STRUCTURE AND DEVELOPMENT OF COMPUTER PROGRAMS

or, how to write code that lasts

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

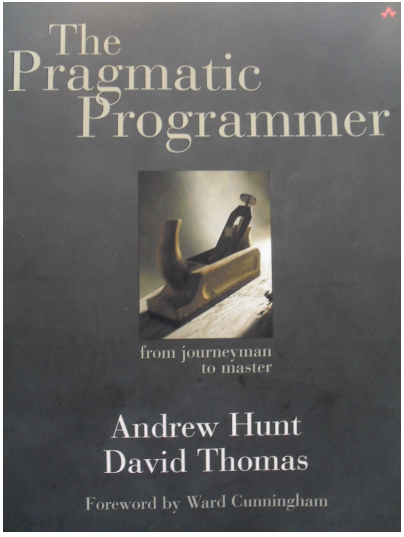
Hi all,

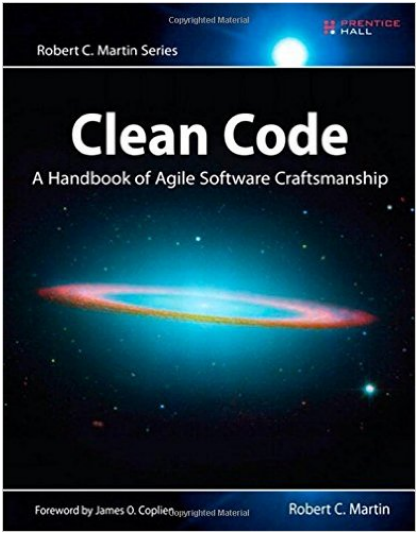
The site has been updated with the slides and example code from Peter Senchyna's talk yesterday:

https://sw-astro-grads.github.io/2019/02/19/interactive-visualization.html

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 it's 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.

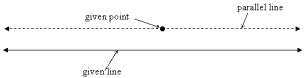
Supermassive black holes swallow whole stars for lunch, converting a sizeable fraction of their mass to energy. $E = MC^2$ is leverage enough, but when M is a stellar mass: Look out! How many stars fell headlong into that maw before the monster was satiated? Could the size of the central void be a hint?

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.

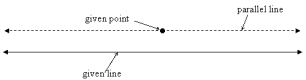
Cover image: © Spitzer Space Telescope

1. POSTULATES

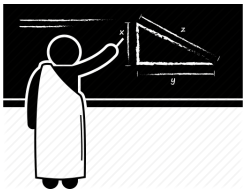


OUTLINE

1. POSTULATES

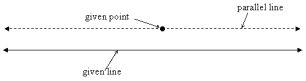


2. THEOREMS

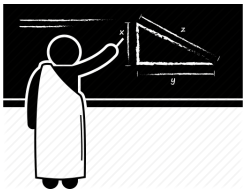


OUTLINE

1. POSTULATES

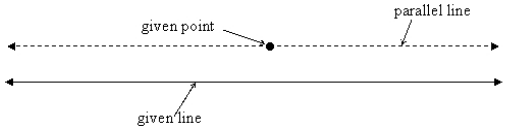


2. THEOREMS



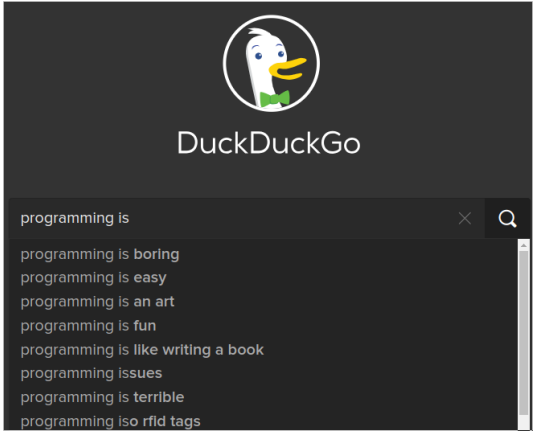
3. APPLICATIONS

1. POSTULATES



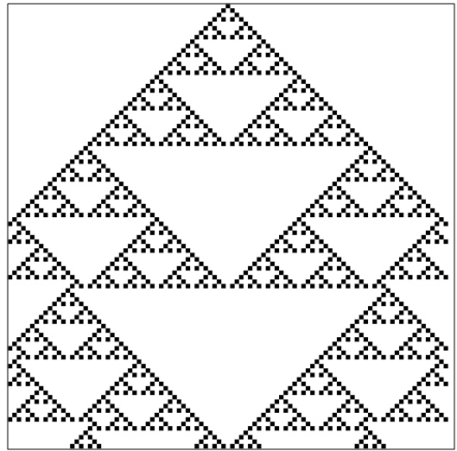
What is PROGRAMMING?

