

# Alternatives in physics: Tales from a computational physicist outside academia.

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# BACKGROUND



UNIVERSIDAD  
**NACIONAL**  
DE COLOMBIA



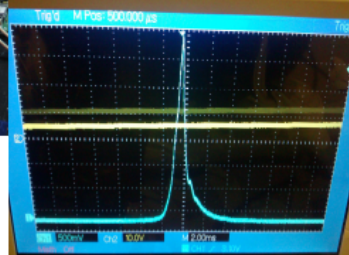
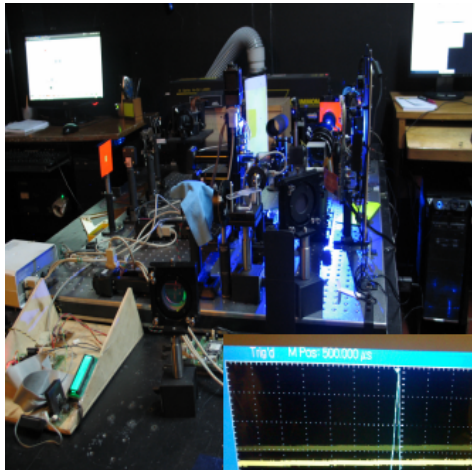
**ssf+un**  
Grupo de Simulación  
de Sistemas Físicos

Departamento de Física  
Profesor José Daniel Muñoz

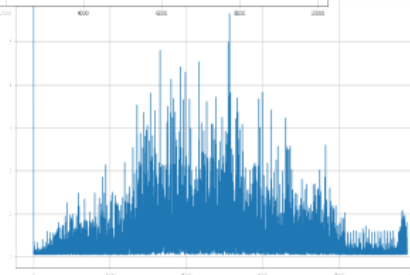
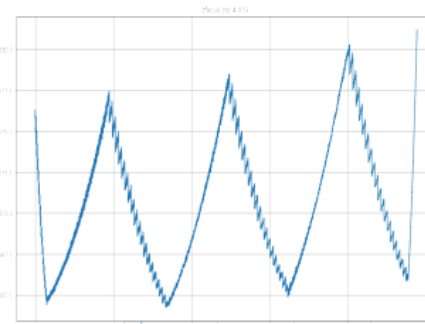


