

STRUCTURE AND DEVELOPMENT OF COMPUTER PROGRAMS

or, how to write code that lasts like pyramids



99 little bugs in the code.
99 little bugs in the code.
Take one down, patch it around.

127 little bugs in the code...

Gabriele Bozzola

bozzola.gabriele@gmail.com

ORIGINALLY...

From: Joseph Long
To: astro-code-coffee@list.arizona.edu
Subject: [astro-code-coffee] Talk materials posted, next meeting info
Flags: replied, seen, list
Date: Wed 20 Feb 2019 01:44:25 PM MST
Maildir: /bozzolagabriele/[Gmail].All Mail
List: astro-code-coffee.list.arizona.edu
Tags: \Important

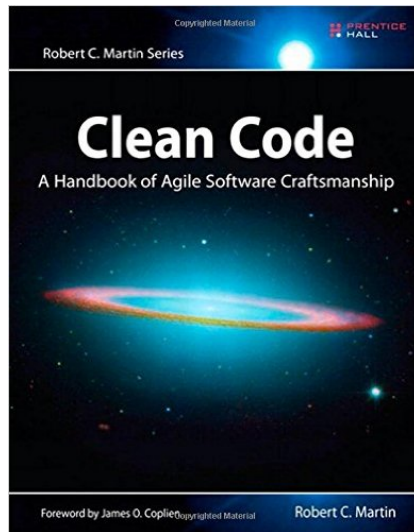
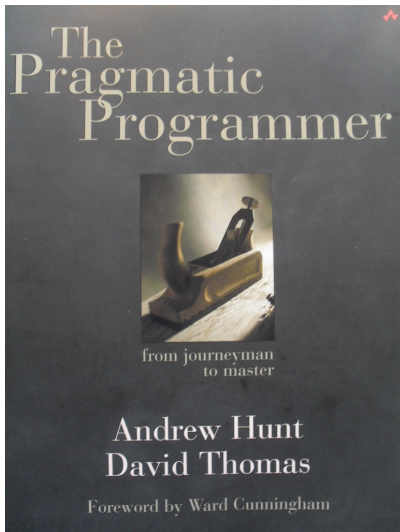
Hi all,

The site has been updated with the slides and example code from Peter Senichyn's talk yesterday:

https://raw.githubusercontent.com/2019-02-19/astro-code-coffee/master/Lecture_010219.pdf

Also, our next meeting will be Tuesday, March 19 at 2pm. Gabriele Bozzola will be presenting on best practices for software development, touching on the following topics:

REFERENCE MATERIAL FOR GOOD CODING PRACTICES



On the Cover

The image on the cover is M104: The Sombrero Galaxy. M104 is located in Virgo and is just under 30 million light-years from us. At its core is a supermassive black hole weighing in at about a billion solar masses.

Does the image remind you of the explosion of the Klingon power moon *Praxis*? I vividly remember the scene in *Star Trek VI* that showed an equatorial ring of debris flying away from that explosion. Since that scene, the equatorial ring has been a common artifact in sci-fi movie explosions. It was even added to the explosion of Alderaan in later editions of the first *Star Wars* movie.

What caused this ring to form around M104? Why does it have such a huge central bulge and such a bright and tiny nucleus? It looks to me as though the central black hole lost its cool and blew a 30,000 light-year hole in the middle of the galaxy. Woe befell any civilizations that might have been in the path of that cosmic disruption.

Supermassive black holes swallow whole stars for lunch, converting a sizeable fraction of their mass to energy. $E = MC^2$ is leverage enough, but when M is a stellar mass: Look out! How many stars fell headlong into that maw before the monster was satiated? Could the size of the central void be a hint?

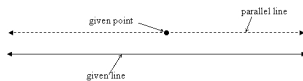
The image of M104 on the cover is a combination of the famous visible light photograph from Hubble (right), and the recent infrared image from the Spitzer orbiting observatory (below, right). It's the infrared image that clearly shows us the ring nature of the galaxy. In visible light we only see the front edge of the ring in silhouette. The central bulge obscures the rest of the ring.

