

Programming Skills



Lecture 1

Thijs Verwijmeren

Why?

- Why does a behavioural scientist need to know how to program?

Testimonials

Being able to program makes you awesome in millions of different ways, e.g.:

- Being able to write your own experiment distinguishes you from other PhD candidates. It is a unique skill.
- Programming your own experiment gives extra insight into your experimental paradigm and thereby improves your experiment.
- Improves your data handling skills in R
- Makes you extremely independent in doing research. Imagine having to depend on or wait for others to program your script.

Inge Huijsmans (RM 2012-2013)

Testimonials

At the moment I am doing my major project at the "Freie Universität Berlin" in Germany, and I was programming sort of a lexical decisions task in Python over the last weeks. [...] Actually, just an hour ago, my supervisor told me that he is quite happy with the programming skills I have, inquiring about the education we got during the research master. I told him about the one course that we had in Python ;)

So looking back, I was happy that I learned Python, because thanks to that course, I was able to program my entire experiment on my own, which is - as I discovered - a non-neglectable part of conducting research in general. Also it seems that researchers are always looking for people who are able to program on their own, so getting to know Python facilitates the career of a scientist.

Marcel Badra (RM 2012-2013)

Testimonials

What I feel about programming is that everytime the script i write runs without any errors makes me quite happy because it solves solid problems: the script works or not, you know it immediately, not like ethereal philosophic quetions which end up in the middle of no where. Learning python for me is like learning a new language, so it's better to use it everyday otherwise I always forget it.

-Xin Gao (RM 2014-2015)

Python

- High-level programming language
- Platform independent
- Open Source
- Guido van Rossum

What can you use Python for?

- Experiments
- Measurements (time accurate, physiological, balance board)
- Websites
- Virtual reality
- fMRI (AFNI)
- Everything computational (including what R can do)

Who else is using Python?

- NASA
- Google
- YouTube
- Dropbox
- Industrial Light & Magic
- Open Science Framework
- Many universities

