Science and Open Source

What do we learn from each other?
Who am I?

- Both a mathematician and a computer scientist.

- I do combinatorics.
def int mperms(p1,p2):
    m = len([i for i in p1 if i==1])
    return perm_to_mperm(inf_perms(mperm_to_perm(p1),mperm_to_perm(p2)),m)

def is_last(perm,i):
    for b in perm[i+1:]:
        if b == perm[i]:
            return False
    return True

def mperm_to_tree(perm):
    values = list(set(perm))
    values.sort()
    values.reverse()
    m = len(perm) / len(values)
    tree = MDescendingTree(m+1,None)
    for v in values:
        tree = tree.insert_from_mperm(perm,v)
    return tree

def mperm_to_tree2(perm, mfor0 = 1):  # tested 2,2 to 2,5
    if len(perm)==0:
        return MDescendingTree(mfor0,None)
    n = max(perm)
    posr = [i for i in xrange(len(perm)) if perm[i]==n]
    m = len(posr)
    children = [[] for i in xrange(m+1)]
    right = {a for a in perm if a!=n}
    for i in xrange(m):
        pos = posr[i]
        for j in xrange(pos-1,-1,-1):
            a = perm[j]
            if a!=n:
                if is_last(perm,j):
                    if a in right:
                        children[i].append(a)
                        right.remove(a)
                elif a in right:
                    right.update({aa for aa in children[i] if aa < a})
                    children[i] = {b for b in children[i] if b > a}
        children[i] = list(right)
    children_trees = [mperm_to_tree2([a for a in perm if a in c], mfor0=m) for c in children]
    return MDescendingTree(m+1,children_trees, label=n)

#tested 3,2 to 3,4
def test_sup_max_classes(m,n):
    maxs = list(max_classes(m,n))
My research relies on code. For every paper I write, there is a program somewhere with experiments and tests.

To know more: see *Experimental pure mathematics using Sage*. 
Science and Software


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What about math?
39 computer algebra systems listed on Wikipedia.
Some non open-source

- Maple: $2275 (Commercial), $2155 (Government), $1245 (Academic), $239 (Personal), $99 (Student)
- Mathematica: $2495 (Professional), $1095 (Education), $295 (Personal), $140 (Student)
- Magma: $1440

(numbers from Wikipedia)
The shared values of science and open-source

As a scientist, I want to contribute.

As a scientist, I want to create knowledge... and share it.

All my papers are accessible.

All my teaching material is open-source.

All my code is open-source.

As a scientist, I collaborate.

Joining forces to create something better.

As a scientist, I want my results to be re-used and improved.
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As a scientist, I need to write open-source
I’m not the only one...
As a scientist, I need to write open-source
I’m not the only one...

Richard Stallman
creator of Free Software Foundation
MIT

Donald Knuth
creator of TeX
Stanford
Math and open-source

A whole ecosystem of open-source math software.
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- Specialized libraries: GAP, Linbox, Pari/GP, MPIR, Singular,...
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- General purpose systems: SageMath
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- General purpose systems: SageMath
- Interactive computing environments: IPython/Jupyter, CoCalc
Math and open-source

A whole ecosystem of open-source math software.

- Specialized libraries: GAP, Linbox, Pari/GP, MPIR, Singular,...
- General purpose systems: SageMath
- Interactive computing environments: IPython/Jupyter, CoCalc
- Together with the wider Scientific Python ecosystem
The SageMath project

▶ Started in 2005 by William Stein
▶ Built around many pre-existing software.
▶ Grew its own python (and cython) library on top of it.
▶ And a vibrant community.
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- Built around many pre-existing software.
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- And a vibrant community.
Currently, 271 contributors
Me and Sage

The combinatorics community “moved” to SageMath shortly before I joined in 2010.

I am a SageMath native!
The challenges...
The challenges...

We need funding, recognition, and sustainability
The challenges...

**We need funding, recognition, and sustainability**

- Who pays for the project?
The challenges...

**We need funding, recognition, and sustainability**

- Who pays for the project?
- How is the development work valued in the community?
The challenges...

We need funding, recognition, and sustainability

▶ Who pays for the project?
▶ How is the development work valued in the community?
▶ How is your software going to survive?
The SageMath development model

The motto is: **for users, by users**. Mostly developed by researchers:
The SageMath development model

The motto is: **for users, by users**. Mostly developed by researchers: we need **better academic recognition for research software development**.
The SageMath development model

Who does the dirty work?
The SageMath development model

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Packaging, interfaces, install scripts, low level software interaction, etc.
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Low research value, high technical value
56% of academics develop their own research software, only 21% of those have received training in software development.
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*We need Research Software Engineers!*
This requires

- Recurrent funding
- Proper career prospects
- Flexibility over time and missions
We’re trying hard...

to convince our institutions, our governments, that open-source, user driven development is the right way, and it needs sustainable funding to function.
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Success!
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**Success!**

Open Digital Research Environment Toolkit for the Advancement of Mathematics

- Horizon 2020 European Research Infrastructures Work Programme
- A budget of 7.6 millions run by 18 partner institutions in 7 countries
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It was a first step...
The challenges...
The challenges...

We need inclusivity and diversity
The challenges...

We need inclusivity and diversity
We need to develop software *for* everyone, *with* everyone.
Some numbers...
Some numbers...

In academia,

- 88% of Windows users and 93% of Linux users use research software
- 41% of Windows users and 90% of Linux users develop research software

Native Windows SageMath install: 2017 (thank you OpenDreamKit!)
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Some numbers...

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88% of Windows users and 93% of Linux users use research software
41% of Windows users and 90% of Linux users develop research software

Native Windows SageMath install: 2017 (thank you OpenDreamKit!)

Open-source is free to use but can be difficult to access

- Never forget the technical cost.
- Never forget the cultural aspects.
Some other numbers...
Some other numbers...

- 56% of researchers develop their own software,
- 70% of male researchers develop their own software, and only 30% of female researchers do so.
- 92% of researchers use research software (same number for men and women!)
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Lack of training? Lack of confidence? **What can we do?**
Support women coders and women initiative
Check your privileges

- How did you get where you are?
Check your privileges

- How did you get where you are?
- When did you have your first computer?
Check your privileges

- How did you get where you are?
- When did you have your first computer?
- When did you write your first line of code?
Check your privileges

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- What field did you study?
Check your privileges

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- What field did you study?
- When did you first hear about open-source?
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- What country are you from?
- Did your parents go to university?
Check your privileges

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- When did you write your first line of code?
- What field did you study?
- When did you first hear about open-source?
- What country are you from?
- Did your parents go to university?
- What is the color of your skin?
Check your privileges

- How did you get where you are?
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- When did you write your first line of code?
- What field did you study?
- When did you first hear about open-source?
- What country are you from?
- Did your parents go to university?
- What is the color of your skin?
- Are you straight? Non disabled? Cis-gendered?

You want people in, who are not like you.
Remember…
We want software **for everybody, by everybody**.

- Science needs software
- Open science needs open software
- Open software needs Research Software Engineers
- This requires funding, career paths, recognition, etc.
- We all need a diverse community
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Thank you!