2018-solutions**. E.g. github.com/YOUR_NAME/ICS2018-solutions. And add me (@Aelphy) to collaborators.
Assignment becomes submitted after sending email to mikhailu@ethz.ch with the subject [ICS2018: assignment_N], where N is the number of assignment. In the body of this email there should be a link to a dedicated folder for this particular assignment. For the first assignment it would be:
github.com/YOUR_NAME/ICS2018-solutions/assignment_0

## Deadlines & Attendance

Unless stated otherwise, submission deadline is 00:01 of 10's day after hanging out.
You loose 10% of initial amount of points every day until submission.
By the time of grading the assignment will be checked in the state of the last commit before the deadline.
Assignment can't yield negative amount of points, even if submitted 2 years past deadline.
Attendance is not strict, but do not disappoint us.

## Grading

The course grade depends entirely on points obtained mostly by completing homework assignments. There will be no course exam at the end.

Some assignment examples are "Implement and optimize factorial computation algorithm", "Implement gradient descent algorithm for logistic regression", "Compare Ridge and Lasso regression for house prices problem", "Implement Perceptron Algorithm"

## Materials

The Hitchhiker's Guide to Python
The Primer on Scientific Programming With Python. H. Langtangen

## Always use

Google
StackOverflow

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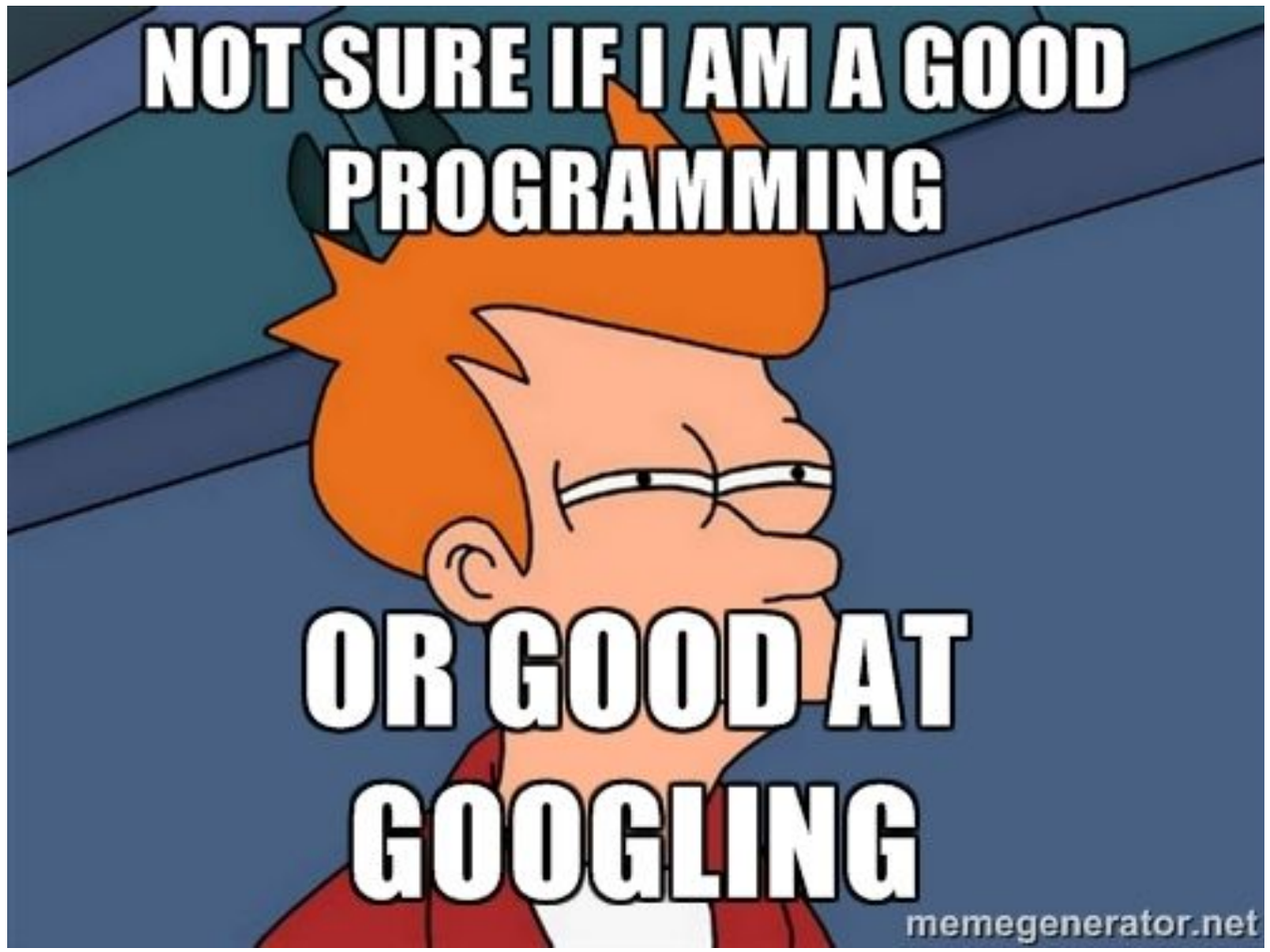