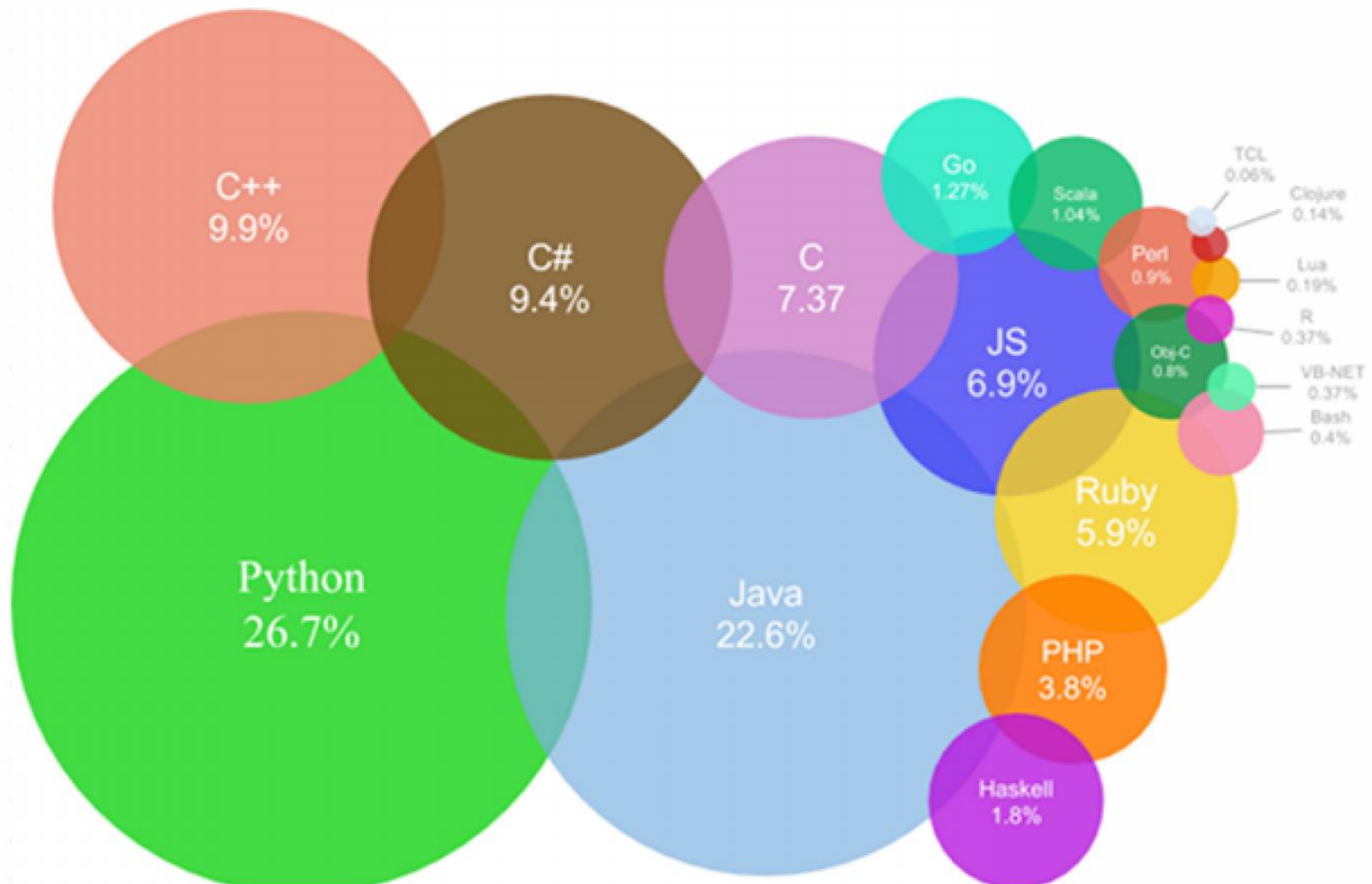
webs



Comparison

- General purpose: Java, PHP, C
- Specialized: R, Matlab, Inquisit, Presentation, E-prime

Most Popular Coding Languages of 2016



Structure of the course

- Lectures
- Lab sessions
- Weekly homework assignments

Structure of the course

- I. How to think like a computer scientist
- II. Programming experiments

Learning goals

1. Think like a computer scientist
2. Knowledge of Python
3. Program experiments
4. Debug code

This is a **skill** class

- Your final grade will reflect skill, so train!
- Knowledge only gets tested through skill

Grades

- Written Exam (50%)
- Take Home Exam (50%)
- Homework requirement

Literature

- E-Book: How to think like a computer scientist
<http://interactivepython.org/runestone/static/ProgrammingSkills1516/index.html>
- Extra help:
 - Python documentation
<http://www.python.org/doc/>
 - PsychoPy documentation
<http://www.psychopy.org>
 - Blackboard forum

Python 2.7 vs. 3.0

- Both are still in use
- We will use 2.7 (psychopy uses it!)
- Will teach both (differences are few and subtle)

Up to week 5

- Python runs in your web browser
- Online editor (demo)
[http:// pythonfiddle.com/](http://pythonfiddle.com/)
- E-book (demo)
<http://interactivepython.org/courselib/static/tinkcspy/index.html>
- Register to get access to the e-book, load and save your code, discuss answers, and show me that you're working on it.

[About](#)[FAQ](#)[Forum](#)[Solutions](#)[Guest
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PYTHON CHALLENGE

The first programming riddle on the net

1 7 3 8 5 8 5 visitors have attempted solving the challenge since May 2005.

There are currently 3 3 levels.



[Click here to get challenged](#)

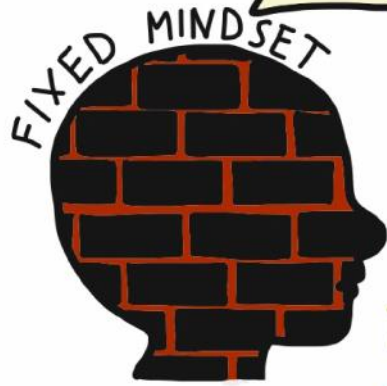
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Hint: try to change the URL address.



10 Growth Mindset Statements



What can I say to myself?

INSTEAD OF:

I'm not good at this.

I'm awesome at this.

I give up.

This is too hard.

I can't make this any better.

I just can't do Math.

I made a mistake.

She's so smart. I will never be that smart.

It's good enough.

Plan "A" didn't work.

