
mathematica
workshop
math21a, 11/19/2009
harvard university
oliver knill

- 5 points in grade

- 5 points in grade
- time effort minimal

- 5 points in grade
- time effort minimal
- no extension at all

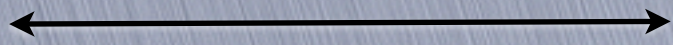
- 5 points in grade
- time effort minimal
- no extension at all
- no electronic submission

- 5 points in grade
- time effort minimal
- no extension at all
- no electronic submission
- no mailbox submissions

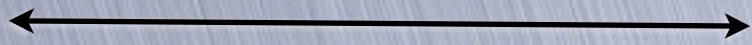
- 5 points in grade
- time effort minimal
- no extension at all
- no electronic submission
- no mailbox submissions
- will be graded by Oliver

- 5 points in grade
- time effort minimal
- no extension at all
- no electronic submission
- no mailbox submissions
- will be graded by Oliver
- is important part of the course

- 5 points in grade
- time effort minimal
- no extension at all
- no electronic submission
- no mailbox submissions
- will be graded by Oliver
- is important part of the course
- gallery of best submissions



already users

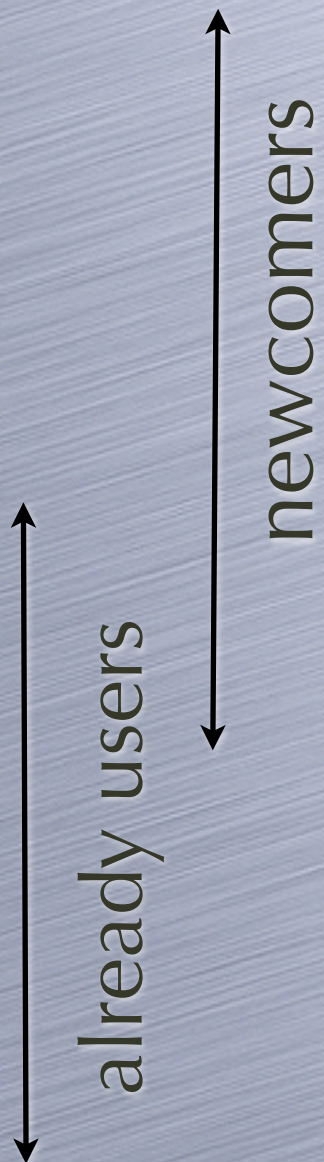


newcomers

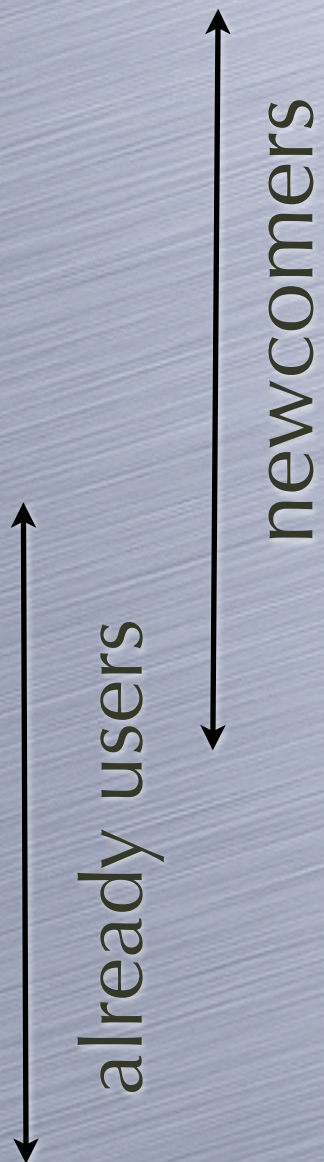
- installation

newcomers

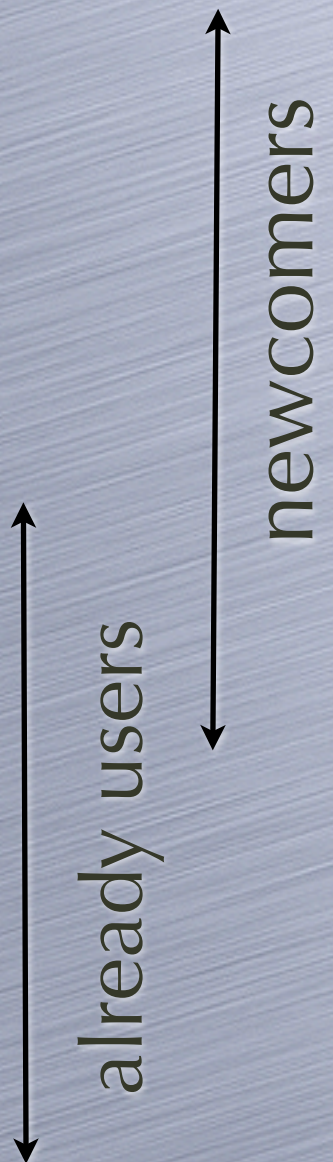
already users



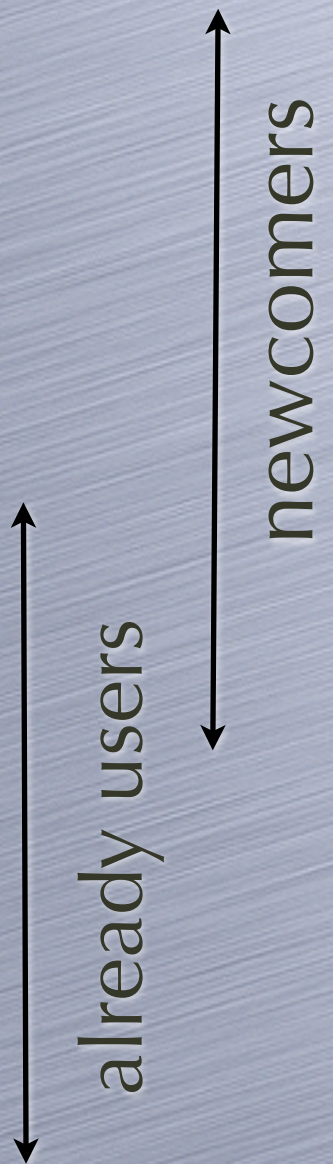
- installation
- the user interface



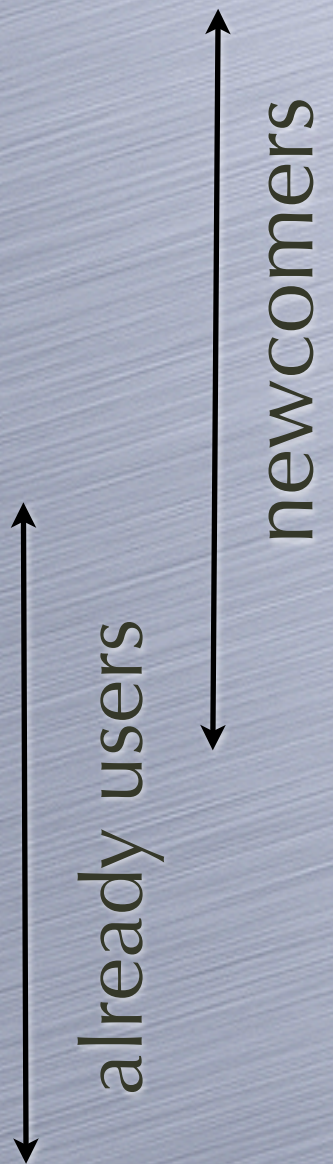
- installation
- the user interface
- getting started



- installation
- the user interface
- getting started
- the assignment



- installation
- the user interface
- getting started
- the assignment
- demonstrations



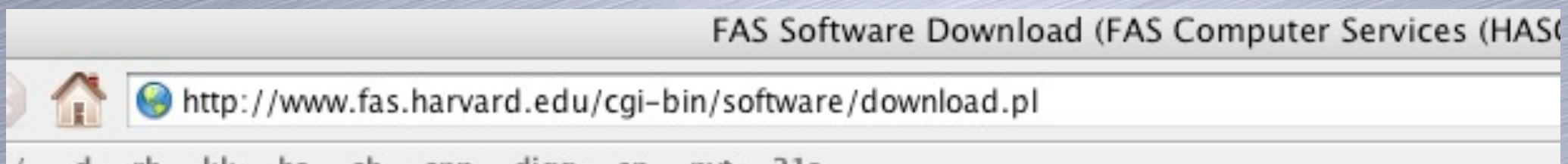
- installation
- the user interface
- getting started
- the assignment
- demonstrations
- questions&answers

installation

- get the program
- start up and get the id
- submit password request
- enter password

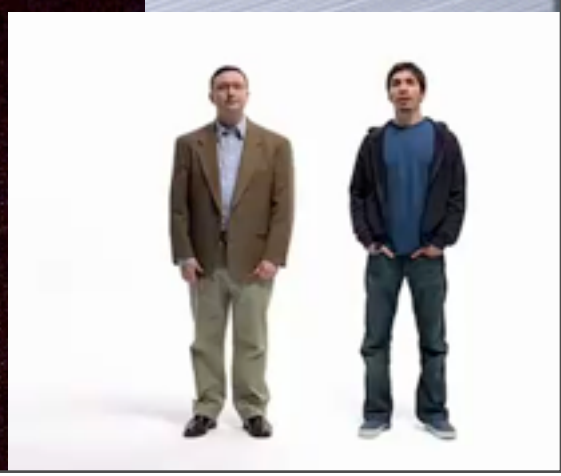
go to the FAS download page

- you need a HUID and pin to access the page
- www.fas.harvard.edu/cgi-bin/software/download.pl