But in the infrared, the hot particles in the ring shine through the central bulge. The two images combined give us a view we've not seen before and imply that long ago it was a raging inferno of activity.

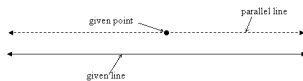


Cover image: © Spitzer Space Telescope

1. POSTULATES



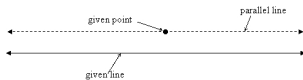
1. POSTULATES



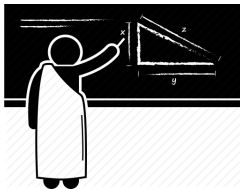
2. THEOREMS



1. POSTULATES



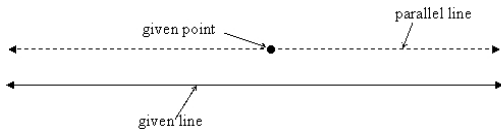
2. THEOREMS



3. APPLICATIONS



1. POSTULATES



What is PROGRAMMING?

PROGRAMMING IS



programming is



programming is **hard**
programming is **so boring**
programming is **fun**
programming is **easy**
programming is **hard reddit**
programming is
programming is **like magic**
programming is **magic**
programming is **included in which core process**
programming is **art**



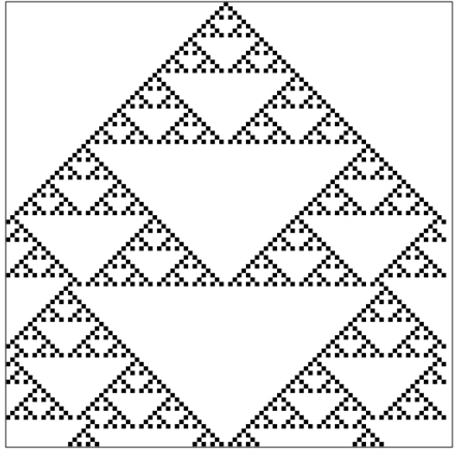
DuckDuckGo

programming is



programming is boring
programming is easy
programming is an art
programming is fun
programming is like writing a book
programming issues
programming is terrible
programming iso rfid tags

**PROGRAMMING IS CONTROLLING
COMPLEXITY**
(with black boxes)

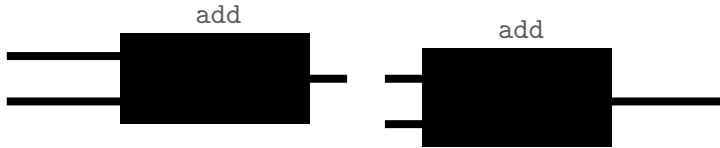


```
add(x, y):  
  z = x + y;  
  return z;
```