## Introduction

How is your code running ?

How is your code running ?

# Semantic Gaps

**Application domain**

Train traffic management system: Trains, velocity, distance, railways, switches, train stations, conflict resolution, time schedule etc.

Simulation of the Universe evolution: Planet movement rules, planet systems, stars classification, star activity etc.

...

**Computer program/ programming language**

- Variable, array, ...
- Function, operator, procedure
- Control structures
- Data types
- Module, class, interface
- ...

**Computer hardware**

- Memory cell
- Memory address
- Register
- Instruction, instruction set
- ...

# Semantic Gap

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So, the main compiler task is:

- To **map** human-written & human-friendly program to computer hardware – to solve a problem

OR:

- **To overcome the semantic gap**.

# Machine Code & Assembly Language

## Off-topic

Mnemonic notation:
ADD 5 7

Binary code of the instruction:
1101010010100111

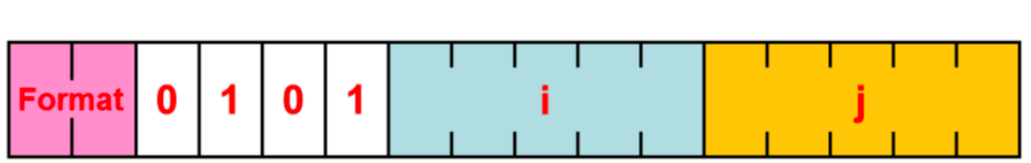
Hexadecimal code of the instruction:
D4A7

Assembler code:

```
.format 32
R5 += R7
```

**ADD i j**

- **The ADD instruction denotes the two's complement arithmetic addition. The contents of registers Ri and Rj are arithmetically added, and the result is put into the register Rj.**
- The instruction format is as follows:




- Memory state is not considered in the instruction, and the memory state does not change.
- If the addition gives a result which cannot be put into the format specified in the instruction, then **overflow** happens

**Suggested assembly statement for the ADD instruction:**

```
Rj += Ri;
```

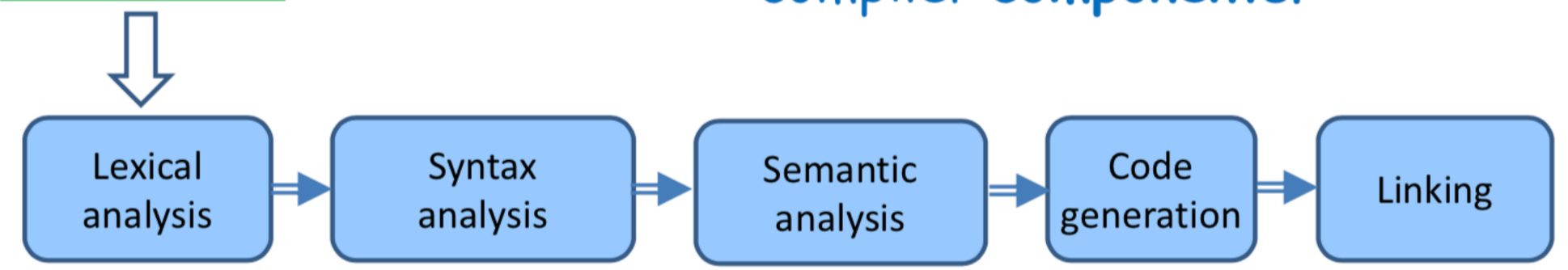
**Additional assembly directives specifying the current instruction format:**