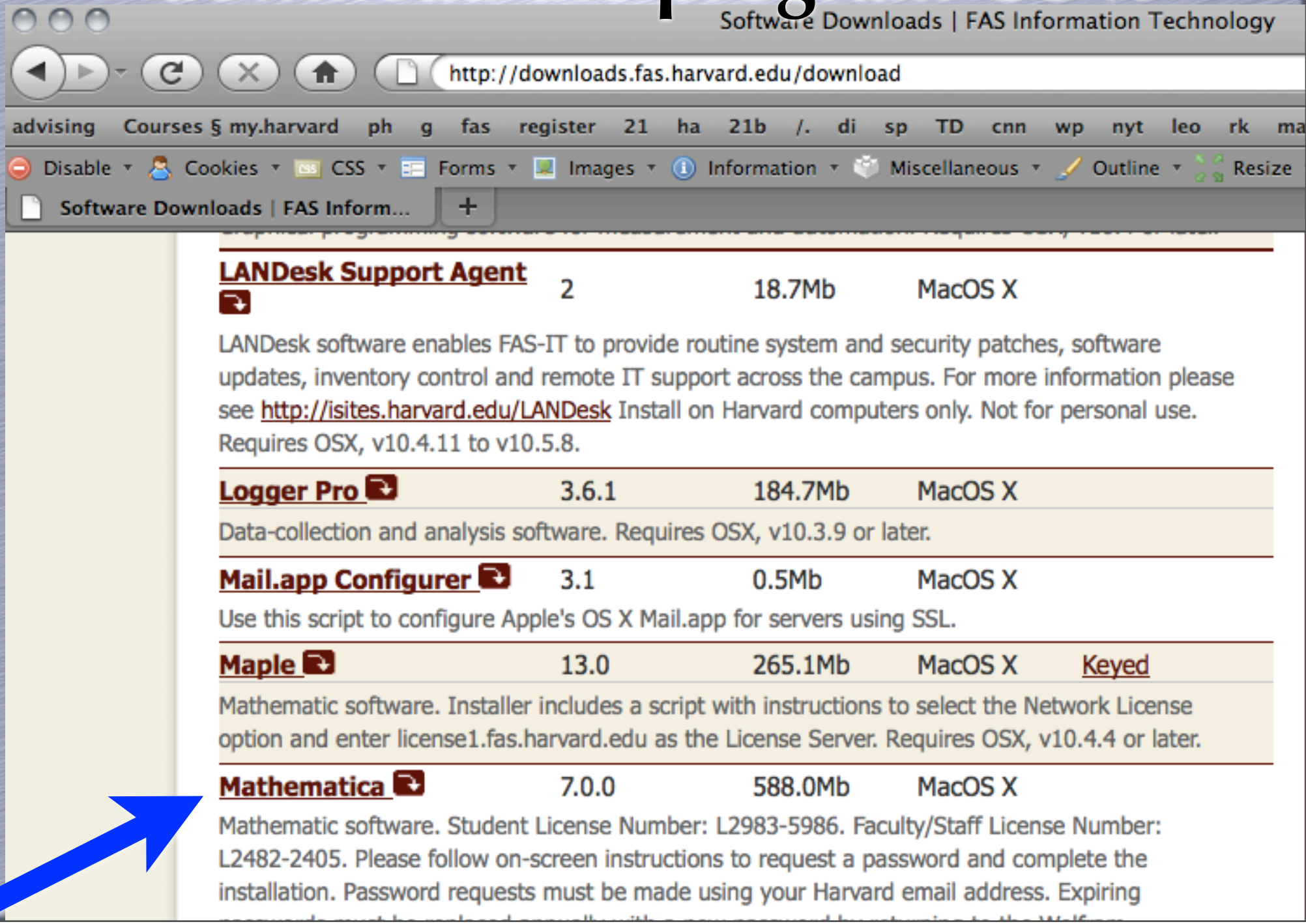


step 1:
get the program

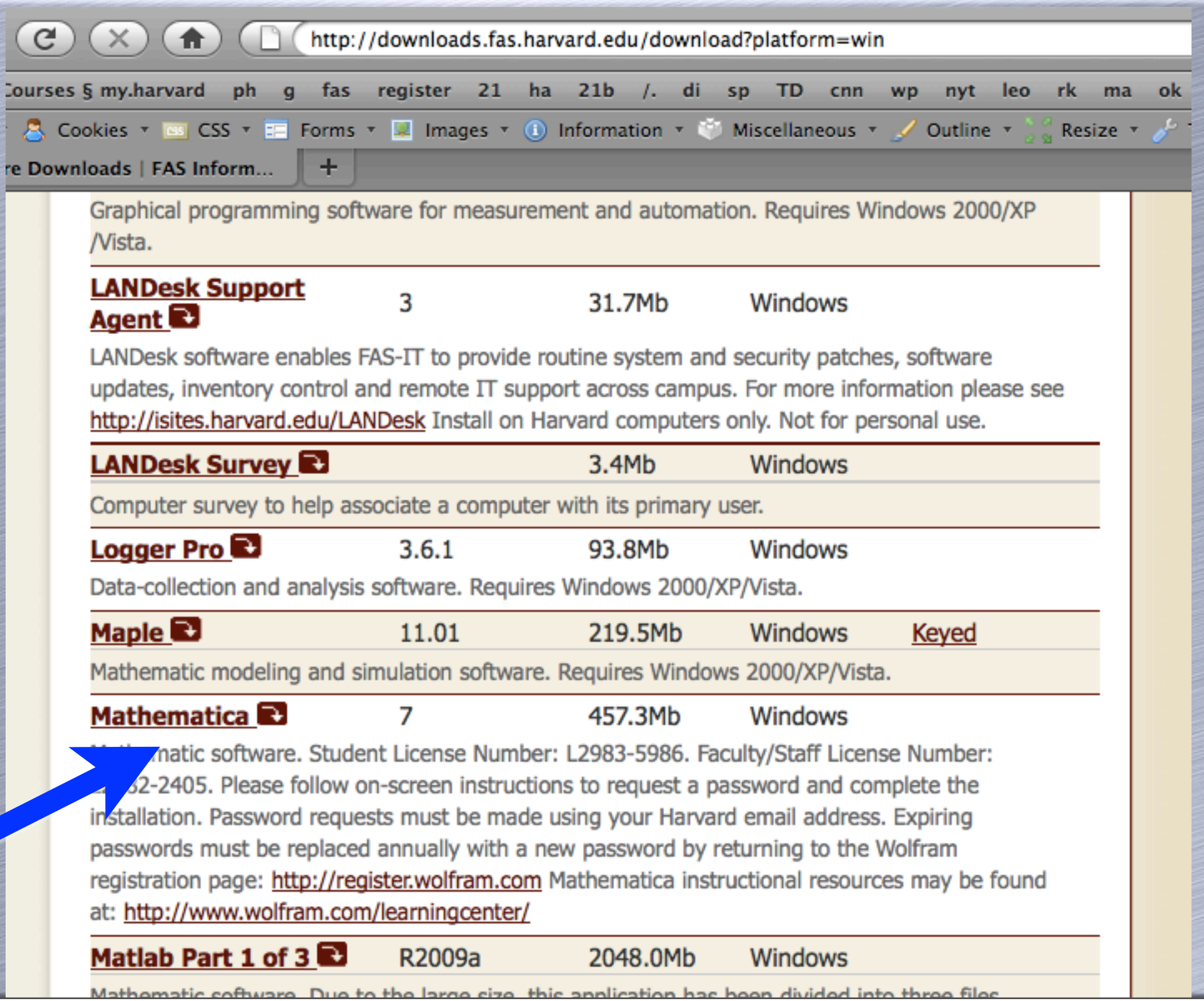
apple users:



download the program OS X




PC
users:


http://downloads.fas.harvard.edu/download?platform=win
Courses § my.harvard ph g fas register 21 ha 21b /. di sp TD cnn wp nyt leo rk ma ok
Cookies CSS Forms Images Information Miscellaneous Outline Resize
re Downloads | FAS Inform...
Graphical programming software for measurement and automation. Requires Windows 2000/XP /Vista.
LANDesk Support Agent 3 31.7Mb Windows
LANDesk software enables FAS-IT to provide routine system and security patches, software updates, inventory control and remote IT support across campus. For more information please see http://isites.harvard.edu/LANDesk Install on Harvard computers only. Not for personal use.
LANDesk Survey 3.4Mb Windows
Computer survey to help associate a computer with its primary user.
Logger Pro 3.6.1 93.8Mb Windows
Data-collection and analysis software. Requires Windows 2000/XP/Vista.
Maple 11.01 219.5Mb Windows Keyed
Mathematic modeling and simulation software. Requires Windows 2000/XP/Vista.
Mathematica 7 457.3Mb Windows
matic software. Student License Number: L2983-5986. Faculty/Staff License Number:
32-2405. Please follow on-screen instructions to request a password and complete the installation. Password requests must be made using your Harvard email address. Expiring passwords must be replaced annually with a new password by returning to the Wolfram registration page: http://register.wolfram.com Mathematica instructional resources may be found at: http://www.wolfram.com/learningcenter/
Matlab Part 1 of 3 R2009a 2048.0Mb Windows
Mathematic software. Due to the large size, this application has been divided into three files


Linux
users:

for Linux, contact me

- we can provide you with a CD image
- or a tar ball with the program

tar ball

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- I do not accept

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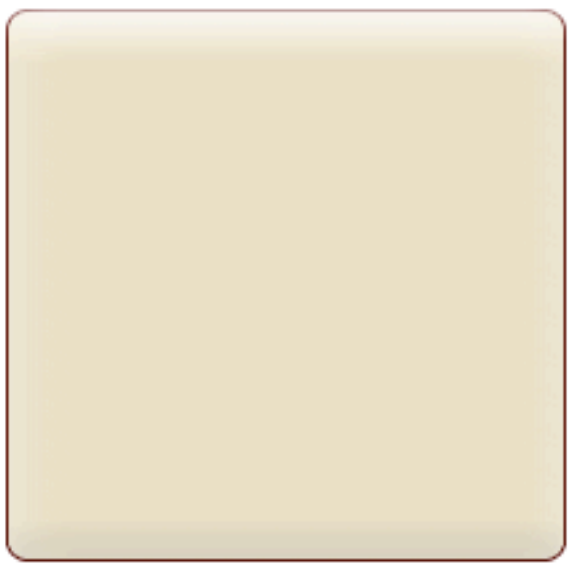
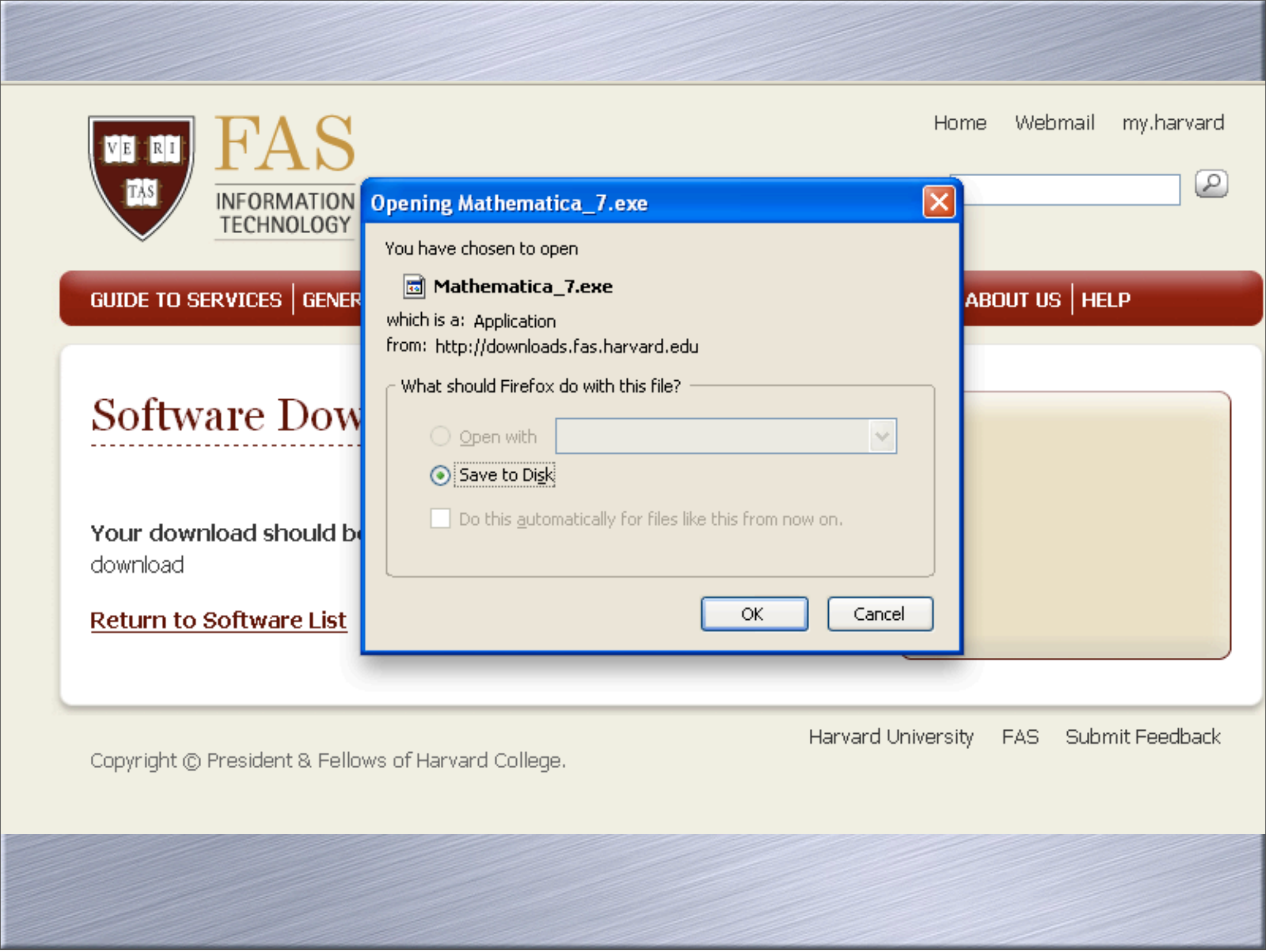