TRY THINKING:



1 What am I missing?

2 I'm on the right track.

3 I'll use some of the strategies we've learned.

4 This may take some time and effort.

5 I can always improve so I'll keep trying.

6 I'm going to train my brain in Math.

7 Mistakes help me to learn better.

8 I'm going to figure out how she does it.

9 Is it really my best work?

10 Good thing the alphabet has 25 more letters!

(Original source unknown)

@sylvia duckworth

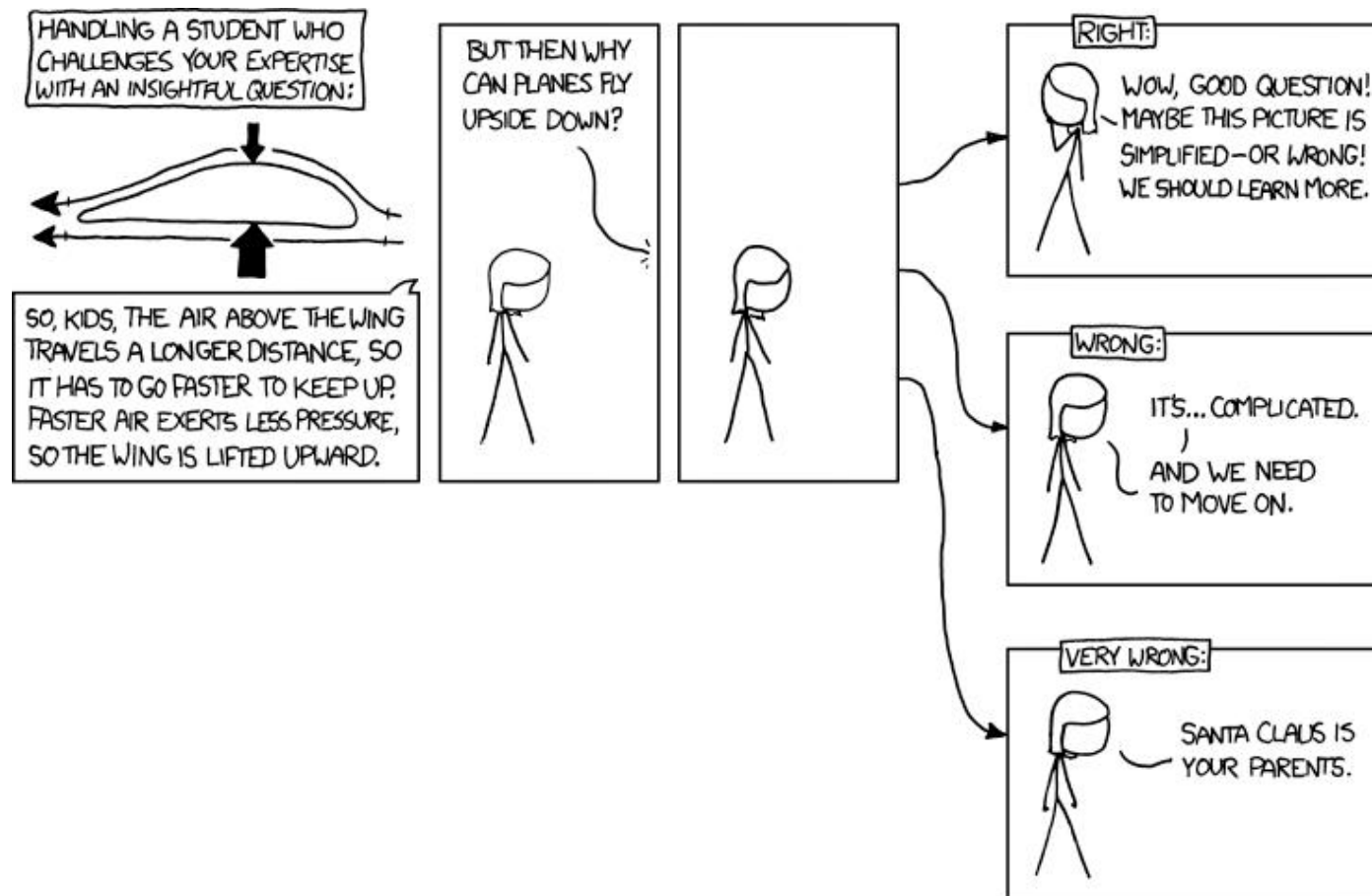
The rules of Python class

1. There are NO stupid questions
2. There are NO stupid questions



The rules of Python class

There are wrong responses to questions:



The Python Oath

I do solemnly swear that I will be, today and forever (or at least until the end of this course), a 100% dedicated, diligent, and brave Pythonista.