**SO, WHAT DO I DO?**

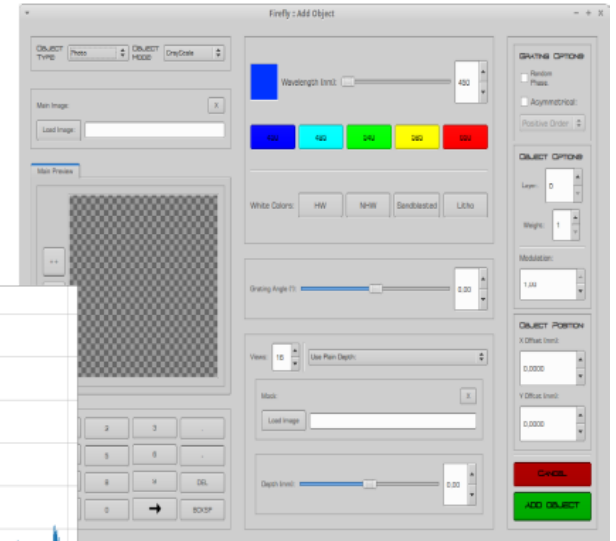
# Professionally



Optical testing

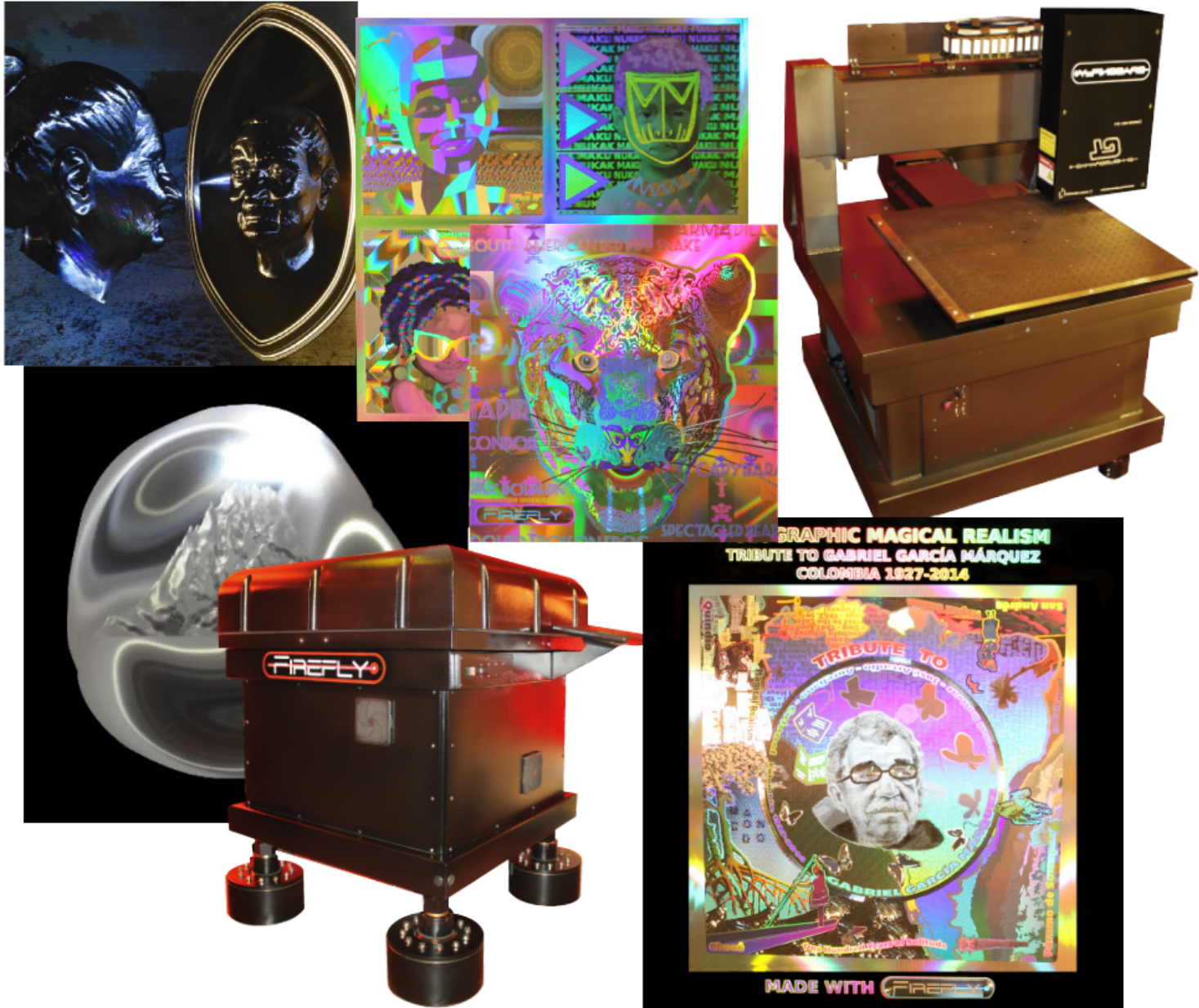


Data Analysis  
Electronic control



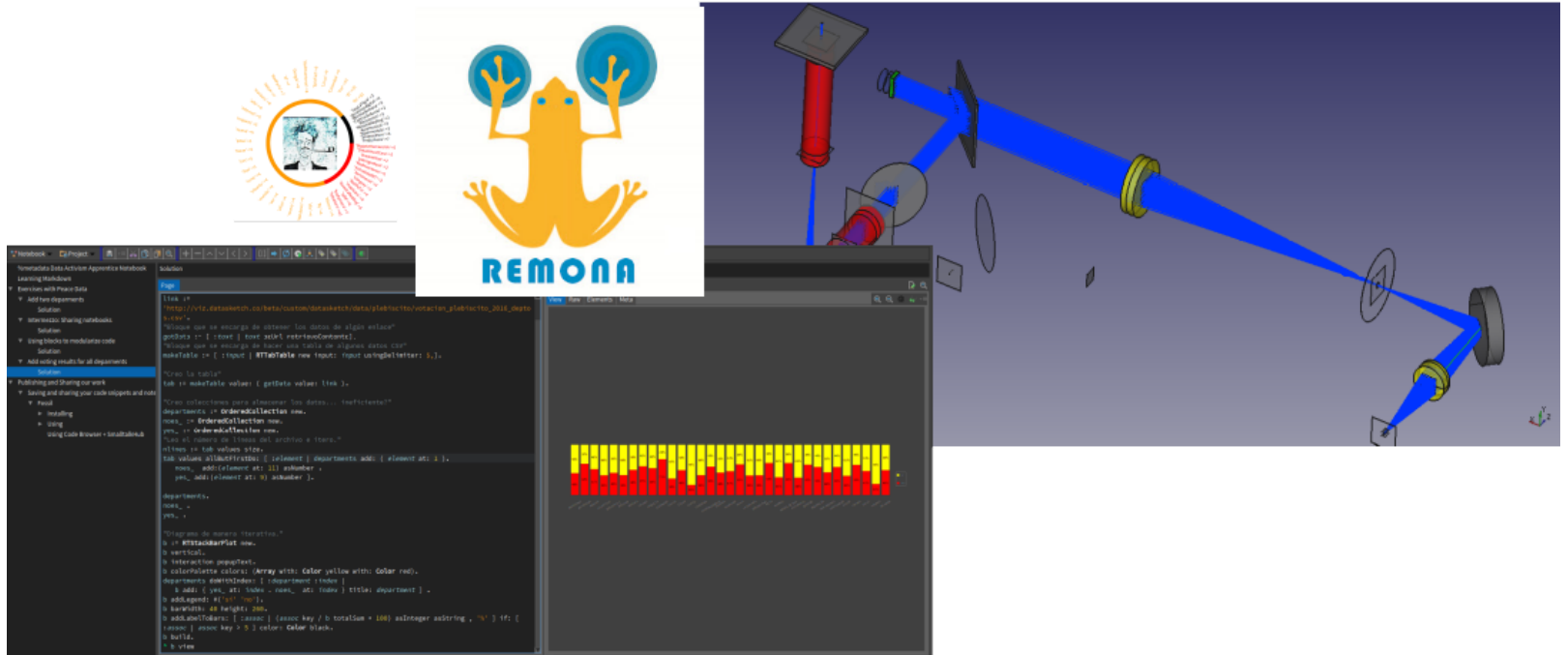
Software Dev.