Harvard University FAS Submit Feedback


FAS
INFORMATION TECHNOLOGY
Home
Webmail
my.harvard
GUIDE TO SERVICES
ABOUT US
HELP
Software Dow
Your download should b
download
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Opening Mathematica_7.exe
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Mathematica_7.exe
which is a: Application
from: http://downloads.fas.harvard.edu
What should Firefox do with this file?
Open with
Save to Disk
Do this automatically for files like this from now on.
OK
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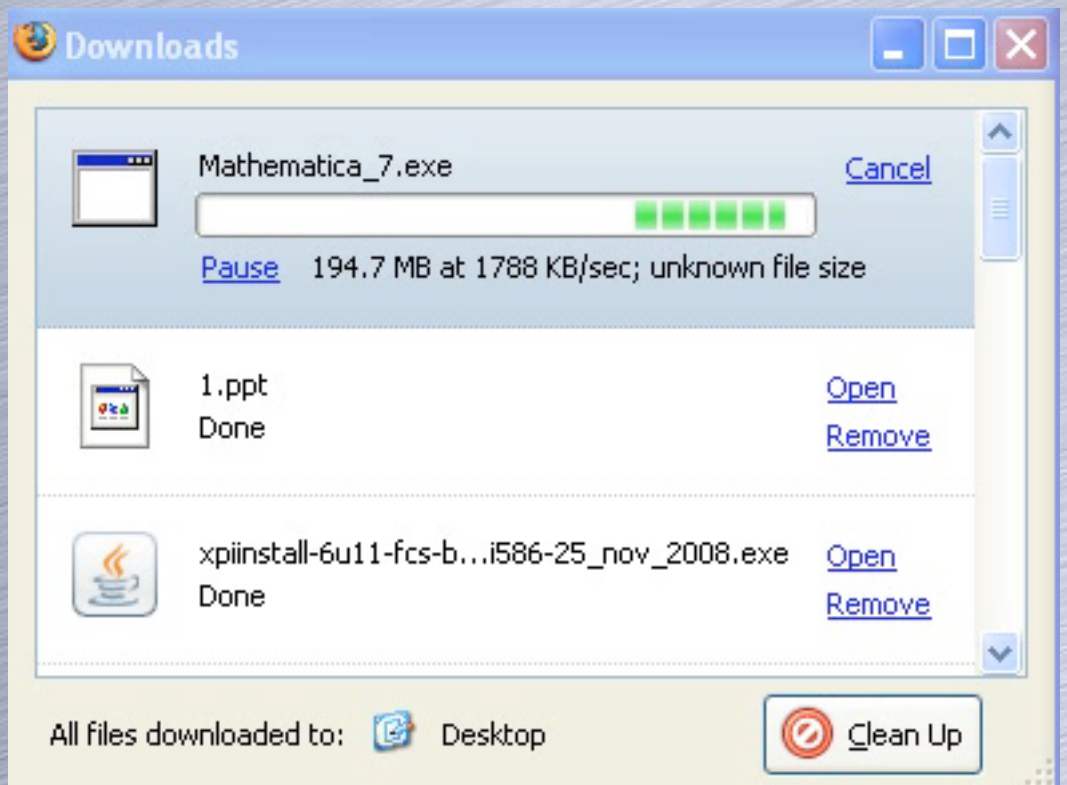
Downloads
Mathematica_7.exe
Cancel
Pause
194.7 MB at 1788 KB/sec; unknown file size
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Open
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xpiinstall-6u11-fcs-b...i586-25_nov_2008.exe
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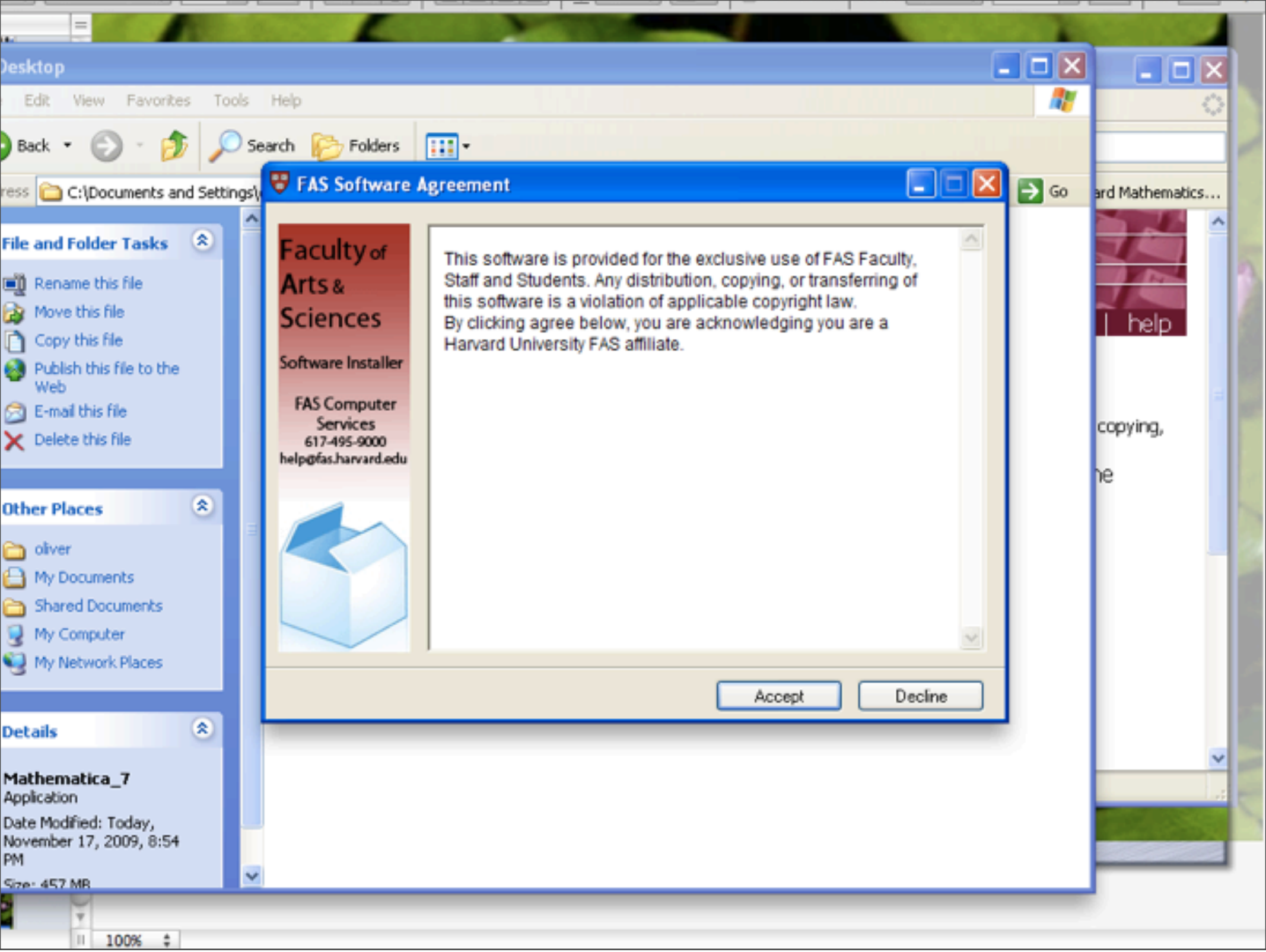
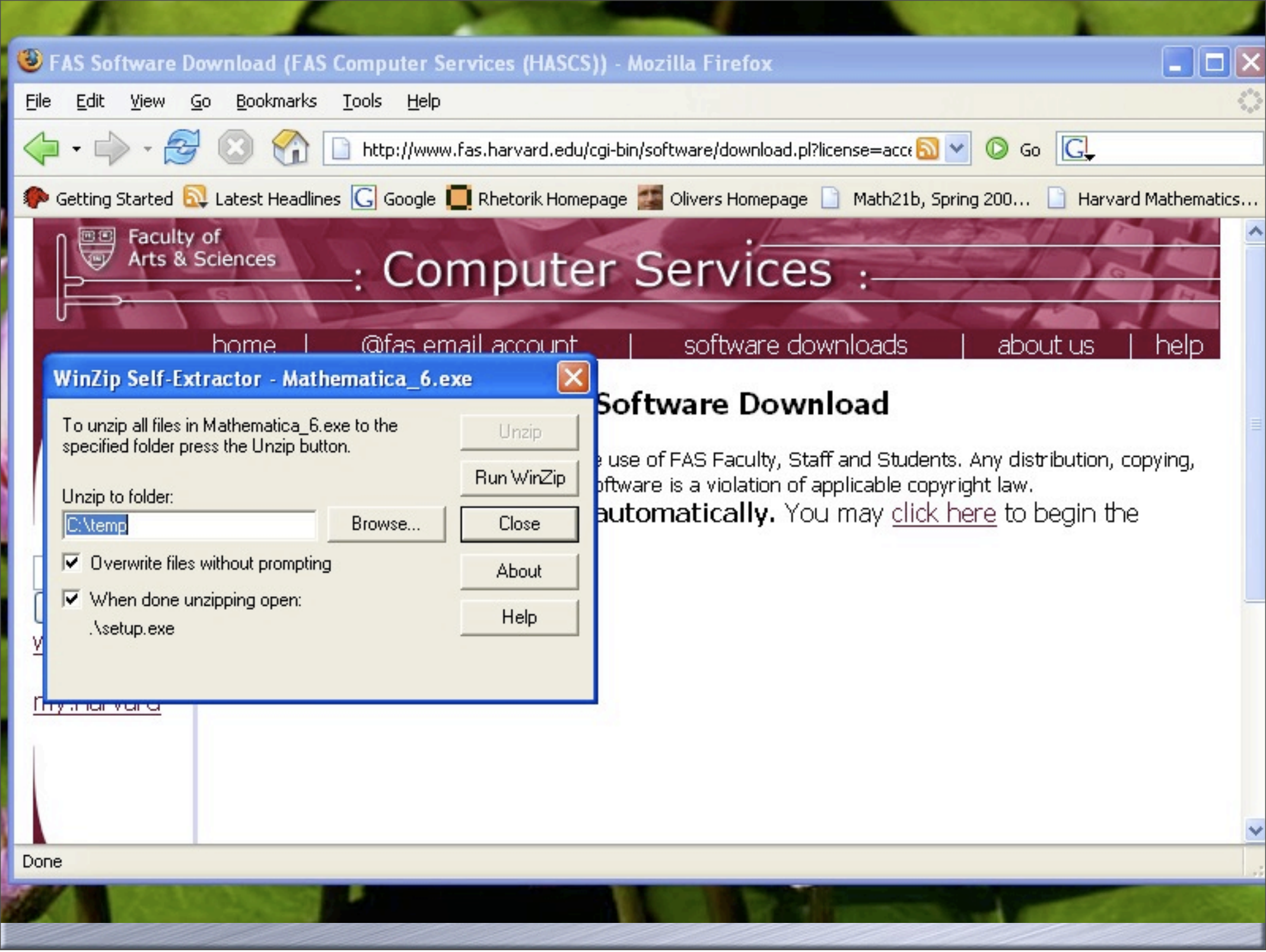
Open
Remove
All files downloaded to:
Desktop
Clean Up