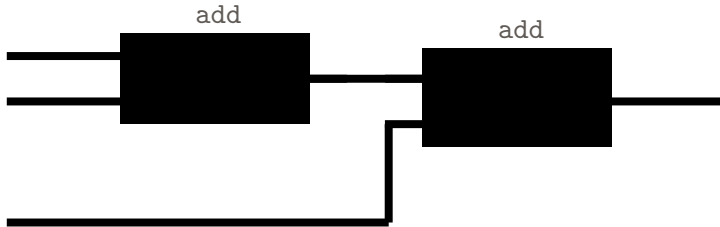
THE BLACK-BOX ABSTRACTION



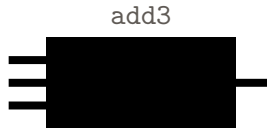
THE BLACK-BOX ABSTRACTION



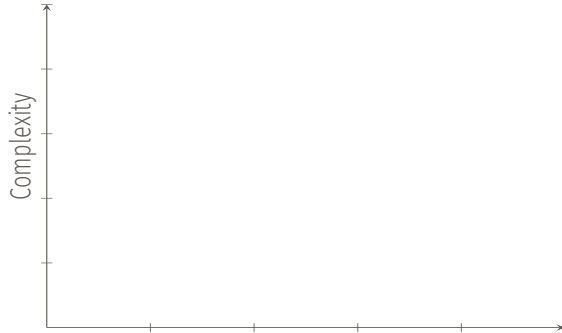
THE BLACK-BOX ABSTRACTION



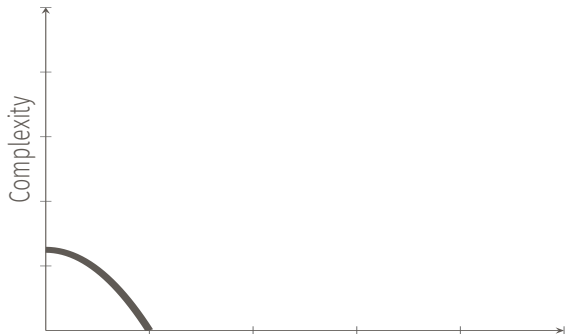




THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY

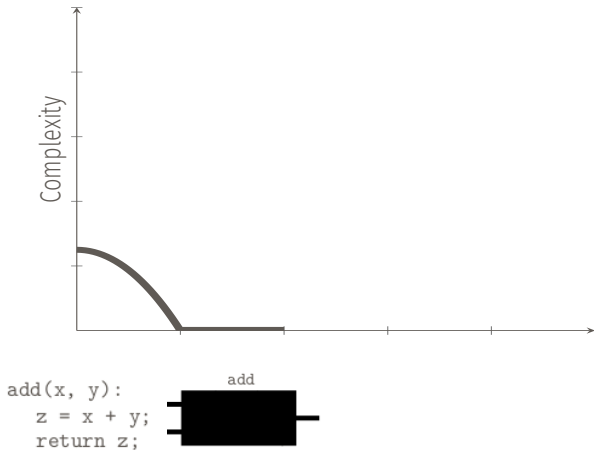


THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY

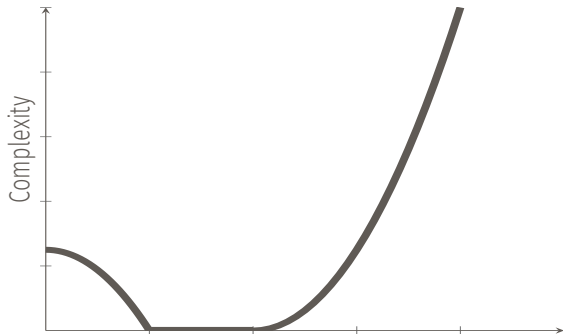


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  return z;
```

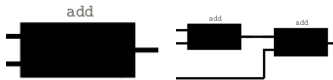
THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY



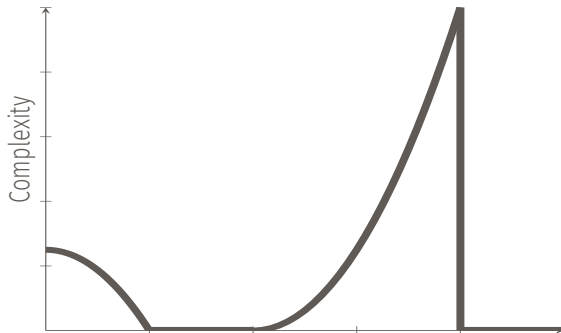
THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY



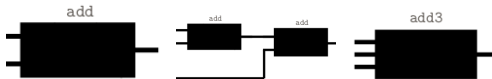
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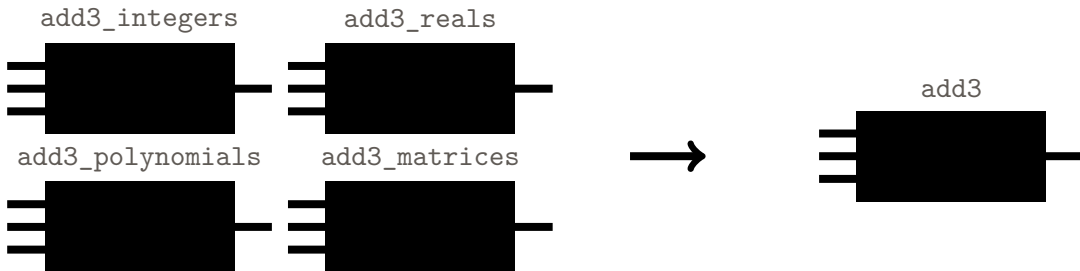
THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY



```
add(x, y):  
  z = x + y;  
  return z;
```



BLACK BOX ABSTRACTION III - POLYMORPHISM AND COMMON INTERFACES

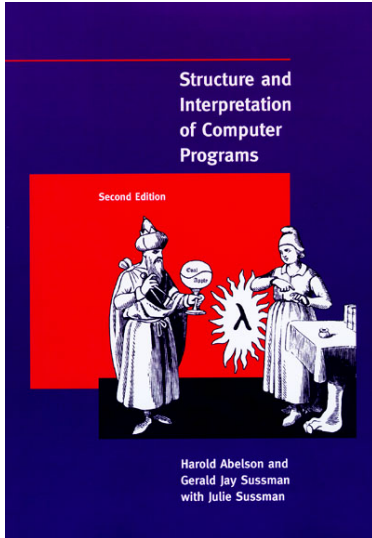


FUNCTIONS SHOULD DO ONE THING. THEY SHOULD DO IT WELL. THEY SHOULD DO IT ONLY.



Programming = controlling complexity

Complexity is lowered by black boxes
and polymorphism



Download for free [here](#)


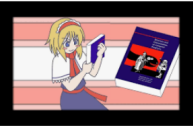









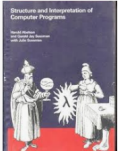
SICP IS FUN

Google search results for "sicmp".

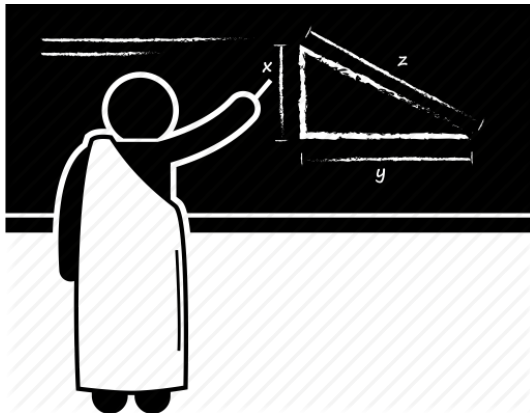
Navigation: All, Videos, **Images**, Books, Shopping, More, Settings, Tools. Collections, SafeSearch.

Character filters: anime girl, satori, wizard, patchouli, 4chan, touhou, lambda, hardcover, patchouli knowledge.

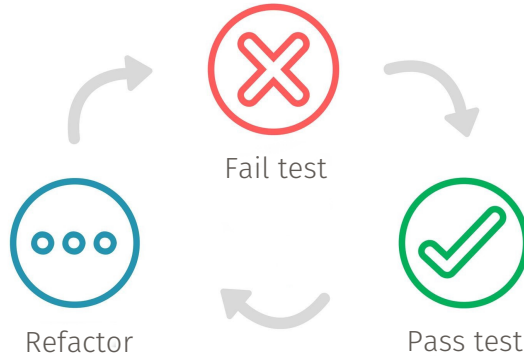
Search results:

- 
Computer Programs ...
en.wikipedia.org
- 
SICP Anime Opening (1080p) - YouTube
youtube.com
- 
SICP Quotes (@SICPQuotes) ...
twitter.com
- 
SICP and Me - Slava Kim - ...
medium.com
- 
sicmp
sicmp.shithouse.tv
- 
SICP Distilled by thattommyhall ...
kickstarter.com
- 
Interpretation of Computer ...
amazon.com
- 
SICP VN Projekt
sicmpvn.sdf.org
- 
SICP
dabeaz.com
- 
Wizard Book: Structure and ...
xahlee.info
- 
Welcome to SICP Distilled
sicmpdistilled.com
- 
Computer Programs by Har ...
goodreads.com

2. THEOREMS



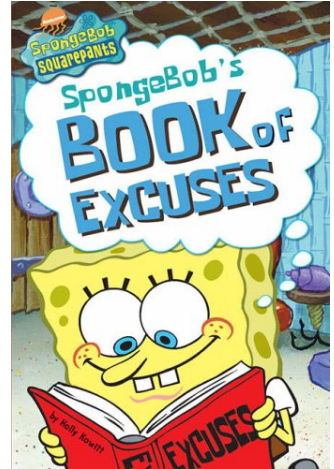
TEST-DRIVEN DEVELOPMENT



BUT...

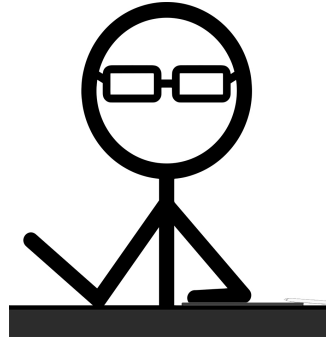
But I cannot spend that much time on coding!

- I need to publish those results!
- My collaboration needs me!
- The yogurt I have in my fridge is expiring!
- ...



«I have no faith in humans. I have faith in systems.»

Development environments and workflows must be frictionless





TDD = atomic commits + tests

(Read [here](#) how to write a good commit message)

Commits in --all