`.format 8;` **or** `.format 16;` **or** `.format 32;`

# Compilation: An Ideal Picture

***A program written by a human (or by another program)***

Source program text




Target code

0101011100111010100001101111010101011001100110101011100011

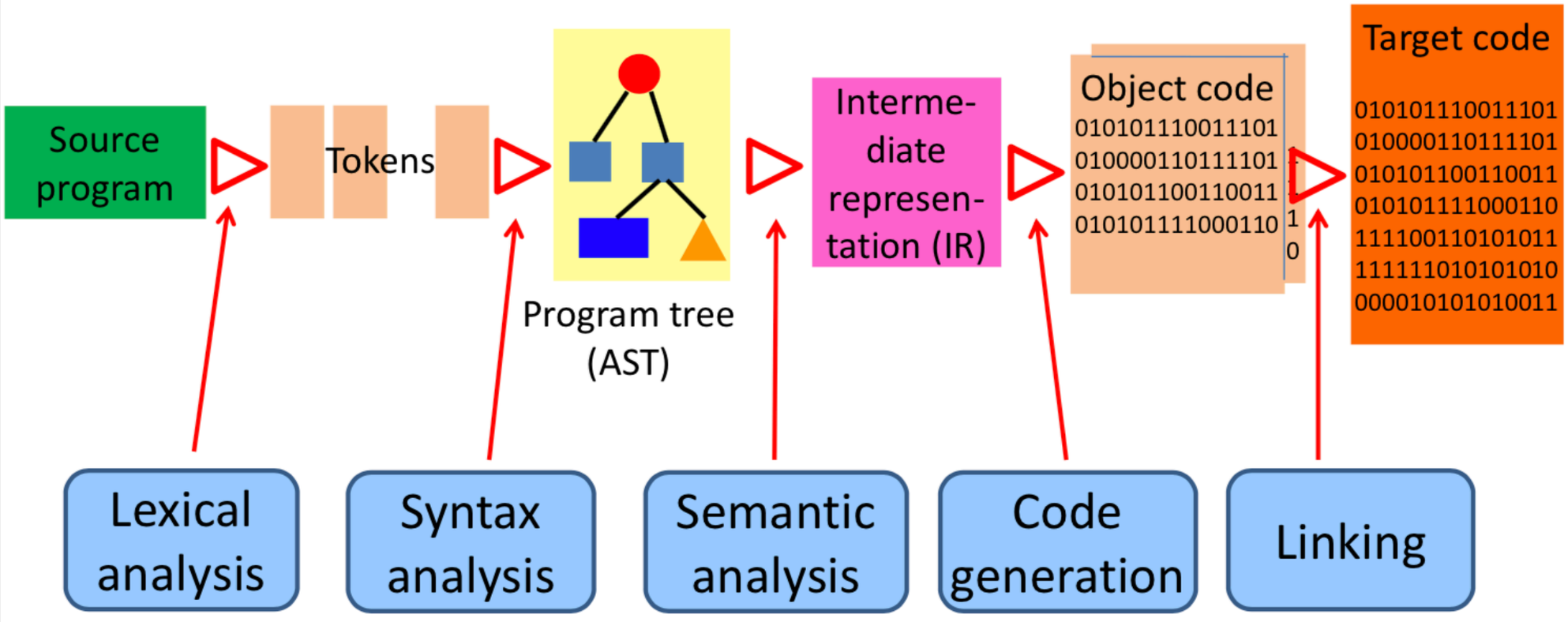
***A program binary image suitable for immediate execution by a machine***

Blue squares just denote some **actions** typical to any compiler; they are not necessarily actual compiler **components**.