... for technology innovation





# Activism and giving back to society



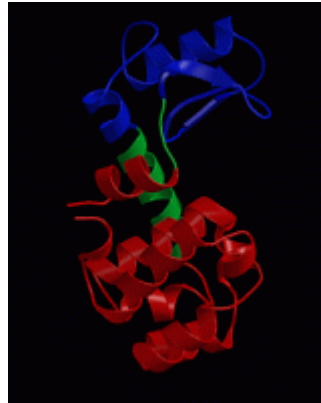
Reproducible Research

Citizen Science

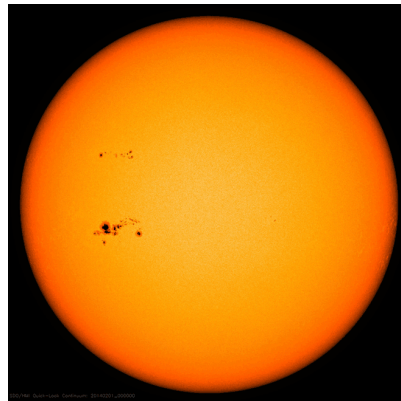
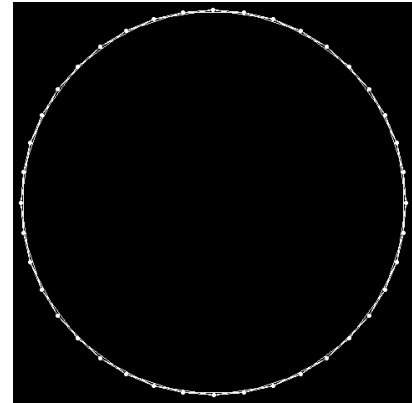
Free/Open-Source Software

# Last but not least... for fun

## Computational Biophysics



## Complexity/Visualization





Common factor: **Scientific Computation & Problem solving**

*The purpose of computing is insight, not numbers.* R. Hamming

**WHAT DO I USE?**

## Literate computing: Beyond just coding

- The proper/comfortable tool for the purpose (C/C++, Python, Smalltalk, etc.)
- Jupyter (<http://jupyter.org/>) environment.
- Grafoscopio (<http://mutabit.com/grafoscopio/>): home-made, community-based.

# Example

```
In [33]: IFrame("https://hub.mybinder.org/user/ijpulidos-statmech-92p0rg3v/notebooks/ex1.7/Exercise%201.7.ipynb", width=1000, height=600)
```

Out[33]:

Oops!

We can't seem to find the Binder page you are looking for.

404 error

Here are some helpful tips.

Is this a Binder that you created?

Your Binder stopped due to an error or it was removed due to age or inactivity.

Return to the [Binder home page \(https://mybinder.org\)](https://mybinder.org) to retry creating your Binder.

Did someone give you this Binder link?

If so, the link is outdated or incorrect. Recheck the link for typos or ask the person who gave you the link for an updated link. A shareable Binder link should look like `https://mybinder.org/v2/gh/...`

[Binder home page \(https://mybinder.org\)](https://mybinder.org)

# Organizing code and more

Imagine organizing projects like this

Language	files	blank	comment	code
C++	11	1228	1190	3603
C/C++ Header	15	938	768	3524
Python	18	742	418	2814
Cython	9	382	432	1563
XML	7	0	0	950
Bourne Shell	2	18	23	57
make	3	32	18	45
SUM:	65	3340	2849	12556

- Knowing what you did to not repeat mistakes and easily find them.
- Share, publish and contribute code (or more).
- Tools that allow feedback from devs, users or general public.
- Organize ideas, execute and follow development of projects.
- Examples:
  - Version control: fossil, mercurial, git.
  - UIs and project managers: Github, bitbucket, redmine.

# Version control systems

The screenshot displays the TortoiseHg Workbench interface for the 'firefly-control' repository. The interface is divided into several panels:

- Repository Registry:** A list of repositories on the left, including 'firefly-control', 'firefly-compiler', 'firefly\_v2\_p\_manager', 'firefly-manuals.manual', 'dragonfly-control', 'dragonfly-hardware', 'firefly-hardware.fv2', 'vccam-focus', 'it-management.cibackup', 'firefly-hardware.ff-horizontal', 'usbkey', 'litografia-software.aerotech-softw...', 'vccam-focus.1', 'software-tools', 'vccam-focus', 'control-luces.1', 'control-luces.arduino-3.0', 'screenlock', 'planimetria.general', 'planimetria.pdfs', 'litografia-software.firefly-lights-be...', 'firefly\_v2.webui', 'ivan.lbm-optics', and 'REMOTE - litografia-software.firefly...'.
- Graph:** A commit history graph showing a sequence of commits. The current commit is 1050+ on the 'beagle\_TEC' branch.
- Table:** A table of commits with columns: Graph, Rev, Branch, Description, Author, Age, Tags, and Phase. The table lists several commits, including a tip commit (1050) and a merge commit (#3239).
- Changeset:** A detailed view of the selected commit (1050), showing the commit message and the changes made. The changeset includes a file named 'exposure/holoprinter.pyx'.
- Code Editor:** A code editor showing the content of the 'exposure/holoprinter.pyx' file. The code includes comments in Spanish and Python code for logging, opening the shutter, and configuring the server.