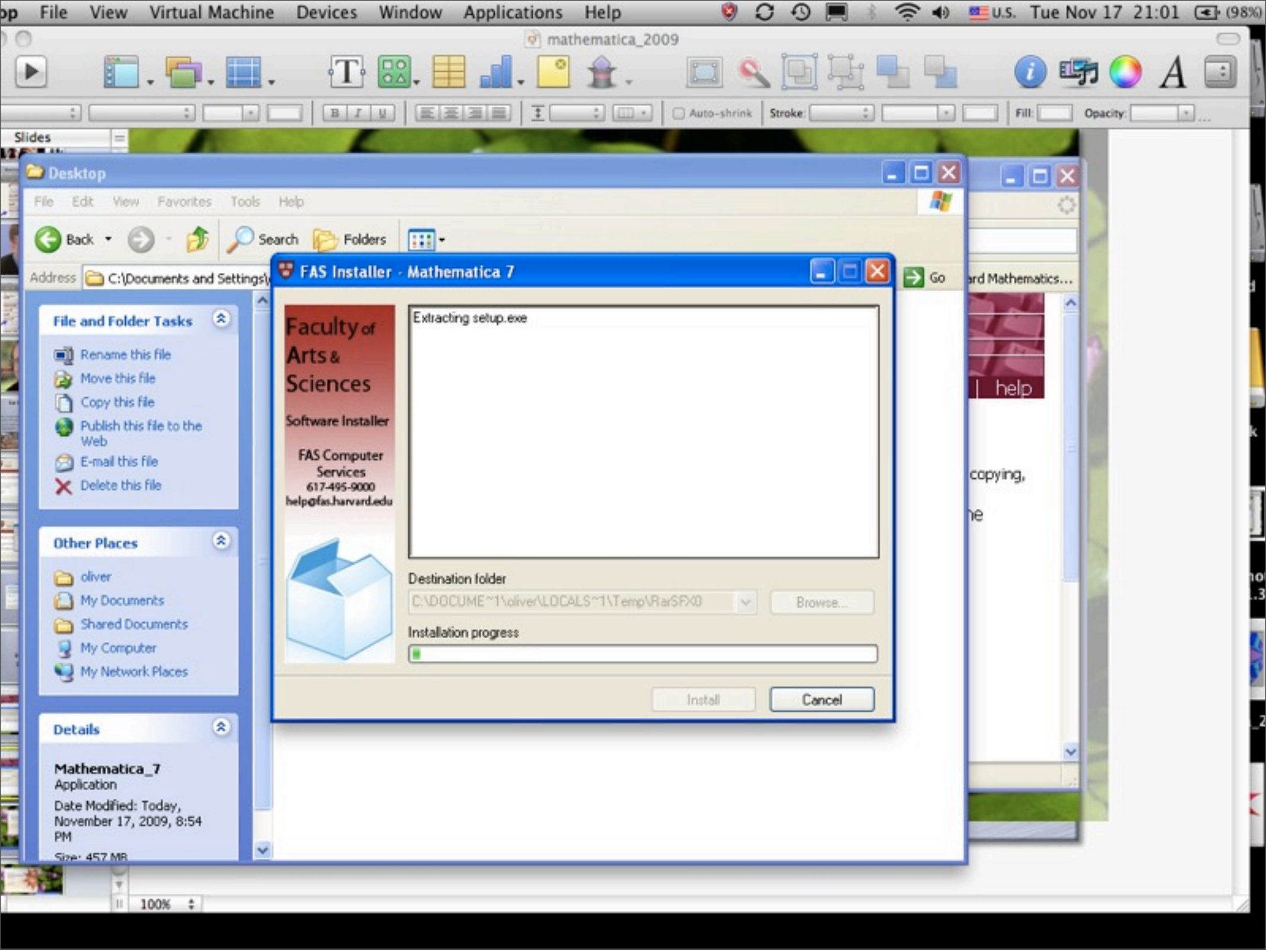
step 2: install the program



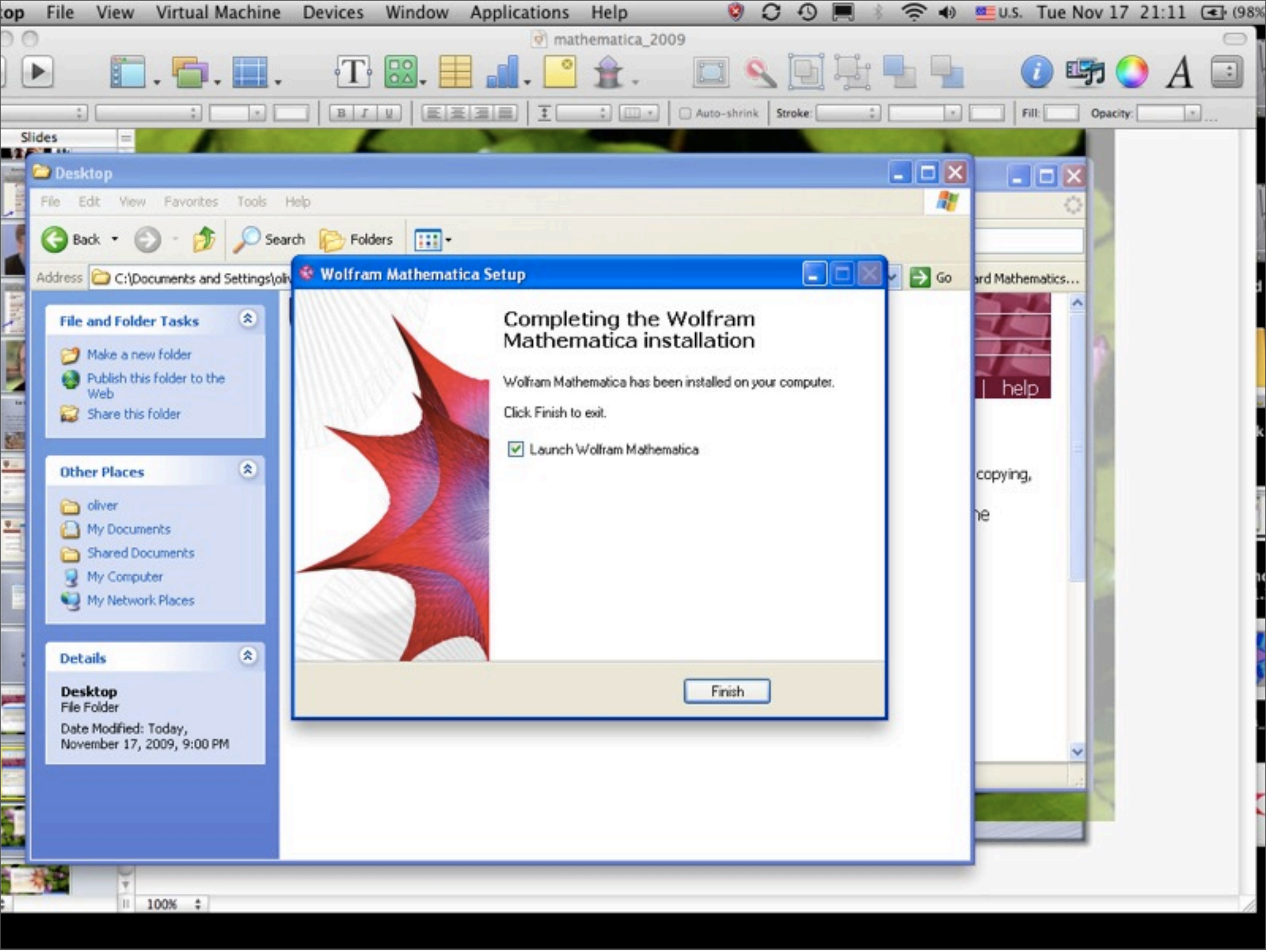
Friday, November 20, 2009



Friday, November 20, 2009



Friday, November 20, 2009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Desktop
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Make a new folder
Publish this folder to the Web
Share this folder
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My Documents
Shared Documents
My Computer
My Network Places
Details
Desktop
File Folder
Date Modified: Today, November 17, 2009, 9:00 PM
Wolfram Mathematica Setup
Completing the Wolfram Mathematica installation
Wolfram Mathematica has been installed on your computer.
Click Finish to exit.
Launch Wolfram Mathematica
Finish
help
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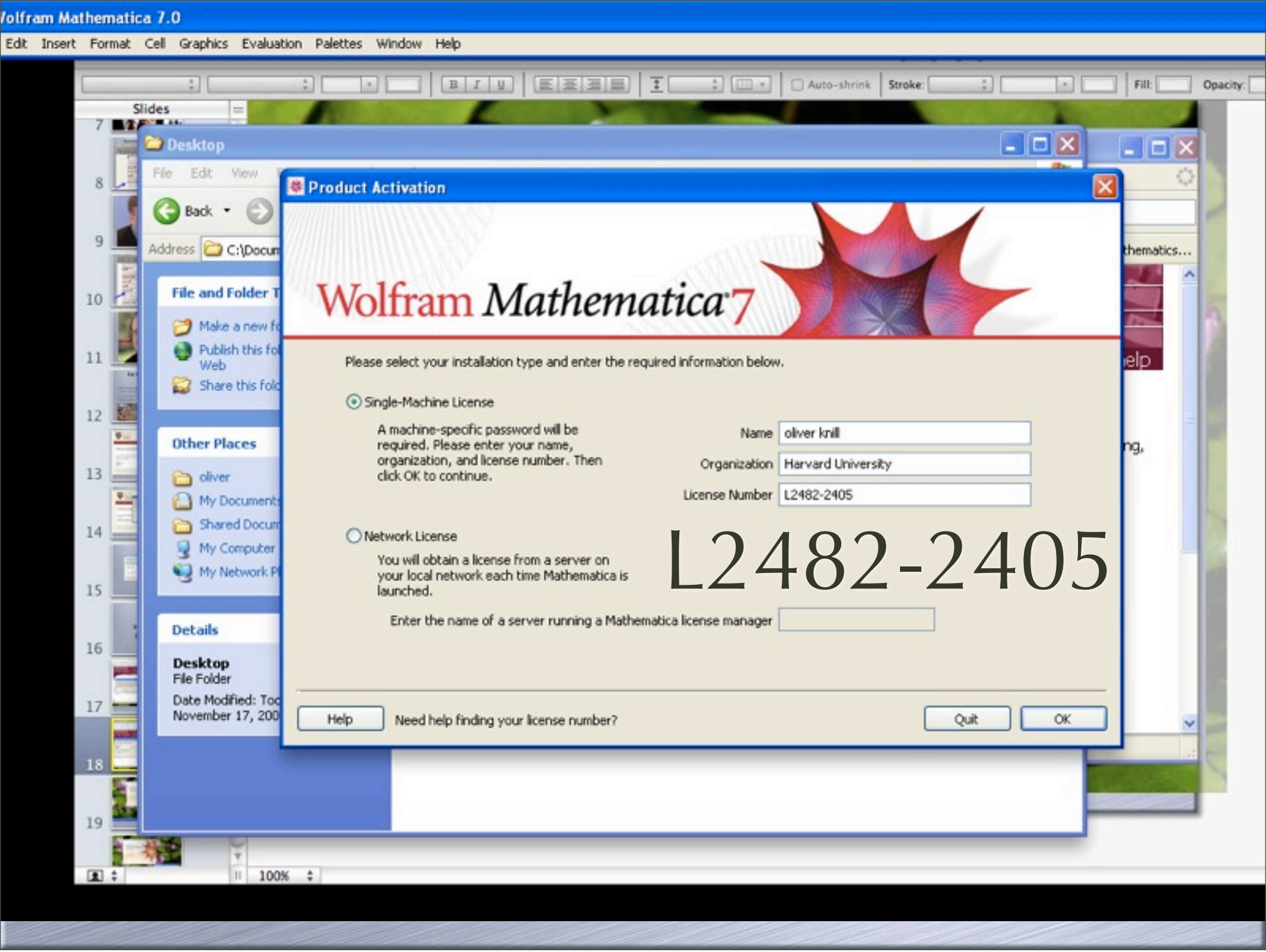
100%

step 3: request a password


Wolfram Mathematica 7.0
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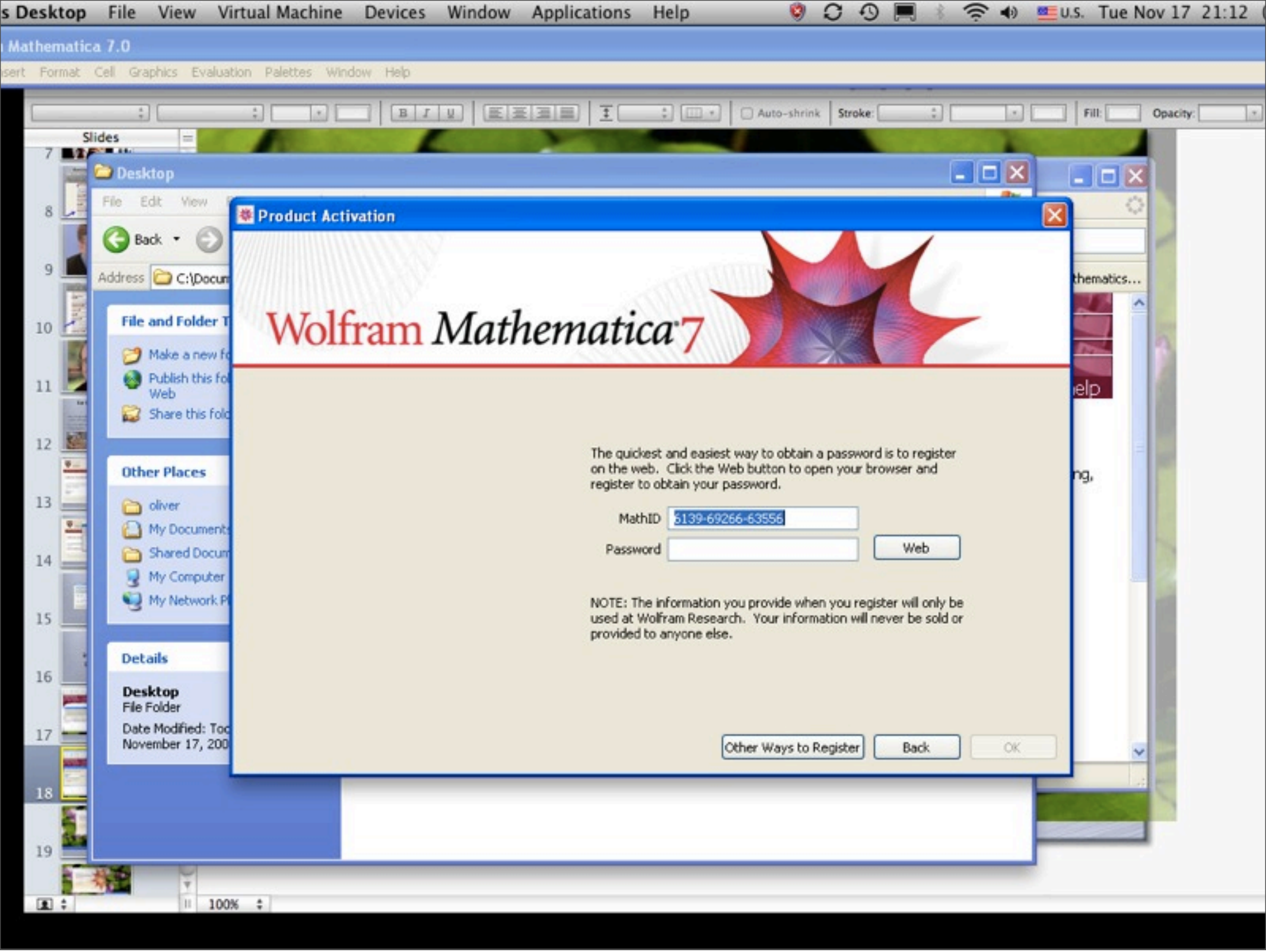
November 17, 200
Product Activation
Wolfram Mathematica 7
Please select your installation type and enter the required information below.
Single-Machine License
A machine-specific password will be required. Please enter your name, organization, and license number. Then click OK to continue.
Name oliver krill
Organization Harvard University
License Number L2482-2405
Network License
You will obtain a license from a server on your local network each time Mathematica is launched.
Enter the name of a server running a Mathematica license manager
L2482-2405
Help
Need help finding your license number?
Quit
OK
100%