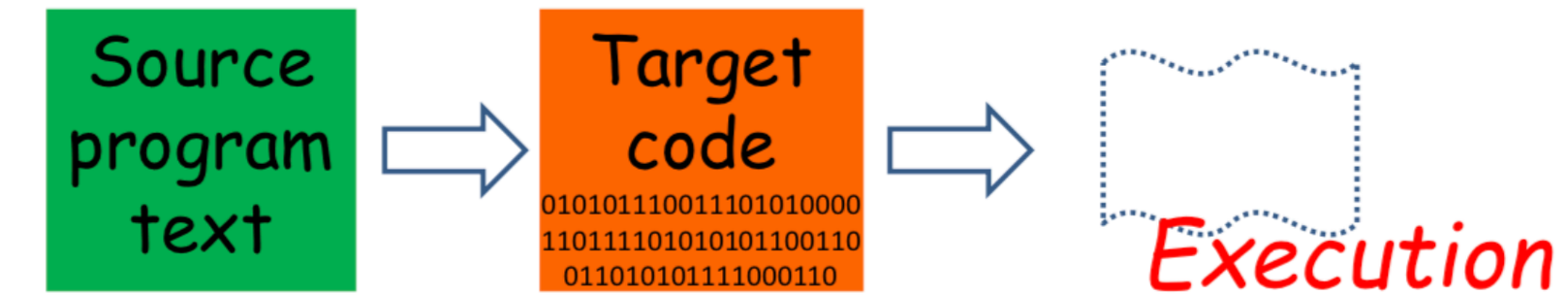
The **contents** of those actions, their **implementation** technique, and how they **interact** with other actions – is just the subject of the course.

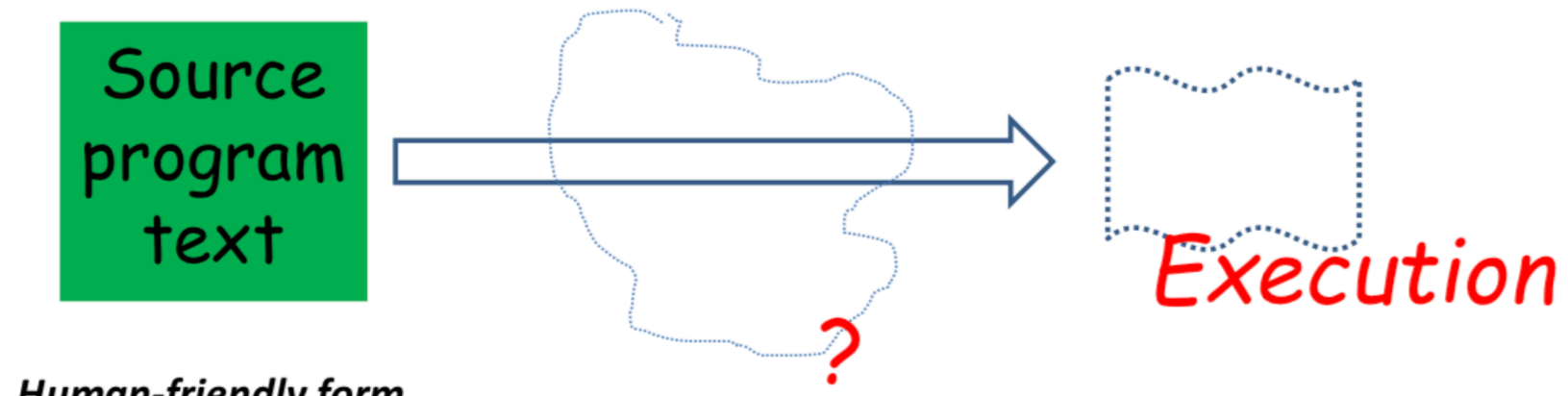
# Compilation Data Structures

This is a different, **data-centric** view at the compilation process. Compilation is **a sequence of transformations** of a source program.