Graph	Rev	Branch	Description	Author	Age	Tags	Phase
	1050+	beagle_TEC	★ Working Directory ★	Ivan Pulido	now		
	1050	beagle_TEC tip	beagle_TEC tip Hago que se inicie el control de temperatura antes de iniciar holograma y se pare después de holograma. ...	Ivan Pulido	4 days	tip	public
	1049	beagle_TEC	Agrego comando en cliente para habilitar y deshabilitar control de temperatura, con compatibilidad con luces viejs (arduino). Refs #3265	Ivan Pulido	5 days		public
	1048	beagle_TEC	Se cambia rutina de calentamiento, ahora detecta si es beagle o arduino.	Ivan Pulido	5 days		public
	1047	default	default Version 2.1a.3 marcada	Buildbot	7 days		public
	1046	default	2.1a.3 Actualizando archivo de revision para creacion del deb	Buildbot	7 days	2.1a.3	public
	1045	default	Merge with #3239	Oscar Rincon	7 days		public
	1044	#3239	#3239 Se cambia el deg2rad por un problema numerico con los decimales	Oscar Rincon	2 weeks		public
	1043	default	Version 2.1a.2 marcada	Buildbot	7 days		public
	1042	default	2.1a.2 Actualizando archivo de revision para creacion del deb	Buildbot	7 days	2.1a.2	public
	1041	V2.0	V2.0 Version 2.0.2 marcada	Buildbot	7 days		public
	1040	V2.0	2.0.2 Actualizando archivo de revision para creacion del deb	Buildbot	7 days	2.0.2	public
	1039	#3239	cambios hechos para implementar una correccion del Moiré en la longitud de onda de los rainbows	Oscar Rincon	3 weeks		public
	1038	V2.0	Se hace que remueva los handlers para el "logging" cuando hace un reset. Fixes #3229 .	Ivan Pulido	5 weeks		public
	1037	default	Se hace que remueva los handlers para el "logging" cuando hace un reset. Fixes #3229 .	Ivan Pulido	5 weeks		public

```
### filter text ###
exposure/holoprinter.pyx
exposure/litoprinter.pyx

Changeset: 1050 (d4c8bc22e401) Hago que se inicie el control de temperatura antes de iniciar holograma y se pare después de holograma. ...
Hago que se inicie el control de temperatura antes de iniciar holograma y se pare después de holograma.
Hago que en la rutina heat se asegure de que está controlando temperatura. Refs #3265

exposure/holoprinter.pyx

- 952,9 +952,10 @@
logger.info("gray_limits = {}".format(gray_limits))
logger.info("subsampling = {}".format(args.subsampling))

# Abrir el shutter antes de exponer cada holograma
# Abrir el shutter y habilitar control de temperatura (beagle) antes de exponer cada holograma
lightclient = LightClient()
lightclient.shutter = "open"
lightclient.temperature_control = True

# Configurar el servidor de enfoque
- 1010,6 +1010,9 @@

# Cerrar shutter al terminar impresión
lightclient.shutter = "close"
```

# Project management

Peticiones - Firefly-Compiler - Intranet CI-Hologramas - Mozilla Firefox

Peticiones - Firefly-Compiler X +

alfred.ici/redmine/projects/firefly-compiler/issues Work ... Search

Inicio Mi página Proyectos Projects treeview Administración Ayuda Conectado como ljpulidos MI cuenta Terminar sesión

Grupo de desarrollo » Firefly-Compiler Búsqueda: » Firefly-Compiler

Vistazo Actividad Planificación **Peticiones** Nueva petición Gantt Calendario Noticias DMSF Documentos Wiki Archivos Repositorio Revisiones de Código Configuración