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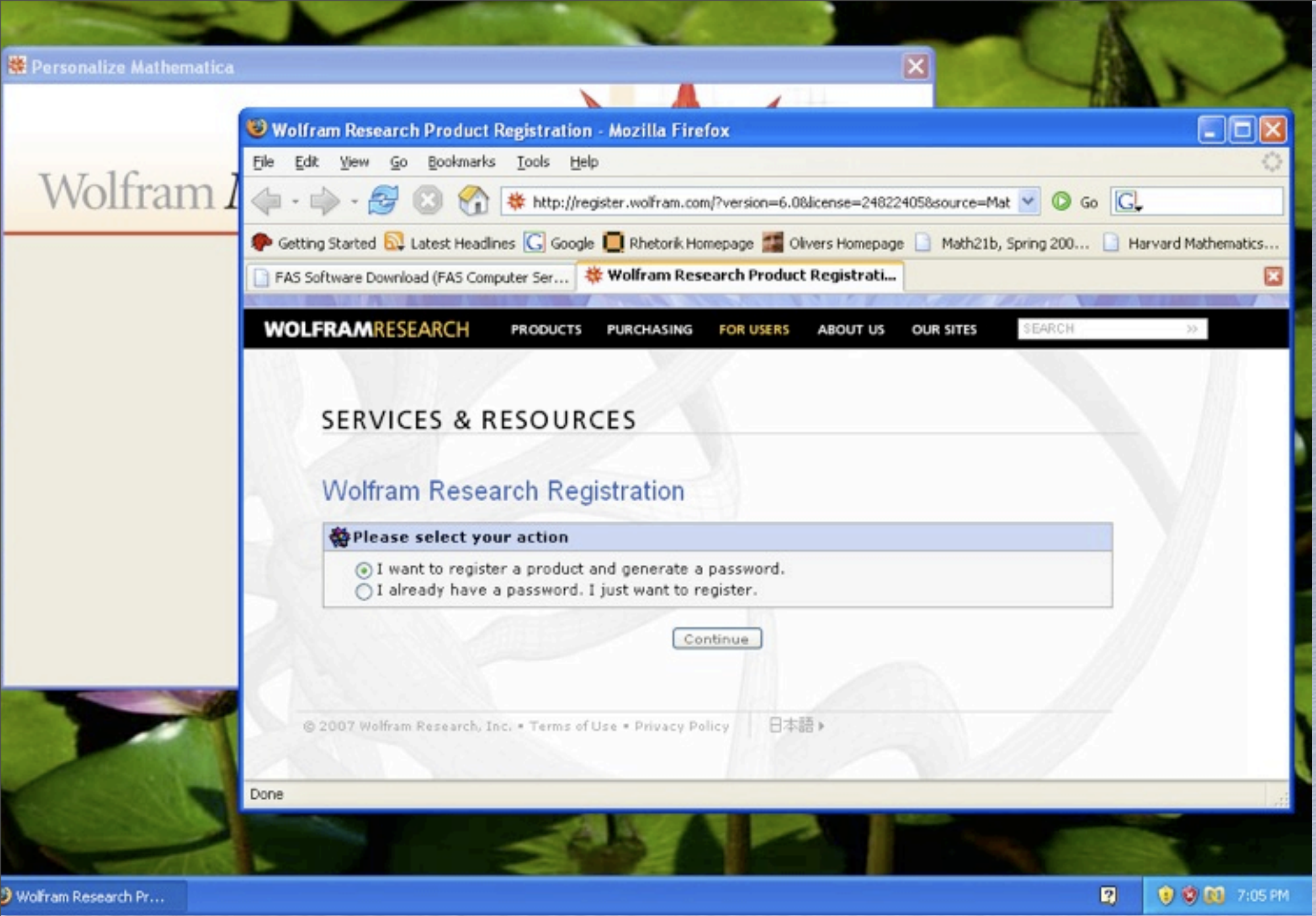
Personalize Mathematica
Wolfram
Wolfram Research Product Registration - Mozilla Firefox
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Go
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Latest Headlines
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Olivers Homepage
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Harvard Mathematics...
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I already have a password. I just want to register.
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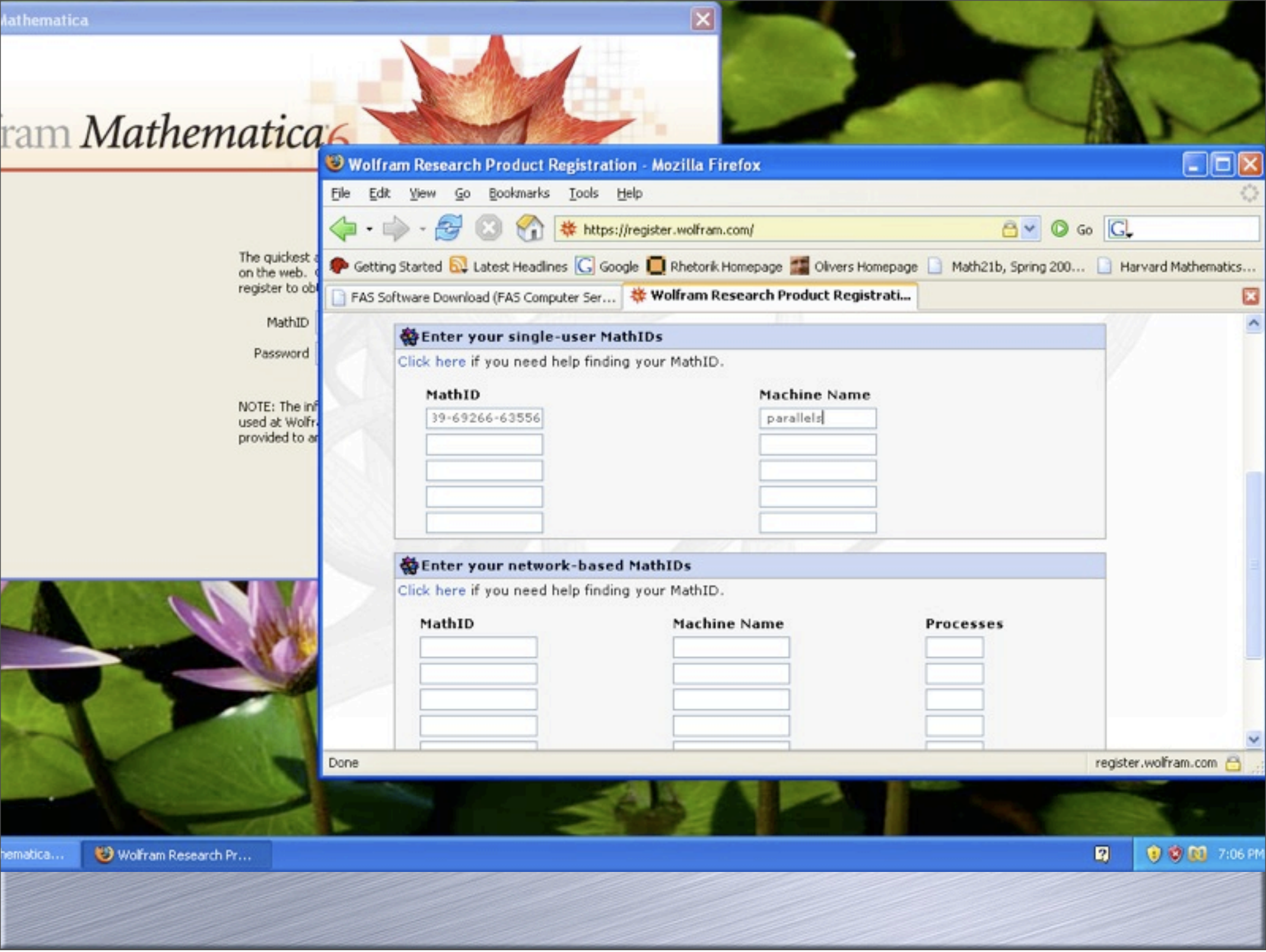
Done
Wolfram Research Pr...
7:05 PM



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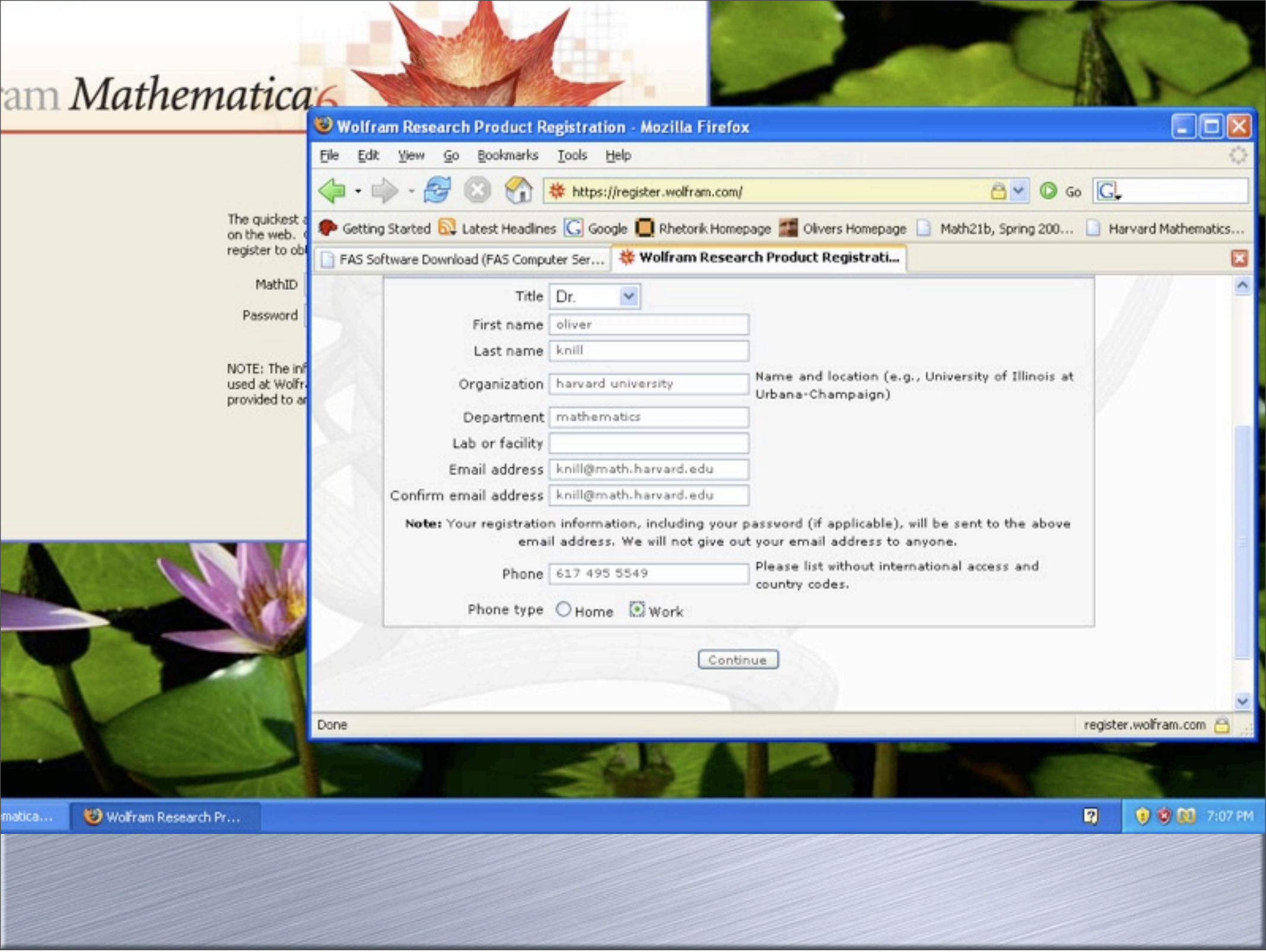
ram Mathematica6
The quickest
on the web.
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Password
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used at Wolfr
provided to a
Wolfram Research Product Registration - Mozilla Firefox
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https://register.wolfram.com/
Go
Getting Started Latest Headlines Google Rhetorik Homepage Olivers Homepage Math21b, Spring 200... Harvard Mathematics...
FAS Software Download (FAS Computer Ser...
Wolfram Research Product Registrati...
Title Dr.
First name oliver
Last name knill
Organization harvard university
Name and location (e.g., University of Illinois at Urbana-Champaign)
Department mathematics
Lab or facility
Email address knill@math.harvard.edu
Confirm email address knill@math.harvard.edu
Note: Your registration information, including your password (if applicable), will be sent to the above email address. We will not give out your email address to anyone.
Phone 617 495 5549
Please list without international access and country codes.
Phone type Home Work
Continue
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register.wolfram.com
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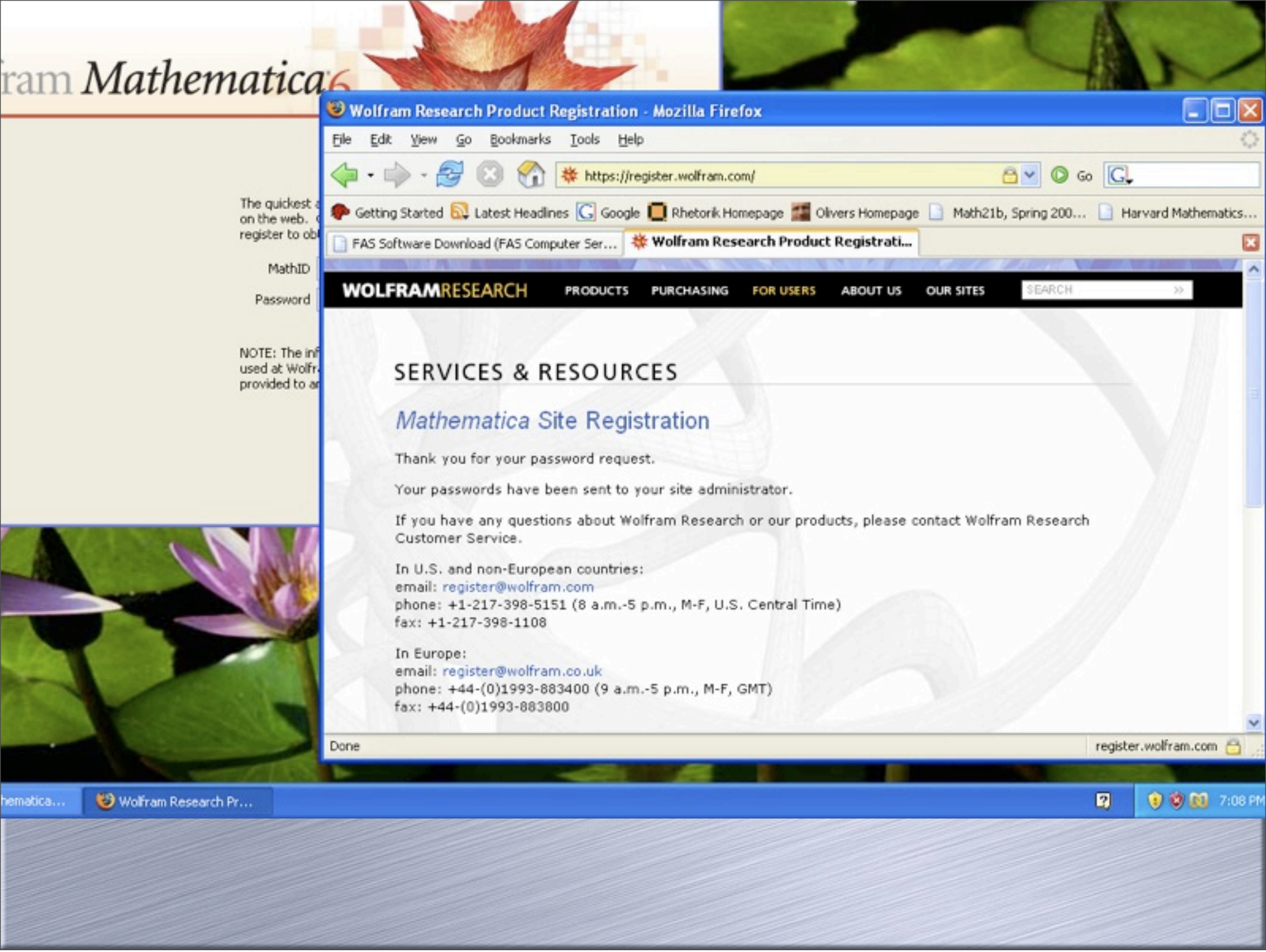
ram Mathematica 6
The quickest
on the web.
register to ob
MathID
Password
NOTE: The in
used at Wolfr
provided to a
Wolfram Research Product Registration - Mozilla Firefox
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Wolfram Research Product Registrati...
WOLFRAMRESEARCH
PRODUCTS
PURCHASING
FOR USERS
ABOUT US
OUR SITES
SEARCH
SERVICES & RESOURCES
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Thank you for your password request.
Your passwords have been sent to your site administrator.
If you have any questions about Wolfram Research or our products, please contact Wolfram Research Customer Service.
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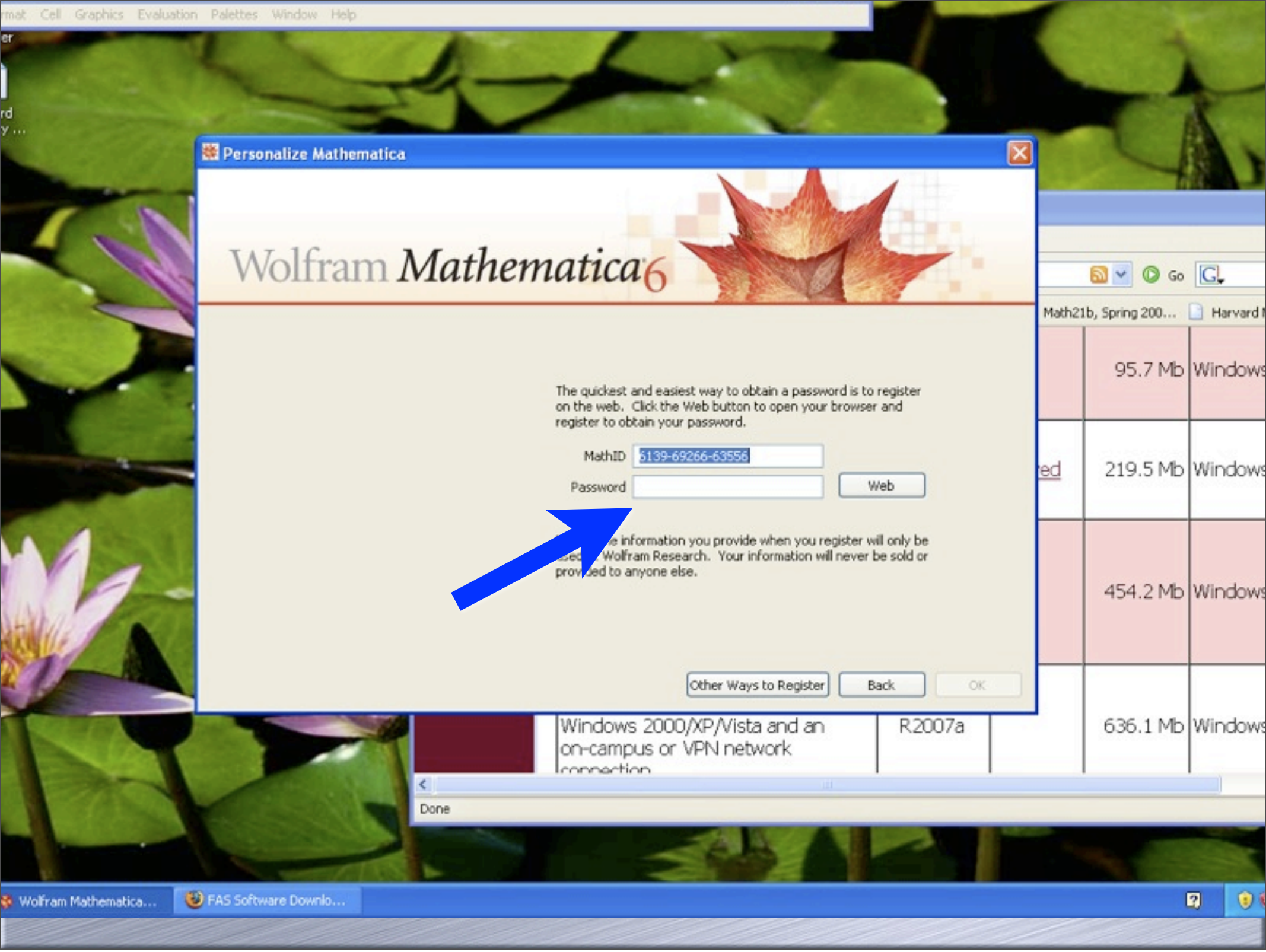
email: register@wolfram.com
phone: +1-217-398-5151 (8 a.m.-5 p.m., M-F, U.S. Central Time)
fax: +1-217-398-1108
In Europe:
email: register@wolfram.co.uk
phone: +44-(0)1993-883400 (9 a.m.-5 p.m., M-F, GMT)
fax: +44-(0)1993-883800
Done
register.wolfram.com
hematica...
Wolfram Research Pr...
7:08 PM