# Compilation vs Interpretation



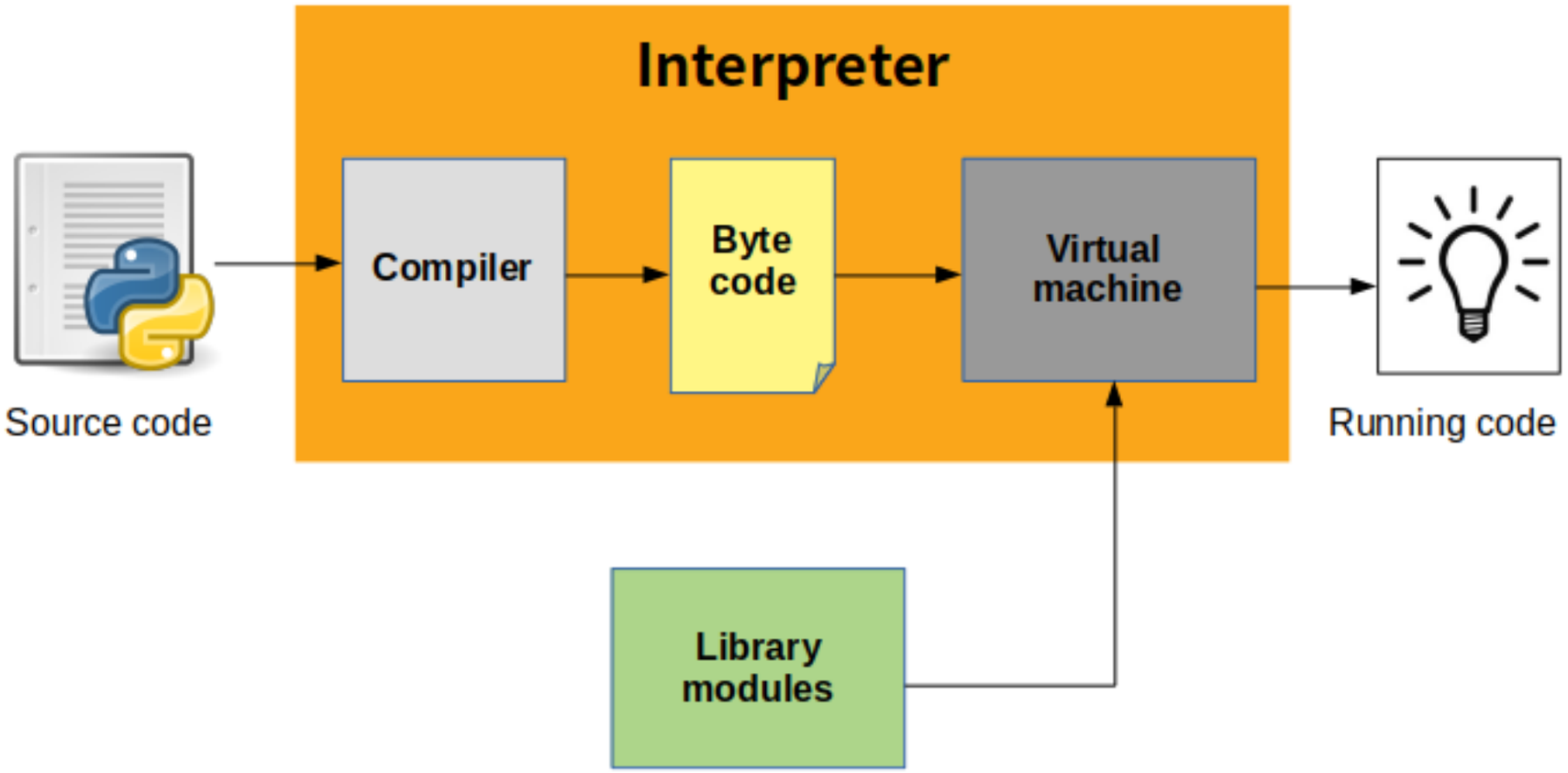



## So, what about Python ?

## From programmer point of view


(c) https://indianpythonista.wordpress.com/2018/01/04/how-python-runs/

# From Python point of view

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## So, what about Python ?