PROGRAMMING IS



PROGRAMMING IS CONTROLLING COMPLEXITY

(with black boxes)



THE BLACK-BOX ABSTRACTION

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

THE BLACK-BOX ABSTRACTION

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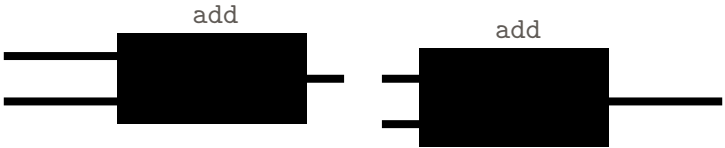

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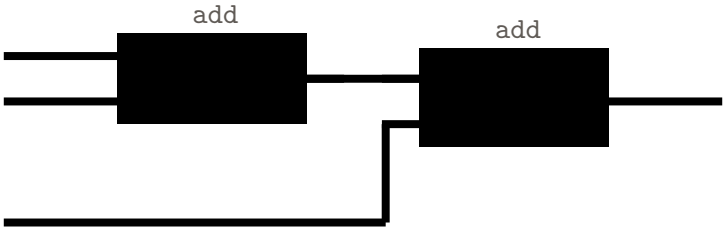

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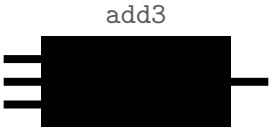
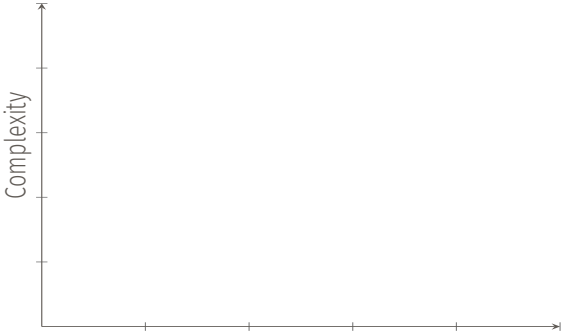


THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY



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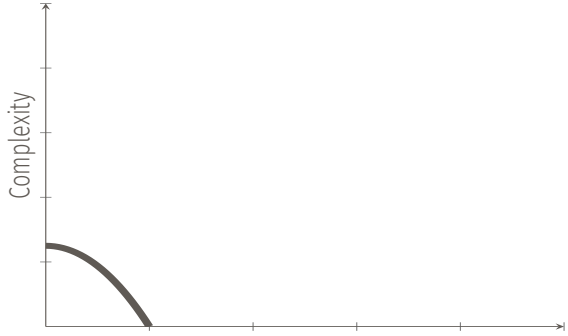


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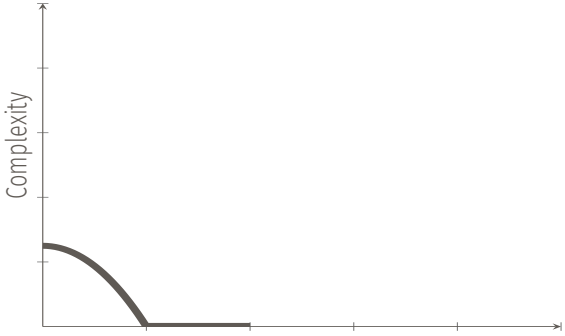


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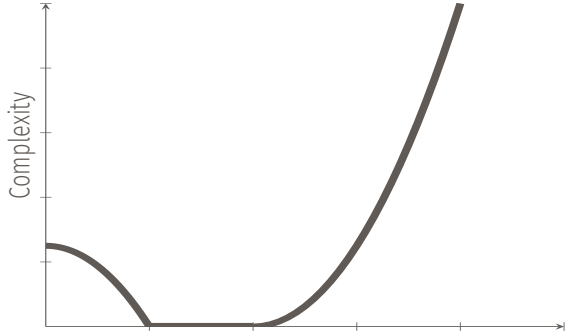
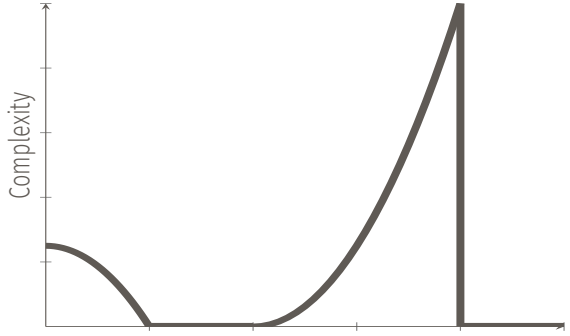