step 4:
enter the password



Friday, November 20, 2009

the user interface

the user interface

the user interface

- notebooks

the user interface

- notebooks
- cells

the user interface

- notebooks
- cells
- submitting commands

the user interface

- notebooks
- cells
- submitting commands
- the menu

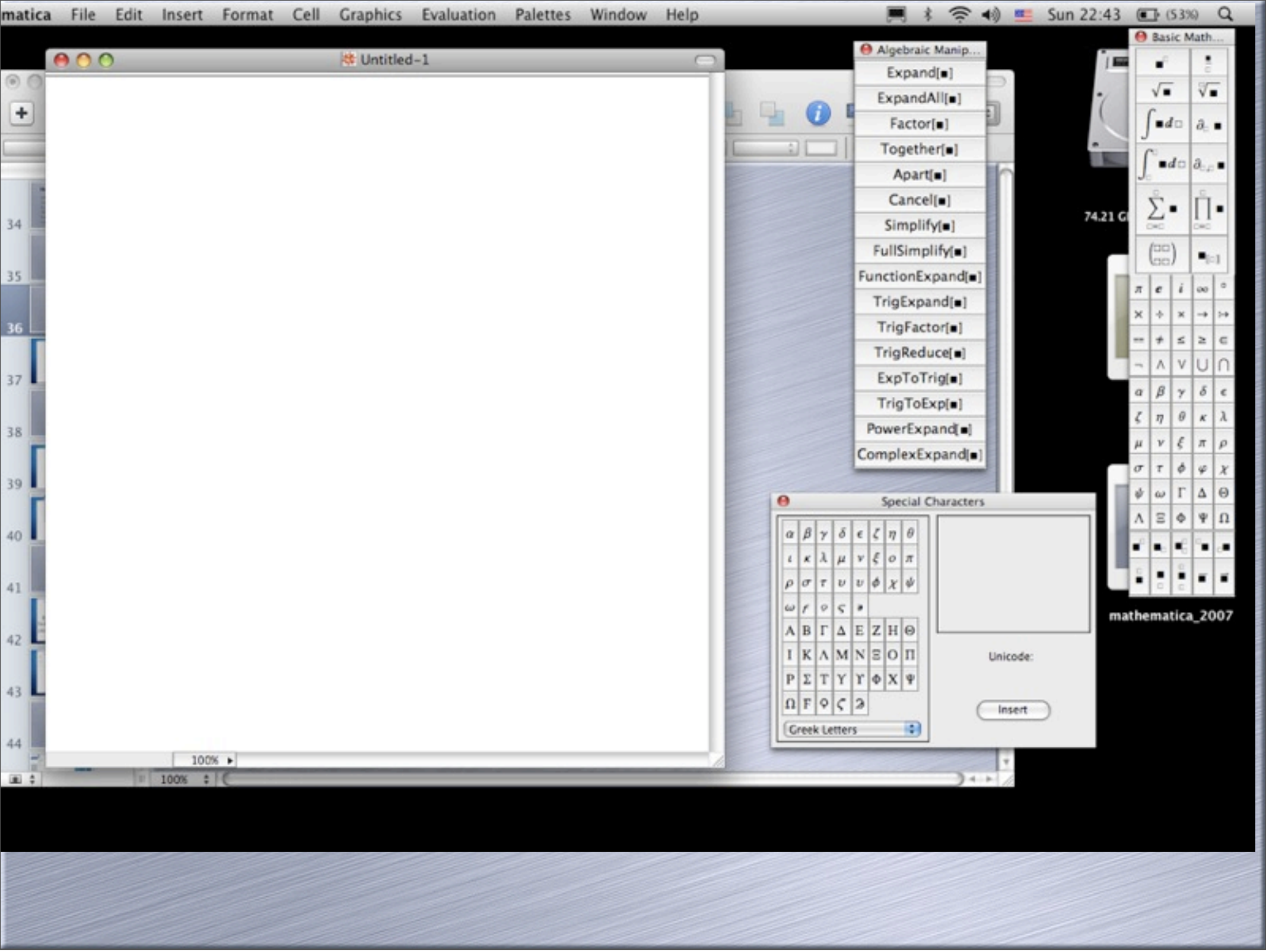
the user interface

- notebooks
- cells
- submitting commands
- the menu
- stopping the kernel

the user interface

- notebooks
- cells
- submitting commands
- the menu
- stopping the kernel
- saving the notebook

notebooks


matica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Sun 22:43
Untitled-1
Algebraic Manip...
Expand[■]
ExpandAll[■]
Factor[■]
Together[■]
Apart[■]
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Simplify[■]
FullSimplify[■]
FunctionExpand[■]
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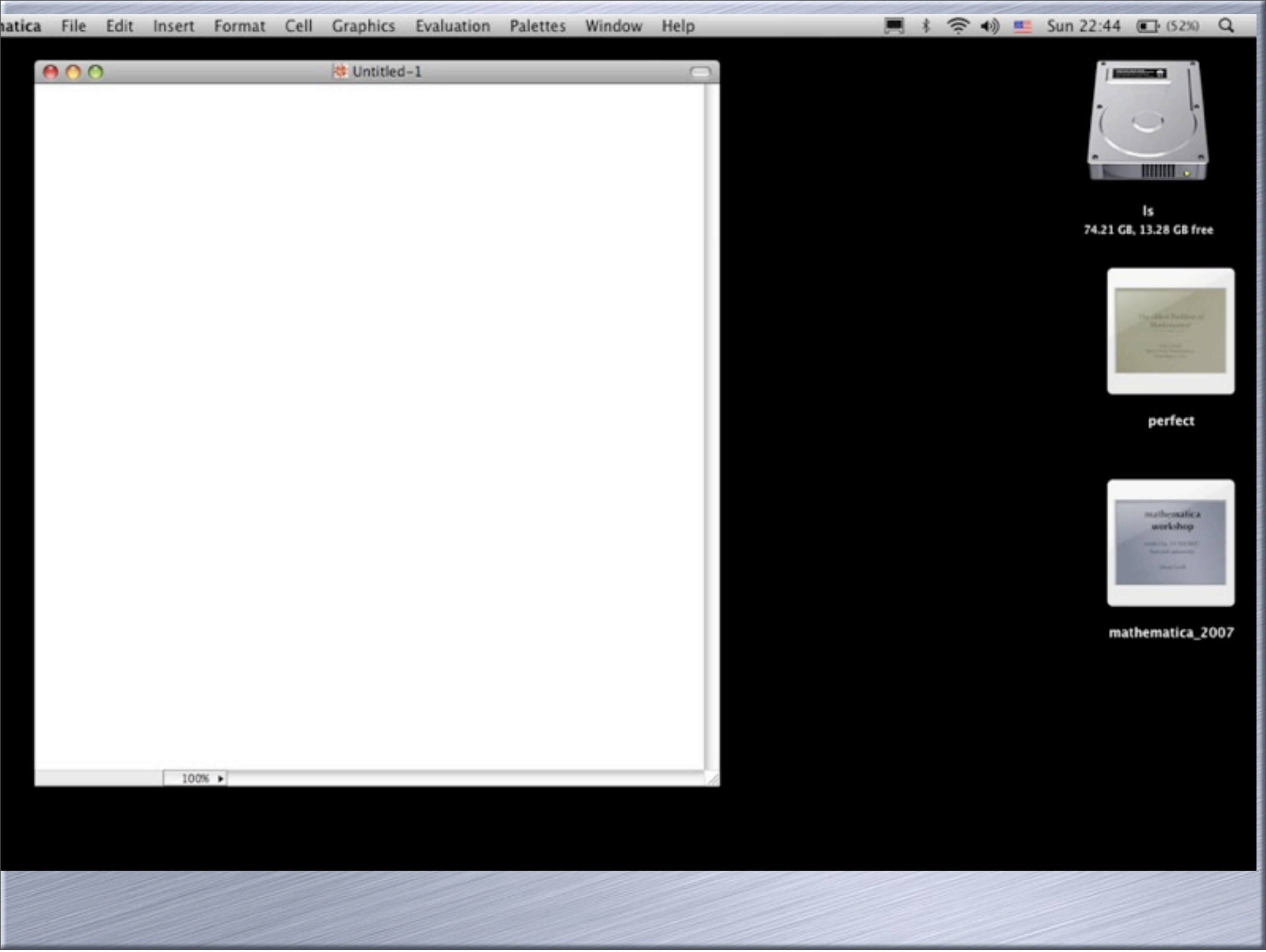
atica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
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74.21 GB, 13.28 GB free
perfect
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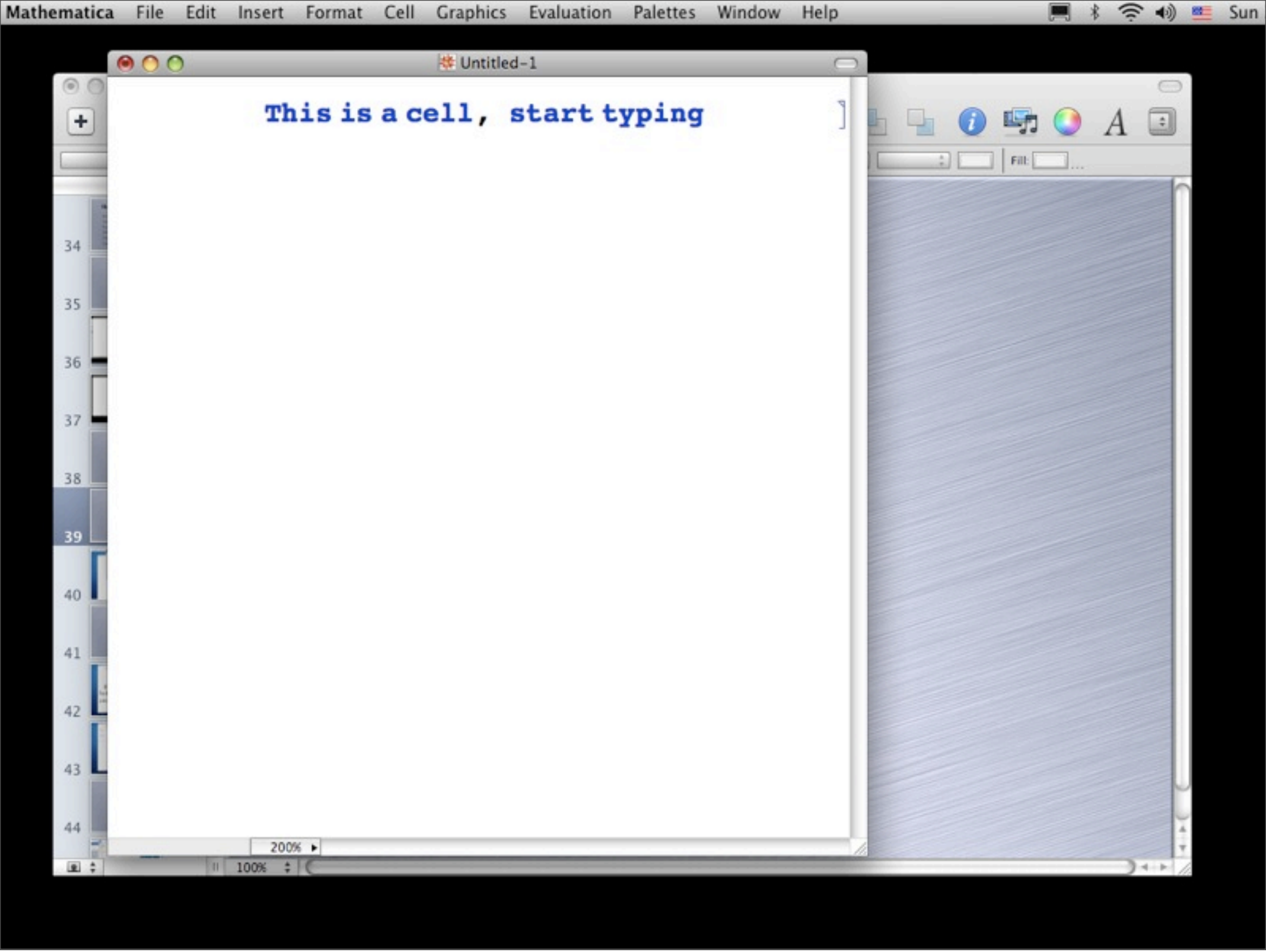
cells