Source code:
hello.c

COMPILER →

Machine code:


**Program** (also called binary, executable ...)

run the program →

result


Source code:
hello.py

→ INTERPRETER → result


(c) medium.com

## How does Python interpret this:

$$X + Y * Z + U$$

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$X + Y * Z + U$

**Stack**

```
push x
push y
push z
multiply
add
push u
add
```

## How does Python interpret this:

### Stack

```
push x
push y
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add
push u
add
```
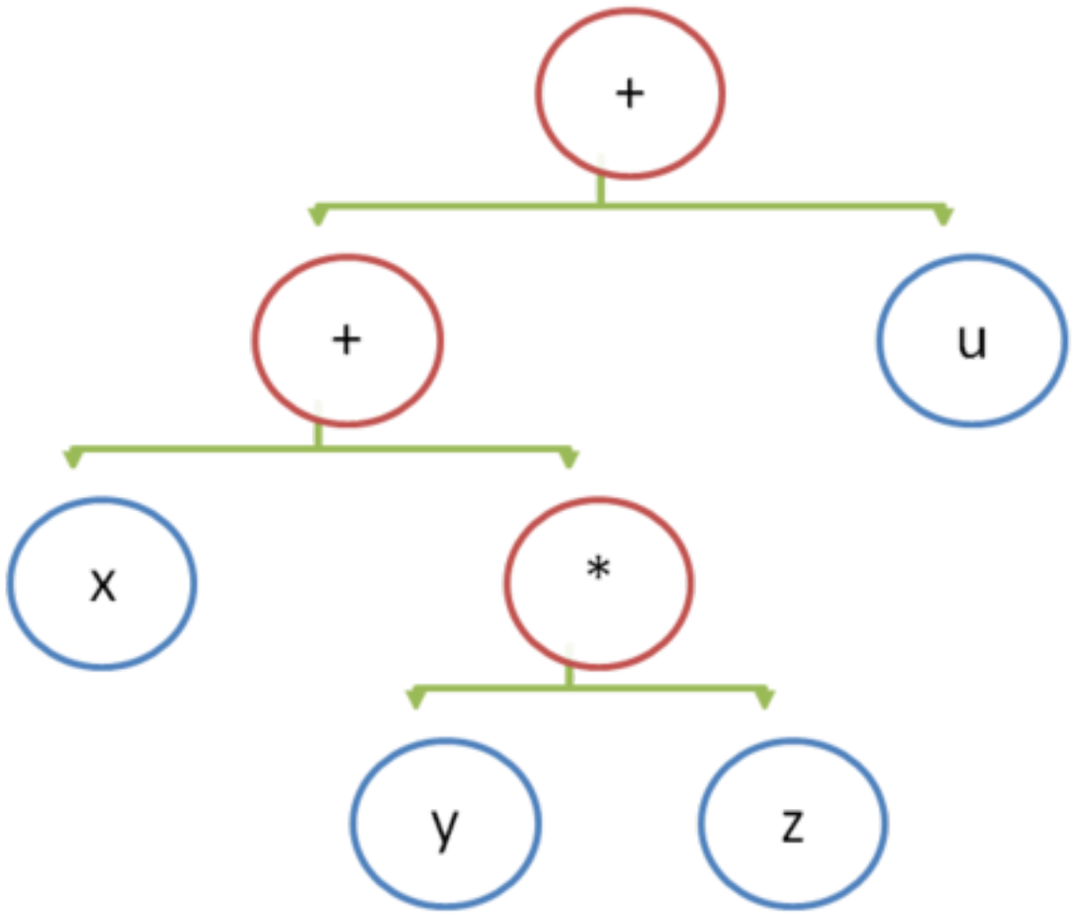

~

### AST



# Python

# Python

# Python

*Pros:*

- **Extensive Support Libraries**
- **Can use C/C++ libs via SWIG**
- **Cross platform**
- **Relatively low entry level**
- **Free & open-sourced**
- **Huge community**

*Cons:*

- **Extensive Support Libraries**
- **Slower than C/C++, assembly**
- **Runtime errors**
- **Parallel(GIL)**