```
b96e770 * master origin/master Last fix/  
2146099 * Final fixes  
83f2a87 * Fixes  
93c0763 * Finish  
016a40a * Daily fixes  
61a73e9 * Fix errors  
393427b * Minor fixes  
4db9376 * Daily fixes  
04ca3ca * Daily fixes  
701b438 * Added pdf in last commit  
2bd51fc * Fixes  
c8ebf3e * Minor fixes  
20f20bc * Fixes  
e7e11cb * Various fixes  
92503a5 * Update  
234cd23 * Fixes
```

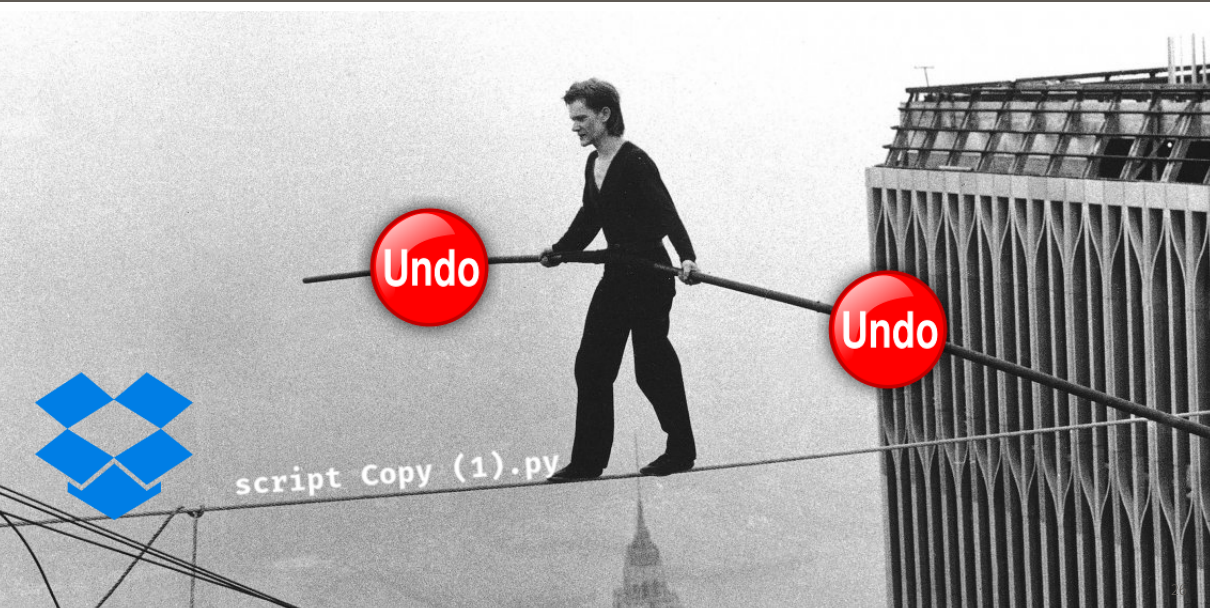
```
Commits in --all
b96e770 * master origin/master Last fix/ Gabriele Bozzola
2146099 * Final fixes Gabriele Bozzola
83f2a87 * Fixes Gabriele Bozzola
93c0763 * Finish Gabriele Bozzola
016a40a * Daily fixes Gabriele Bozzola
61a73e9 * Fix errors Gabriele Bozzola
393427b * Minor fixes Gabriele Bozzola
4db9376 * Daily fixes Gabriele Bozzola
04ca3ca * Daily fixes Gabriele Bozzola
701b438 * Added pdf in last commit Gabriele Bozzola
2bd51fc * Fixes Gabriele Bozzola
c8ebf3e * Minor fixes Gabriele Bozzola
20f20bc * Fixes Gabriele Bozzola
e7e11cb * Various fixes Gabriele Bozzola
92503a5 * Update Gabriele Bozzola
234cd23 * Fixes Gabriele Bozzola
```

Commits in --all