THE BLACK-BOX ABSTRACTION II -- CONTROLLING COMPLEXITY



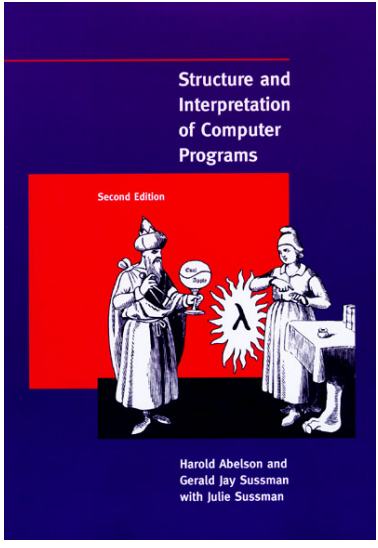
BLACK BOX ABSTRACTION III - POLYMORPHISM AND COMMON INTERFACES

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

box

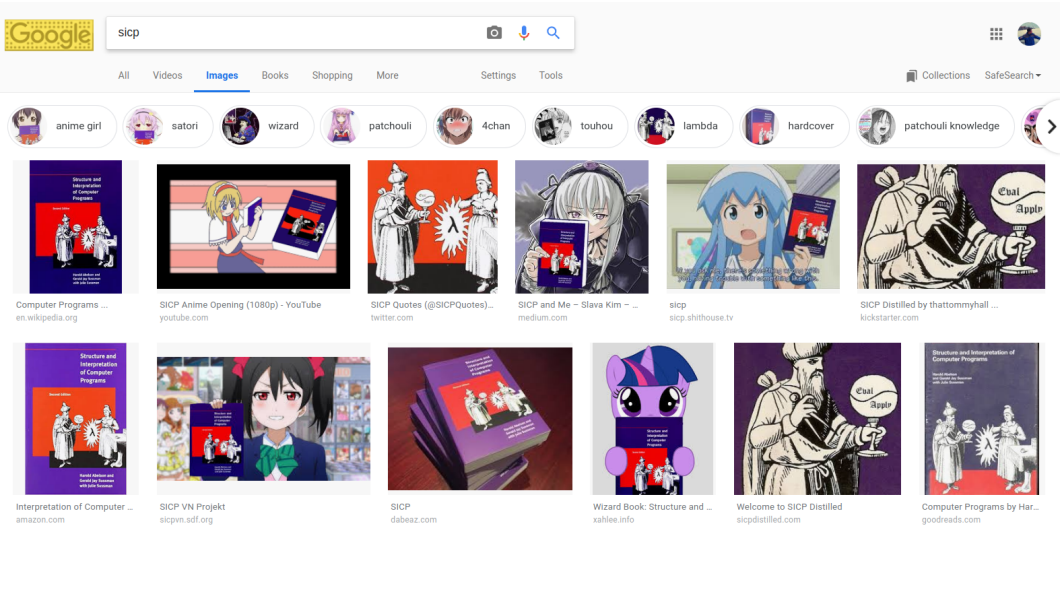
contract

IF YOU WANT TO GO DEEP



Download for free **here**

SICP IS FUN


Google
sicp
All
Videos
Images
Books
Shopping
More
Settings
Tools
Collections
SafeSearch
anime girl
satori
wizard
patchouli
4chan
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lambda
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Structure and Interpretation of Computer Programs
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SICP and Me – Slava Kim – ...
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sicp.shithouse.tv
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SICP Distilled by thattommyhall ...
kickstarter.com
Interpretation of Computer ...
amazon.com
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xahlee.info
Welcome to SICP Distilled
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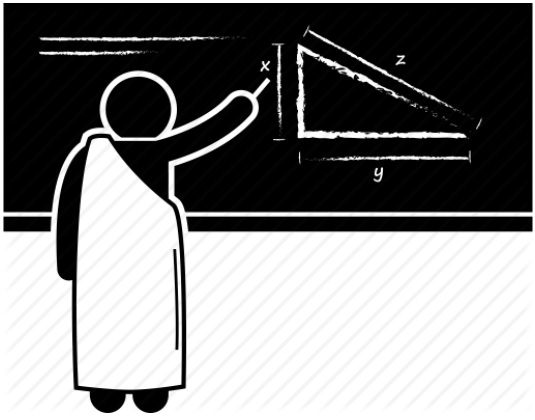
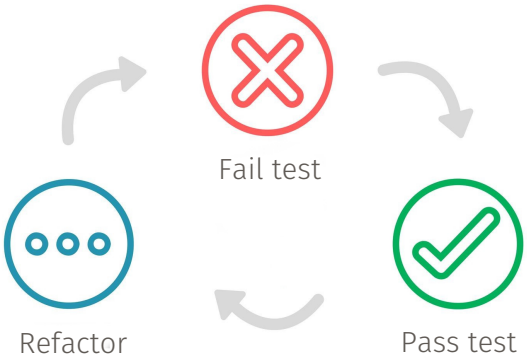
Computer Programs by Har...
goodreads.com