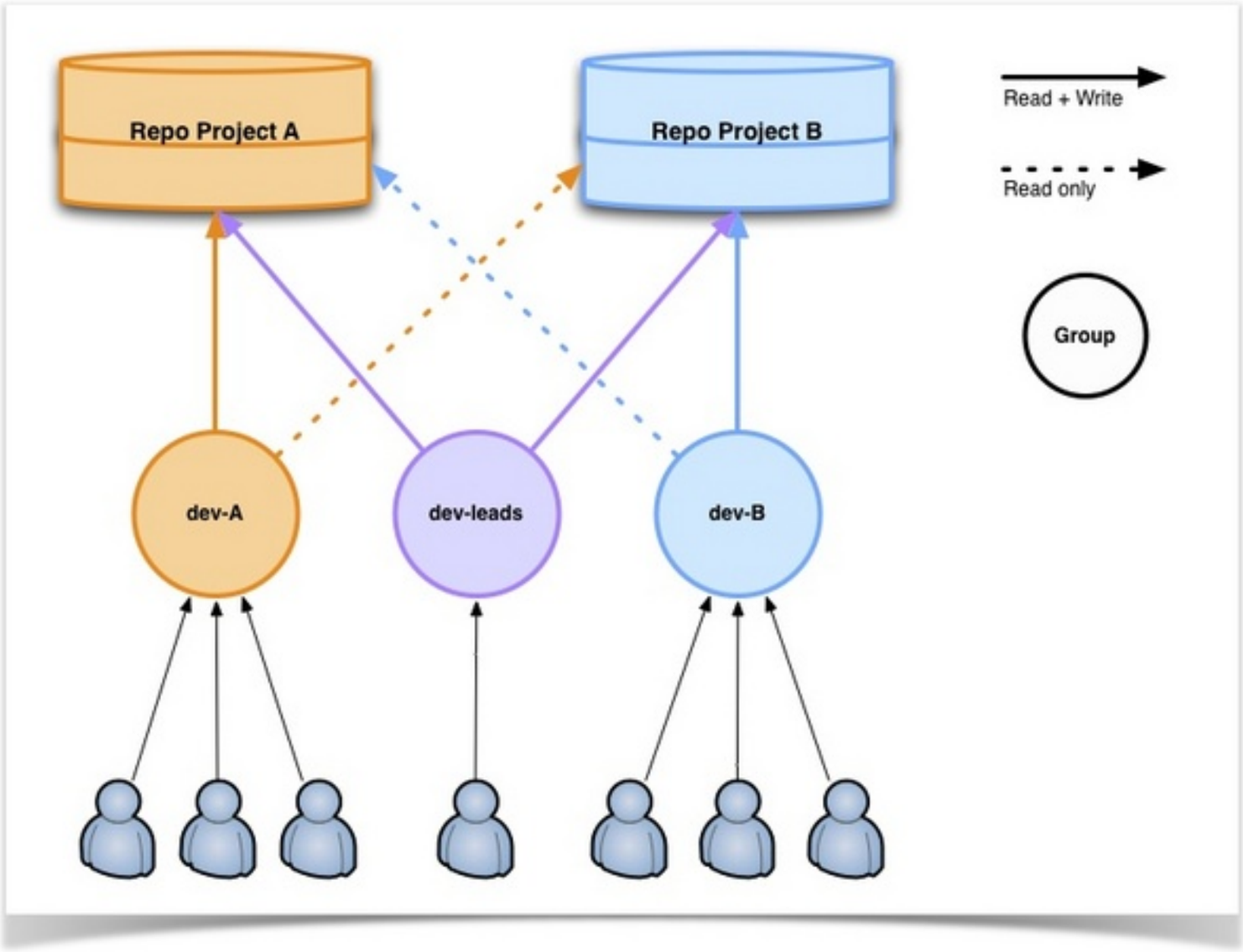
## Python environments

pip - Pip Installs Packages - package manager for python. Can be used together with condo but very carefully