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
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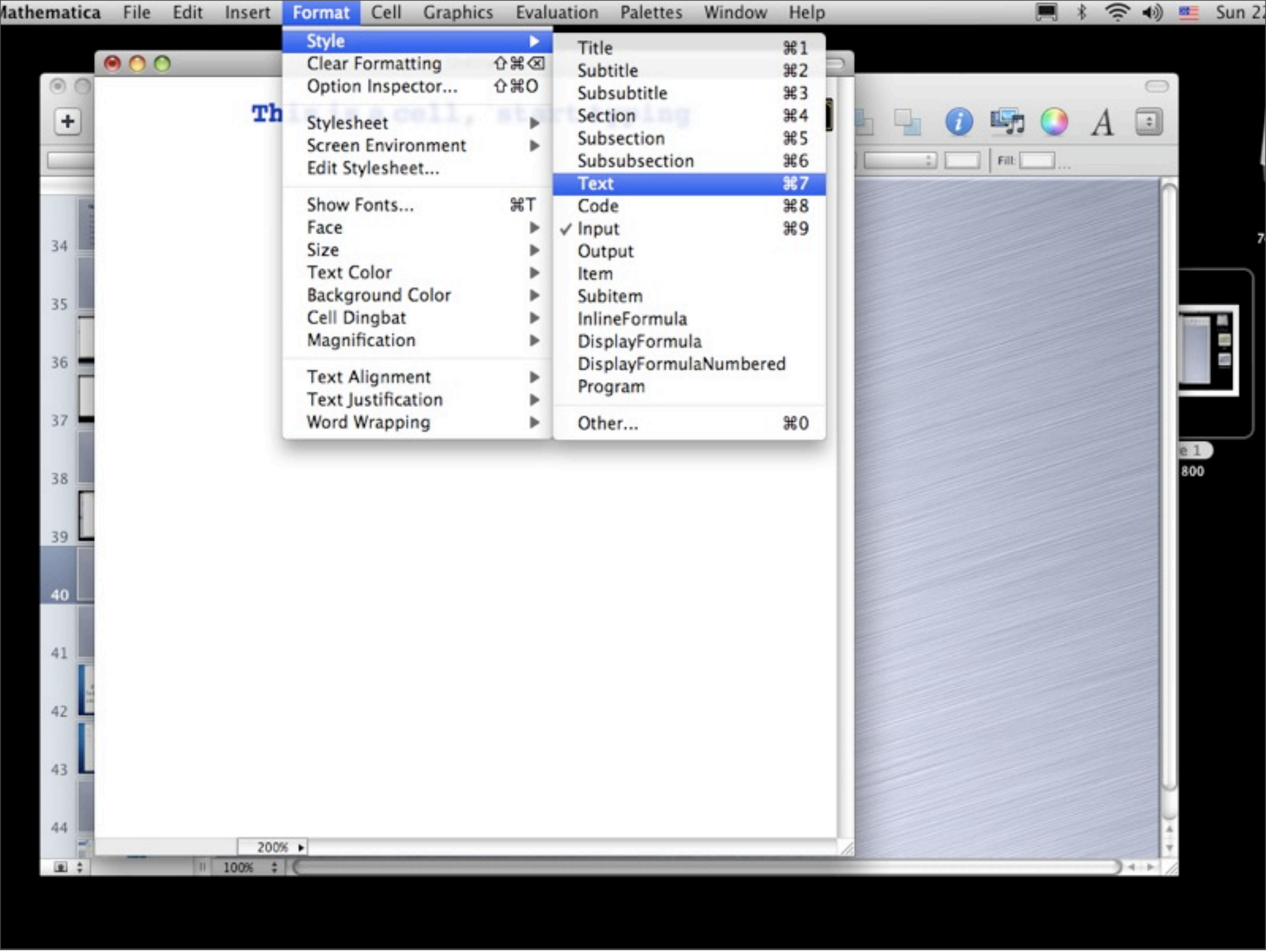
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
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Magnification
Text Alignment
Text Justification
Word Wrapping
Title ⌘1
Subtitle ⌘2
Subsubtitle ⌘3
Section ⌘4
Subsection ⌘5
Subsubsection ⌘6
Text ⌘7
Code ⌘8
Input ⌘9
Output
Item
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Program
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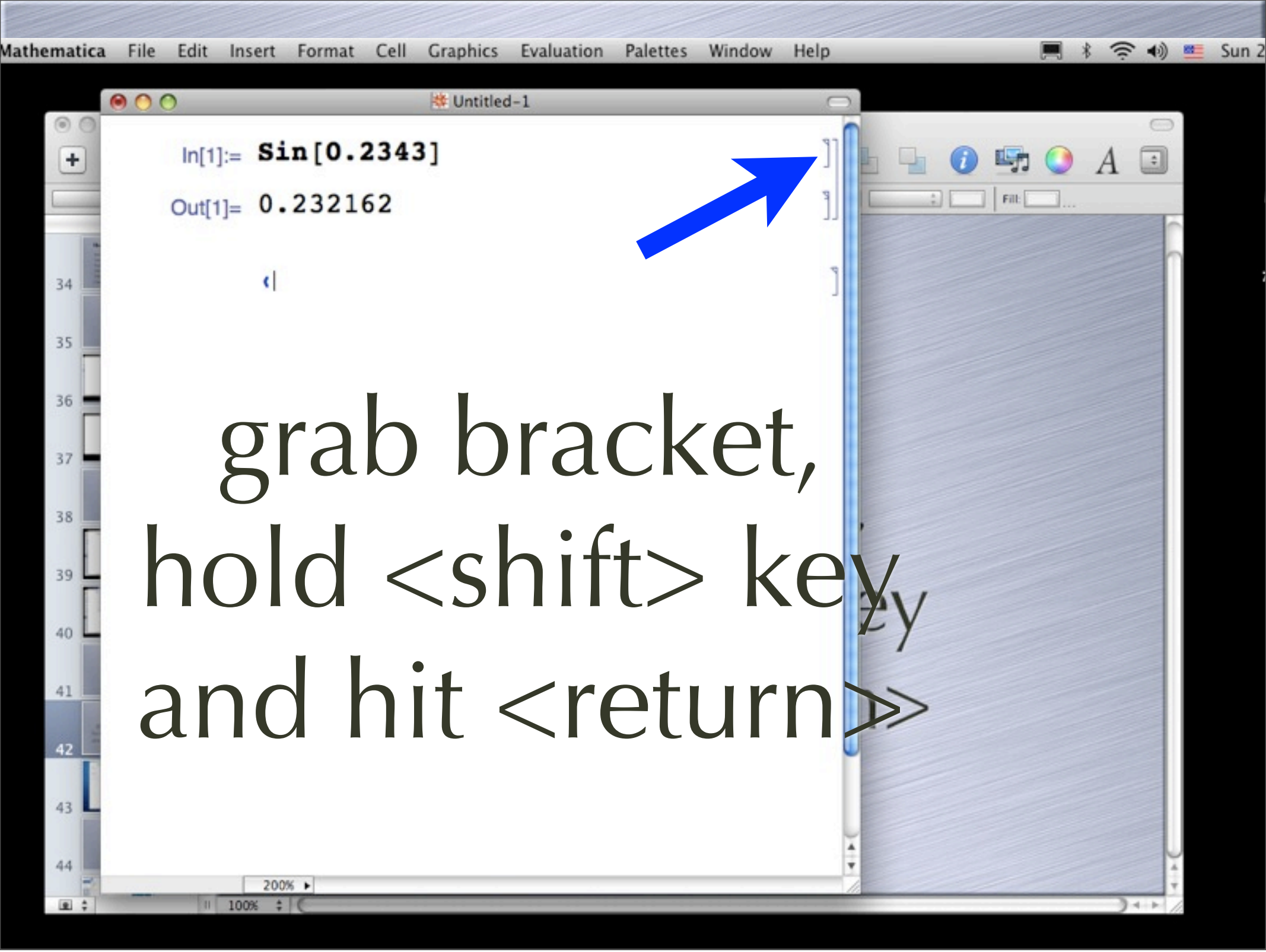
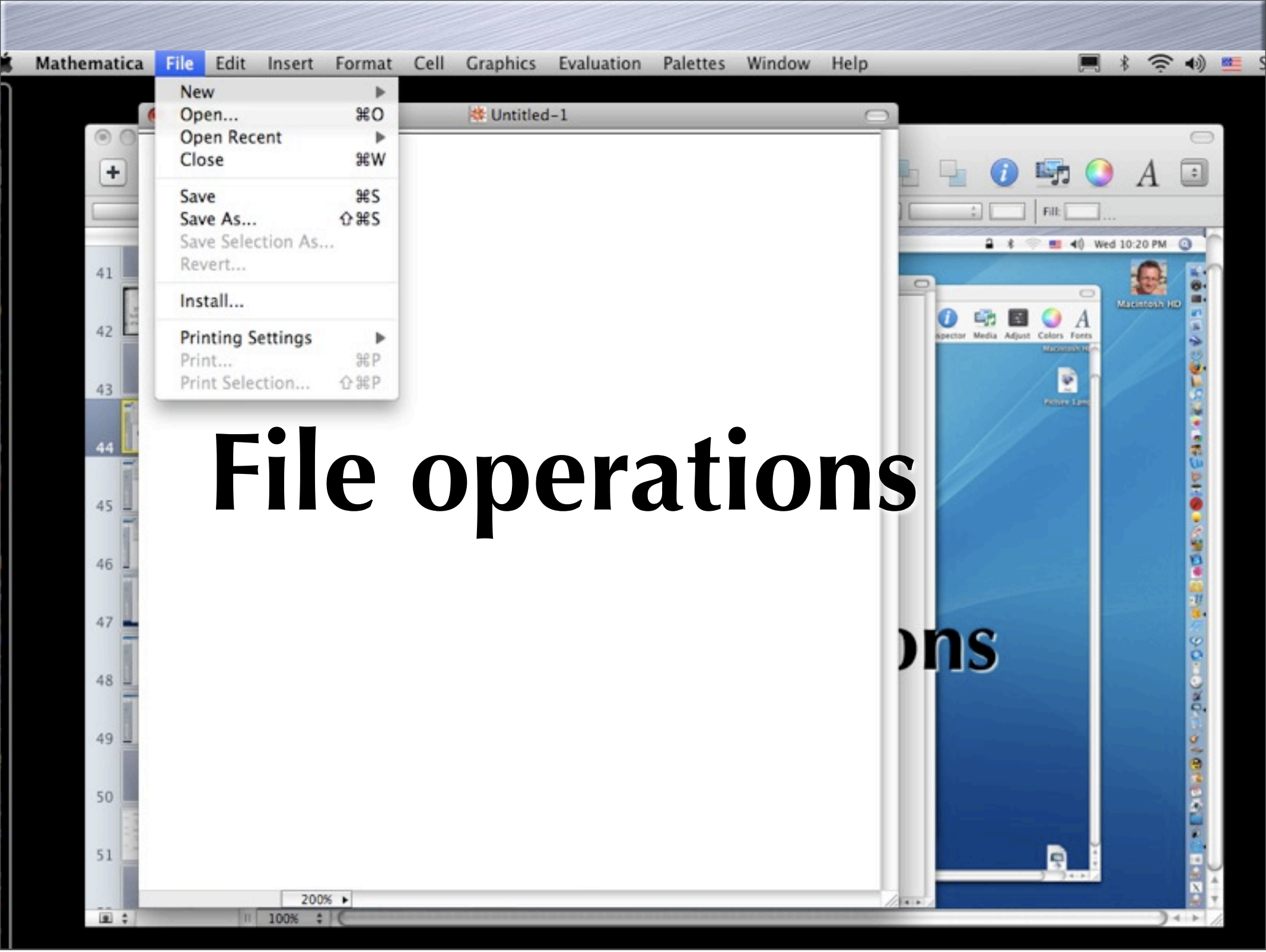
100%