I promise always to do my homework and never give up, even when things get tough.

I promise to see failures as part of learning how to program so I will not be discouraged by mistakes.

I swear to use the knowledge and skills I have learned in this course only for good and I promise never to harm anyone with a Python program.

I choose the way of the Pythonista!



Two major skills

- Learn a language
- Learn how to communicate with a computer

Algorithms

RECIPE: Tomato vegetable pasta

Serves: 5

Cost per portion: 32p

Ingredients:

500g prepared veg (carrots, broccoli, cabbage)
1 onion, peeled 2 cloves garlic, peeled
1 tbsp cooking oil 1kg passata
2 tbsp dried mixed herbs 100g spaghetti



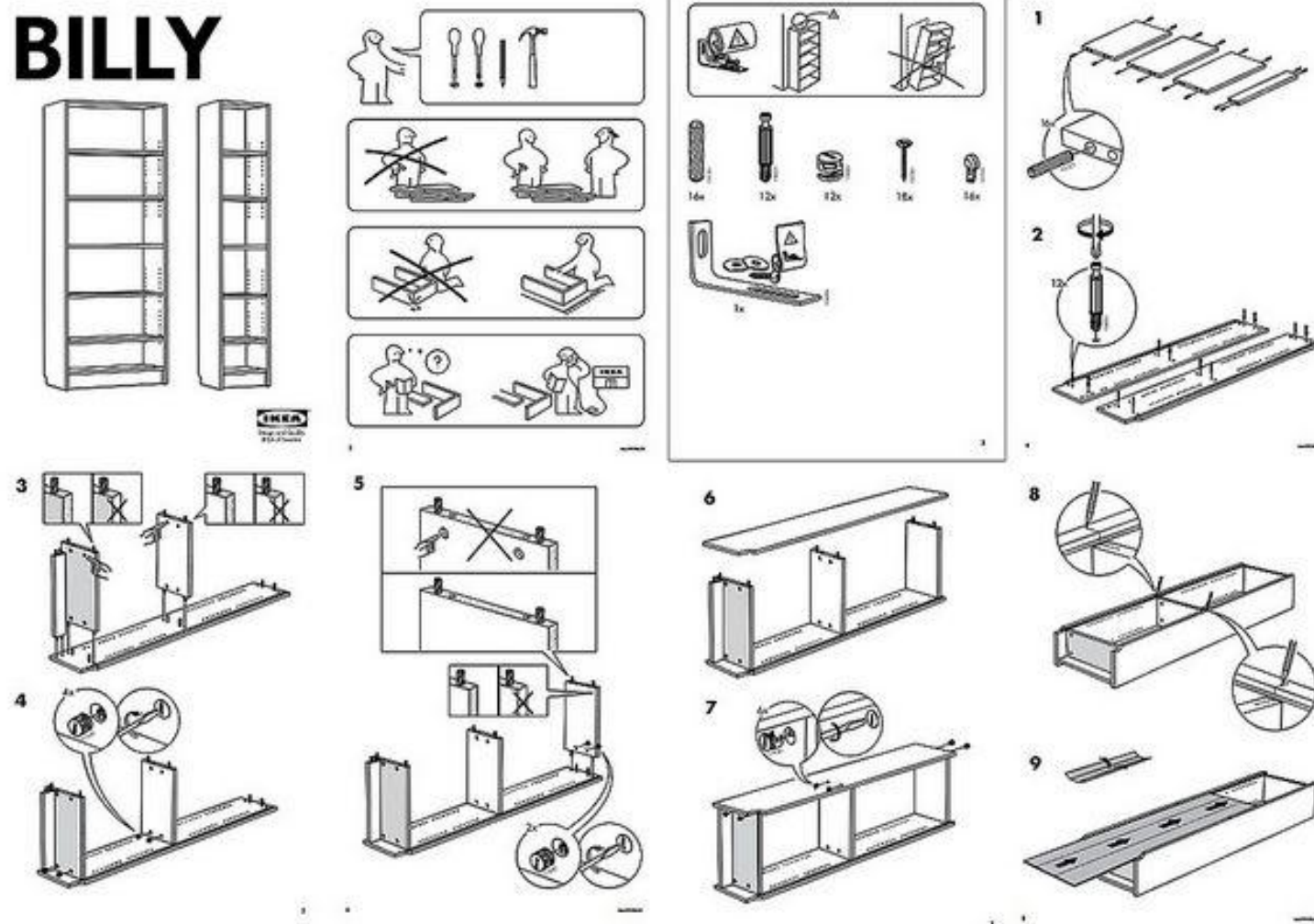
Method:

1. Finely chop the veg, onion and garlic in a food processor.
2. Put the oil in a pan and add the vegetable mix. Fry for 5-10 minutes until they are soft.
3. Add the passata and herbs, stir and leave to simmer for 20 minutes.
4. Make up the spaghetti according to the package instructions.
5. Remove the sauce from the heat and pulse in a blender.

Star rating (out of 5): ★★★★★

Algorithms

BILLY



Method

(See pp. 5-6 of the Sample Paper)

The method section describes how the study was conducted and is usually divided into, at minimum, two subsections: (1) participants, and (2) procedure.

Typing: The word "method" is boldfaced, centred, typed in upper and lower case, and immediately follows the last sentence of the introduction section.

Participants

The participants subsection describes the people who volunteered for the study. This includes information about the number of participants, their sex and average age and any other defining characteristics of the group of people (do not list details of individual participants).

Typing: The word "participant" is boldfaced, left justified, and typed in upper and lower case. This subsection is written in past tense. The first line of this subsection is indented 5-7 spaces (1.27cm or $\frac{1}{2}$ "). When reporting the number of participants, present the number as digits if the numerical value is greater than or equal to 10. If the number of participants is less than 10, type the numerical value as a word.

Procedure

The procedure subsection provides a description of: the sampling procedure – how the participants were recruited – and sample size; the equipment and/or tests that were used; the research design; and a summary of the steps followed during data collection.

When describing standard materials (e.g., stop-watches) a detailed description is not required. If a test was used, cite the test name and author(s) in APA style and include the source of the test in the reference list. If the test (or data recording form) has instructions typed on the test form, describe the instructions; do not provide verbatim instructions. If the test uses a rating scale, include a description of the rating scale and how total scores are produced. When describing a test that uses a rating scale, type the rating scale as digits and the anchors for the scale should be italicised and in parentheses. For example, the participants rated their responses from 1 (*most important*) to 5 (*least important*).

The description of the procedure should be in chronological order. Provide enough detail to enable the reader to understand how the data was collected. This description should include: how participants were separated into groups or conditions; where the testing took place; any verbal instructions given to each group or condition; the order of presentation of testing material; any experimental manipulations; how the dependent variable(s) were measured and any variables that were held constant.

Typing: The word "procedure" is boldfaced, left justified, typed in upper and lower case and immediately follows the last sentence of the "participants" subsection. This subsection is written in past tense. The first line of this subsection and subsequent paragraphs are indented 5-7 spaces (1.27cm or $\frac{1}{2}$ ").

How does python read code?

- Algorithms
- Interpretation vs. compilation

First python script

- Output something (or multiple things) to the console with `print()`

Variables

Chapter 2

- Values
- Variables
- Expressions

Values (objects)

- “Text”
- 4
- 3.141592

Data types (classes)

- “Text”: String
- 4: Integer
- 3.141592: Float

Use `type()` to find out

Data types (classes)

- 4
- 4.0
- “4”

Strings

- “I don’t like homework”
- ‘and then she said: “Do your homework!”’
- “”I replied: “I don’t like homework!”””

Type conversion

- `int()`
- `float()`
- `str()`

Variables

- Name that refers to a value
- Assignments:
 - $\pi = 3.141592$
 - $N = 40$
 - `thijs = "awesome"`

Naming rules and conventions

- Not all names are allowed (keywords)
- Can't start with numbers
- Can't use illegal characters (e.g., \$, +)
- Use meaningful names
- useThisConvention or use_this_convention or usethisconvention but not all.