## Peticiones

▼ Filtros

☒ Estado abierta ▼ Añadir el filtro ▼

► Opciones

✓ Aceptar Anular Guardar

✓ # ▼	Proyecto	Tipo	Estado	Prioridad	Asunto	Asignado a	Actualizado	Fecha de inicio	Fecha fin	Versión prevista
<input type="checkbox"/> 3248	Firefly-Compiler	Errores	Nueva	Normal	Exposure manager se muere si hay problema de permisos de uno de los archivos de la lista	Ricardo Amezcuita	27/03/2018 17:18	27/03/2018		
<input type="checkbox"/> 3242	Firefly-Compiler	Errores	Nueva	Normal	Problema con imagen de un proyecto	Ricardo Amezcuita	23/03/2018 09:34	23/03/2018		2.0
<input type="checkbox"/> 2569	Firefly-Compiler	Errores	Nueva	Inmediata	Bug en generacion de photo-depthmap	Oscar Julian Rincón	01/08/2017 11:54	01/08/2017		1.5
<input type="checkbox"/> 1832	Firefly-Compiler	Tareas	Nueva	Normal	Cambiar el simetrico de onda sinusoidal a binaria	Oscar Julian Rincón	10/05/2017 11:35	23/11/2016		
<input type="checkbox"/> 1752	Firefly-Compiler	Tareas	Nueva	Normal	Implementacion del	Ricardo	21/11/2016 10:59	19/10/2016		1.4

### Peticiones

[Ver todas las peticiones](#)  
[Resumen](#)  
[Calendario](#)  
[Gantt](#)

### Consultas personalizadas

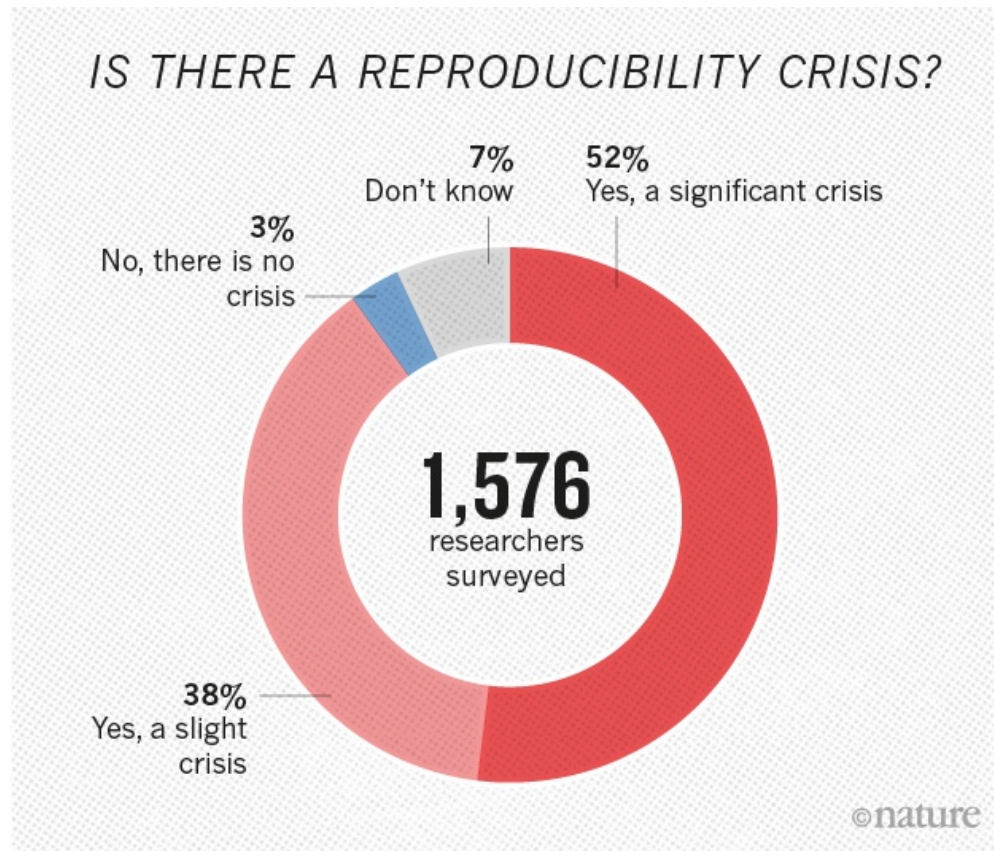
[Done](#)  
[PorEstado](#)