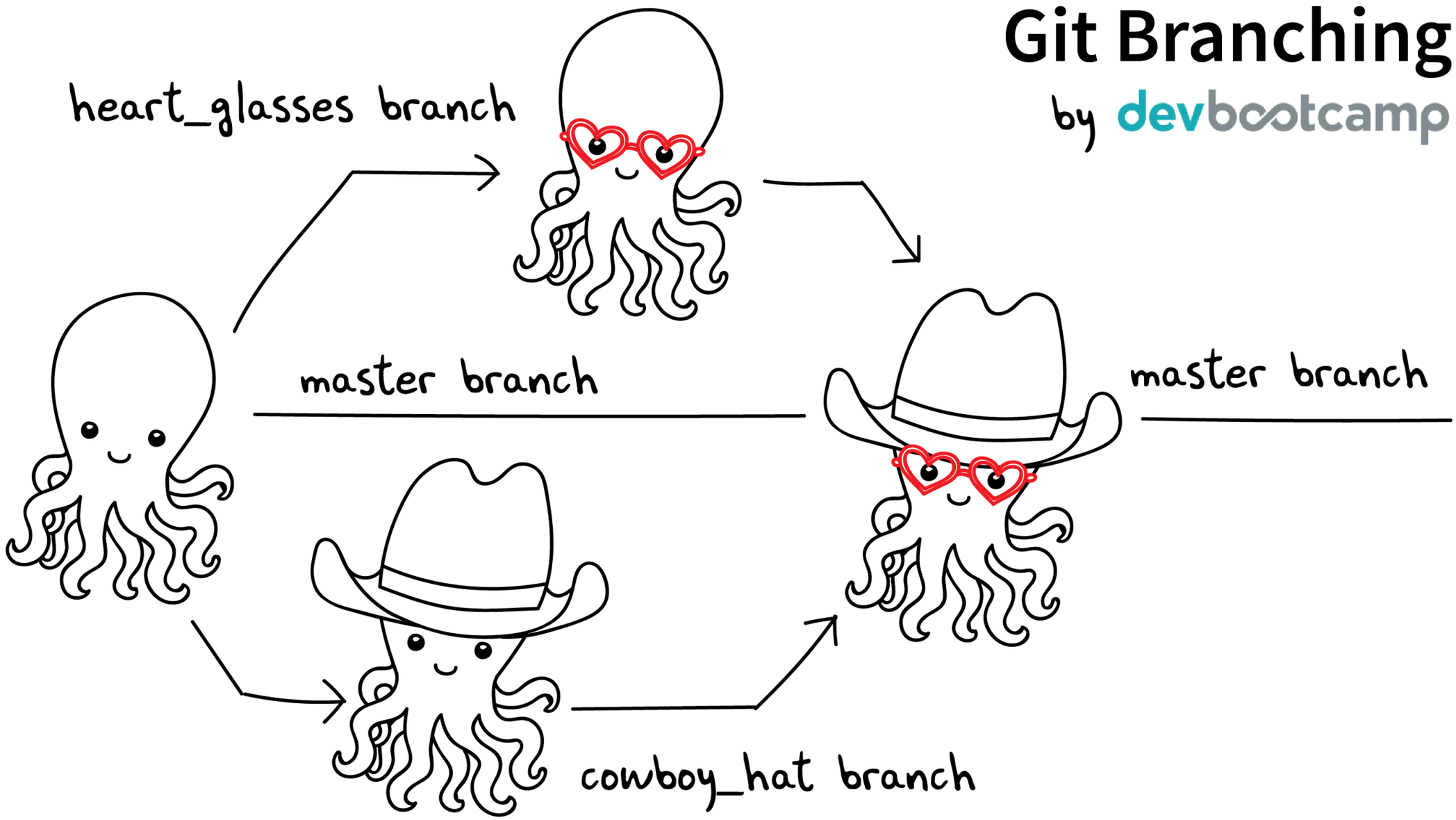
If you use python without anaconda:
- virtualenv, source activate, pip install

If you use anaconda:
- conda activate, conda install + pip install

# Git: repositories



# Git: branches



# Git: white board slide

# Let's code


First day of programming lab:
Today you will be making a program using Python
*TA*
*Me*
CHALLENGE ACCEPTED
>>> print 'Hello World'
Hello World
>>>
I AM A F KING
PROGRAMMER