Expressions

```
print (1+1)
```

```
print (len("hello"))
```

```
print(x)
```

Operators

- -
- +
- *
- /
- %
- **
- // (Python 3.0)

Note: in 2.7 / results in an integer if integers are used, float if one of them is float

User input

- `raw_input("question")`
 - argument: string
 - returns: string
- Python 3.0: `input("question")`

More on variables

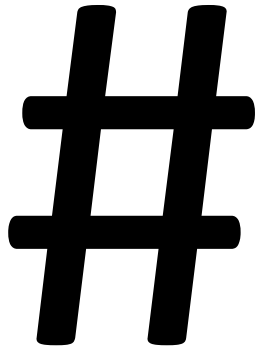
Reassignment

```
a = 5  
b = a  
print (a, b)  
a = 3  
print(a, b)
```

Updating

```
x = 6  
print(x)  
x = x + 1  
print(x)
```

Comments



Types of errors

- Syntax errors (typos)
- Runtime errors (exceptions)
- Semantic errors

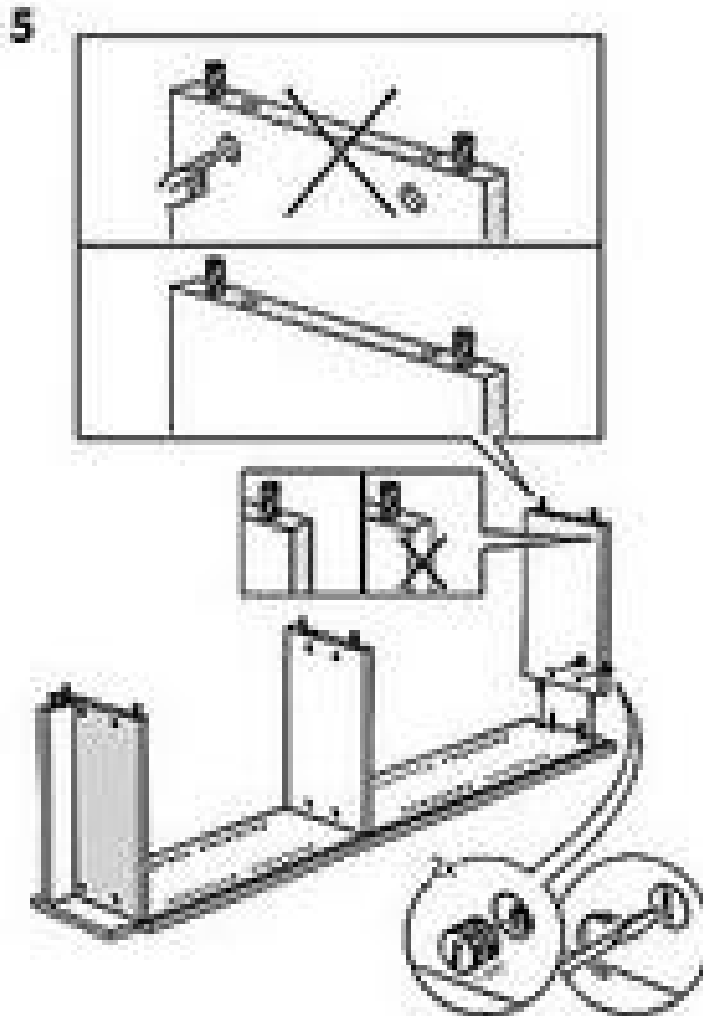
Computers don't know what they are supposed to do!

Syntax Errors

RECIPE: Tomato vegetable pasta

- 3. Add the passata and herbs, stir and leave to simmer for 20 minutes.
- 3. **Arr** the passata and herbs, **stip** and **lead** to **sicker** for 20 minutes.

Runtime Errors



Semantic Errors

Participants were invited to come to the lab on the fourth floor. When they walked back to the elevator and we measured the time it took them to traverse the distance from the lab to the elevator. Then participants completed a questionnaire containing words that primed the concept of elderly.

Debugging



www.phdcomics.com

We're only human

- Programming errors are pervasive, persistent, and inevitable
- Software testing is an essential part of software development
- Any changes made in correcting a programming error should be fully understood as to why the changes correct the detected error

Recap

- Debugging (it's all about the mistakes!)
- Variables
- Expressions

functions

`print()`

`int(), str(), float()`

`type()`

`len()`

`input()`

Homework assignments

- Register for e-book (use <http://interactivepython.org/runestone/static/ProgrammingSkills1516/index.html>)
- Read e-book Chapters 1 (The way of the program) and 2 (Variables, Expressions and Statements)
- Do problems of Chapter 2 (1-12) and *save them online*
- Bring hard copy problems of all even exercises to lab session (i.e., problems 2, 4, 6, 8, 10)
- Recommended: do all self-test exercises that you encounter in those chapters
- Make an algorithm of your morning routine