**WHY? PURPOSE?**

# Proper science

- **Reproducibility issues:** Pressure and not enough information.
- **Dynamic publications:** Science content nowadays is anything but static.
- **Papers as just a product:** For profit editorials, more than Coca Cola?
- **Tackle misconceptions.**
- **Immediate publish-ready results**



## Academia $\leftrightarrow$ Industry

- Nothing fundamentally wrong with just academia and paper publishing, but...
- When you are off the pressure of just publishing traditionally you can actually get things done.
- Local innovation and science jobs.
- Creativity circle between academia and industry. Tools from academia powering industry and back.

## Automatization and interdisciplinarity

- Tools for automatizing tedious research tasks.
- Let the less knowledgeable understand and play with your work.
- Tell your stories with science and data.
- Teach science in a different and modern way.

```
In [26]: IFrame("http://nbviewer.jupyter.org/github/barbagroup/CFDPython/blob/master/lessons/16_Step_12.ipynb", width=1000, height=600)
```

Out[26]:

Did you make it this far? This is the last step! How long did it take you to solve the Navier-Stokes solver in Python following this interactive module? Let us

## Step 12: Channel Flow with Navier-Stokes

---

The only difference between this final step and Step 11 is that we are going to add a pressure term to the  $u$ -momentum equation, to mimic the effect of a pressure-driven flow. Here are our modified Navier-Stokes equations:

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = -\frac{1}{\rho} \frac{\partial p}{\partial x} + \nu \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right)$$

$$\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} = -\frac{1}{\rho} \frac{\partial p}{\partial y} + \nu \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} \right)$$

$$\frac{\partial^2 p}{\partial x^2} + \frac{\partial^2 p}{\partial y^2} = -\rho \left( \frac{\partial u}{\partial x} \frac{\partial u}{\partial x} + 2 \frac{\partial u}{\partial y} \frac{\partial v}{\partial x} + \frac{\partial v}{\partial y} \frac{\partial v}{\partial y} \right)$$

### Discretized equations

With patience and care, we write the discretized form of the equations.

## Some references

- <https://www.nature.com/news/1-500-scientists-lift-the-lid-on-reproducibility-1.19970> (<https://www.nature.com/news/1-500-scientists-lift-the-lid-on-reproducibility-1.19970>)
- <http://blog.fperez.org/2013/04/literate-computing-and-computational.html> (<http://blog.fperez.org/2013/04/literate-computing-and-computational.html>)
- [Sethna, J. P., \(2017\) Statistical Mechanics: Entropy, Order Parameters and Complexity](http://pages.physics.cornell.edu/~sethna/StatMech/) (<http://pages.physics.cornell.edu/~sethna/StatMech/>)
- <http://jakevdp.github.io/blog/2017/03/03/reproducible-data-analysis-in-jupyter/> (<http://jakevdp.github.io/blog/2017/03/03/reproducible-data-analysis-in-jupyter/>)
- <http://jakevdp.github.io/blog/2013/10/26/big-data-brain-drain/> (<http://jakevdp.github.io/blog/2013/10/26/big-data-brain-drain/>)
- [Berendsen, et al. \(1995\) Comp. Phys. Comm. 91: 43-56.](https://www.sciencedirect.com/science/article/pii/001046559500042E?via%3Dihub) (<https://www.sciencedirect.com/science/article/pii/001046559500042E?via%3Dihub>)