```
e27ef00 * master origin/master Remove epsilon from TCP
e5e3dc7 * Update Ocelote config files
0fdaed6 * Modernize convergence study in TCP
130b24d * Allow for zero v and a in TCP
5b96f04 * Make RN fields as default EM fields
10cf892 * Add support for pickles
ba49b1f * Improve error handling in __getattr__ in Thorn
7ae2d56 * Add common plot options (and improve vector fields)
3461adc * Remove VolumeIntegral from SimDir
27da9d0 * Fix rendering of variables with underscores in the name
7058055 * Add tentative complete list of thorns with UAThorns
f959ffc * Update hwloc for ocelote
```

In case of desperation: **whatthecommit.com**

DEVELOPING WITHOUT VERSION CONTROL



script Copy (1).py

THE GOLDEN HAMMER

Golden hammer is excessive dependence on a specific tool to perform many different functions.



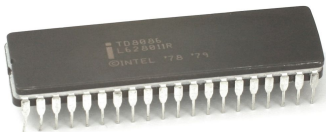
THE WAIT CALCULATION - THE BIG PROBLEM WITH INTERSTELLAR TRAVEL



WHICH IS MORE CONVENIENT?

It's 1978, you have to calculate the first 1M digits of π .

Option 1:



Option 2:



Sometimes it is worth spending time learning something new!

Sometimes it is worth spending time learning something new!

But also, double-down on tools

DO YOU KNOW HOW TO?

- Search and replace (with regexps)
- Do rectangular selections
- Rename multiple files
- Record and re-play keyboard macros
- Use a debugger
- Visualize images/edit files on remote machines
- Generate documentation
- Automate the boring stuff

Read **here** why Jupyter Notebooks are ineffective development tools

3. APPLICATIONS



Example: test-driven development of `add2` and `add3`

Goal: write a program that takes two or three integers and returns the sum