2. THEOREMS



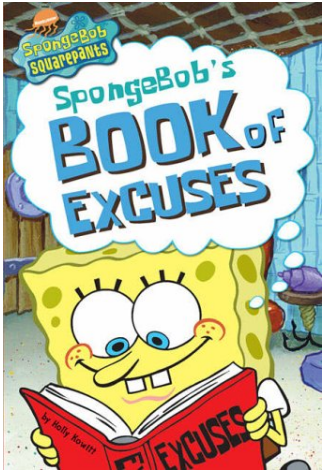
TEST-DRIVEN DEVELOPMENT



BUT...

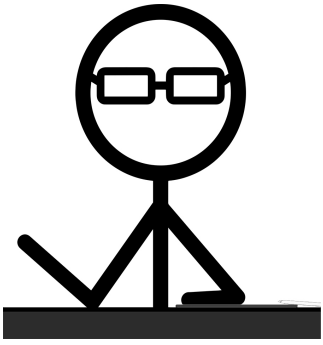
But I cannot spend that much time on coding!

- → I need to publish those results!
- → My collaboration needs me!
- → The yogurt I have in the fridge is about the expire!
- → ...



«*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)

GIT ROLE MODELS

```
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
```

GIT ROLE MODELS

```
Commits in --all
b96e770 * master origin/master Last fix/   Gabriele Bozzola
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83f2a87 * Fixes                            Gabriele Bozzola
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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
```
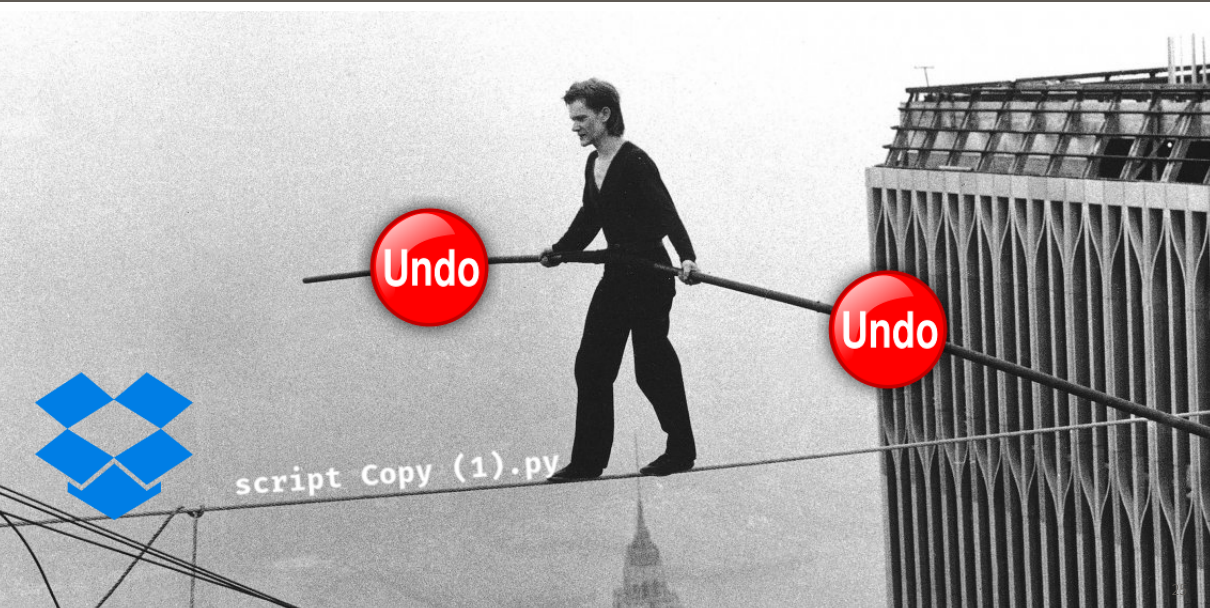

GIT ROLE MODELS

```
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



THE GOLDEN HAMMER

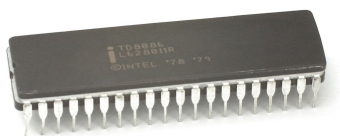
Golden hammer is excessive dependence on a specific tool to perform many different functions.

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