submitting commands


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Sun 2
Untitled-1
In[1]:= Sin[0.2343]
Out[1]= 0.232162
grab bracket,
hold <shift> key
and hit <return>
200%
100%

the menu


Mathematica
File
Edit
Insert
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Save ⌘S
Save As... ⇧⌘S
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Printing Settings
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Untitled-1
File operations
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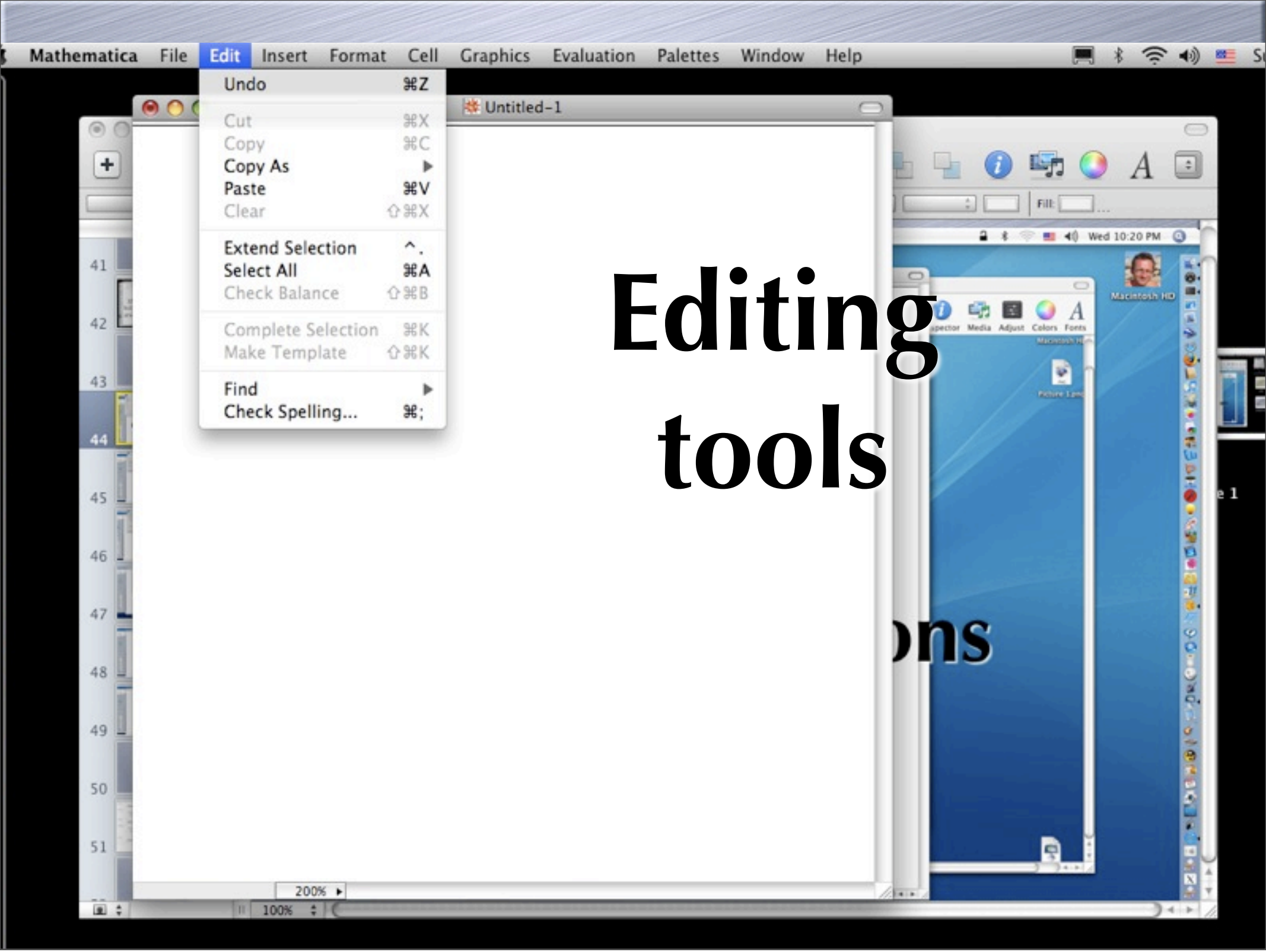
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Undo ⌘Z
Cut ⌘X
Copy ⌘C
Copy As
Paste ⌘V
Clear ⇧⌘X
Extend Selection ^.
Select All ⌘A
Check Balance ⇧⌘B
Complete Selection ⌘K
Make Template ⇧⌘K
Find
Check Spelling... ⌘;
Untitled-1
Editing tools
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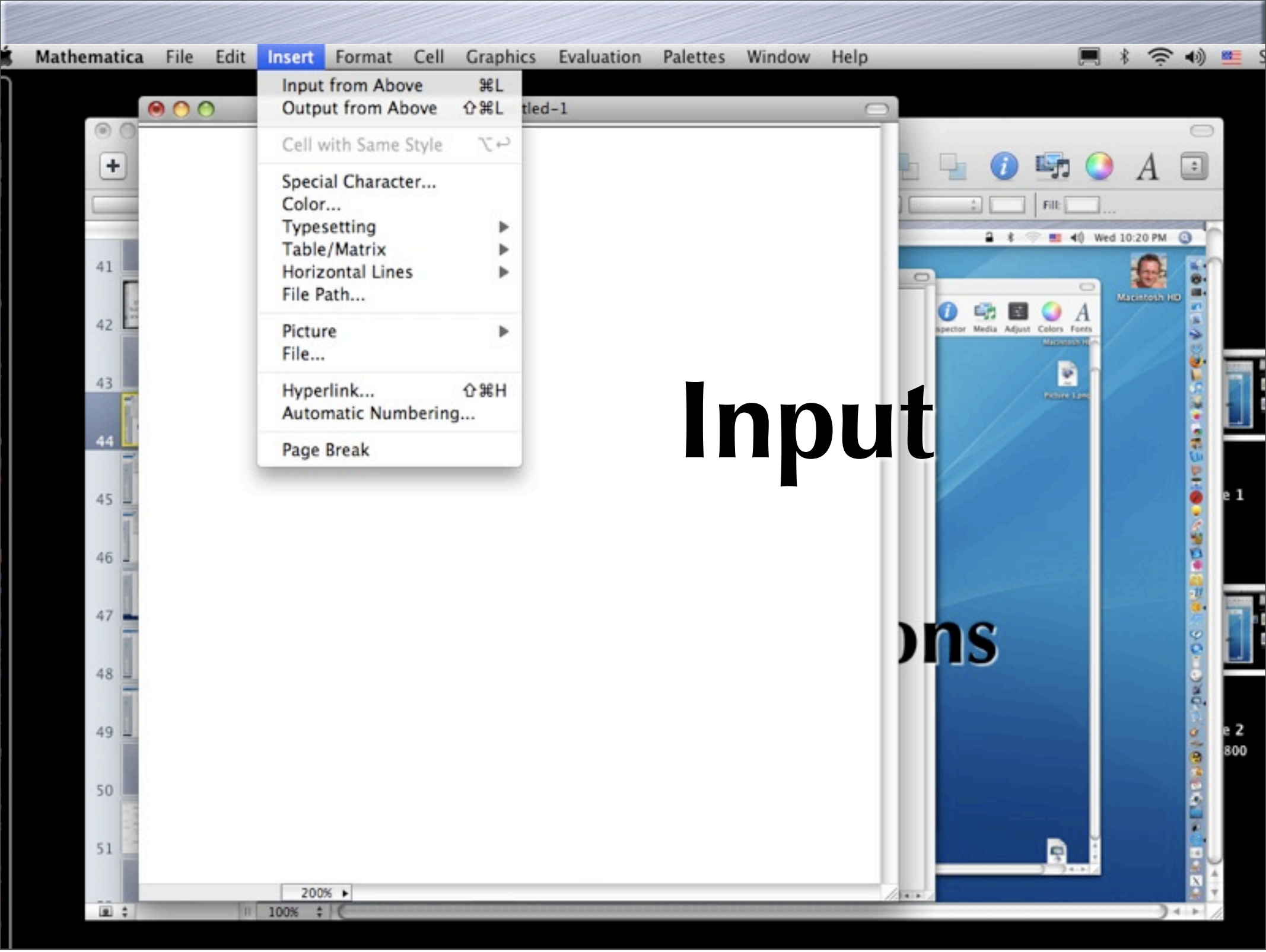
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Input from Above ⌘L
Output from Above ⇧⌘L
Cell with Same Style ⌥↩
Special Character...
Color...
Typesetting
Table/Matrix
Horizontal Lines
File Path...
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Input
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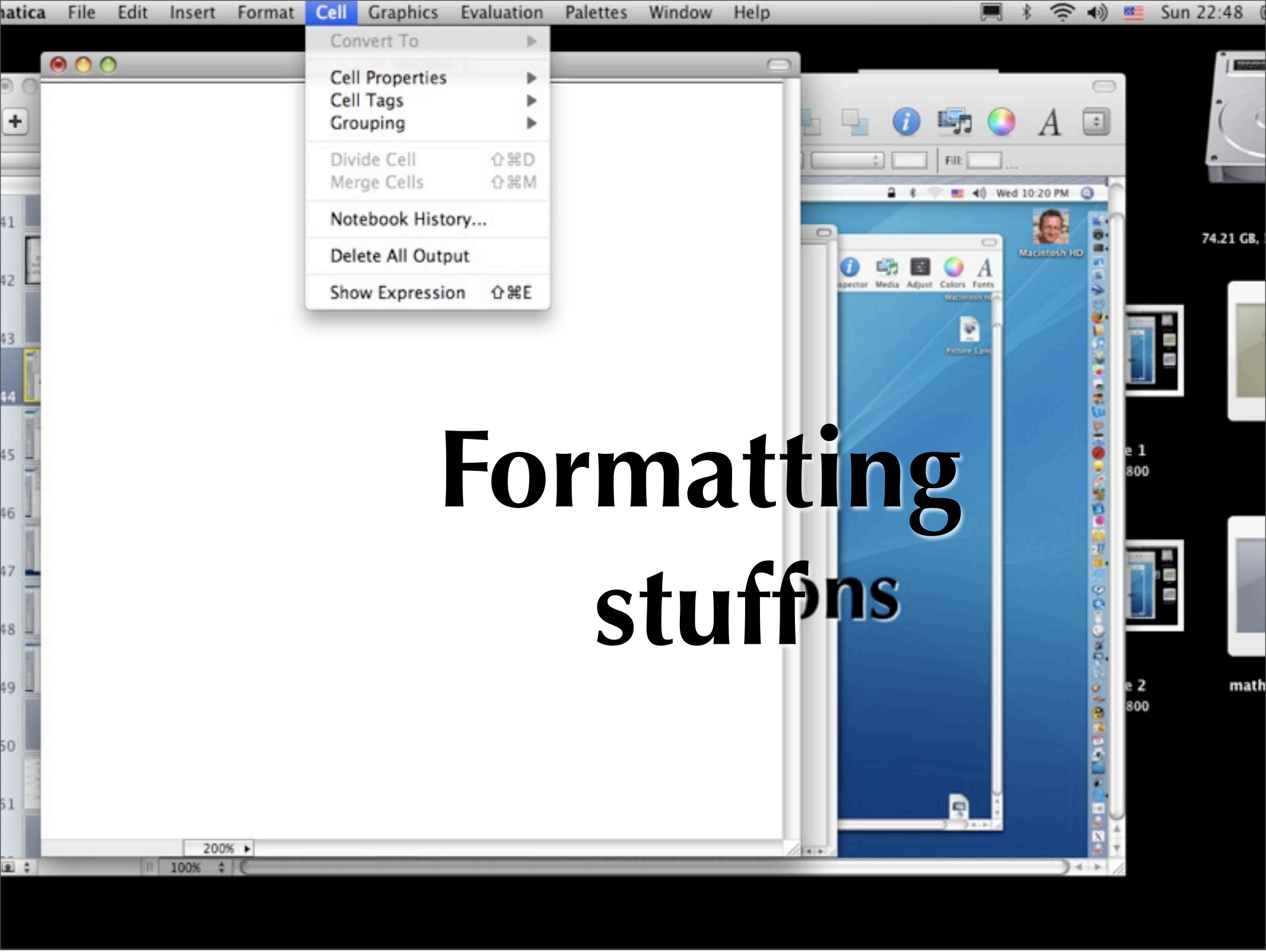
File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
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Convert To
Cell Properties
Cell Tags
Grouping
Divide Cell ⇧⌘D
Merge Cells ⇧⌘M
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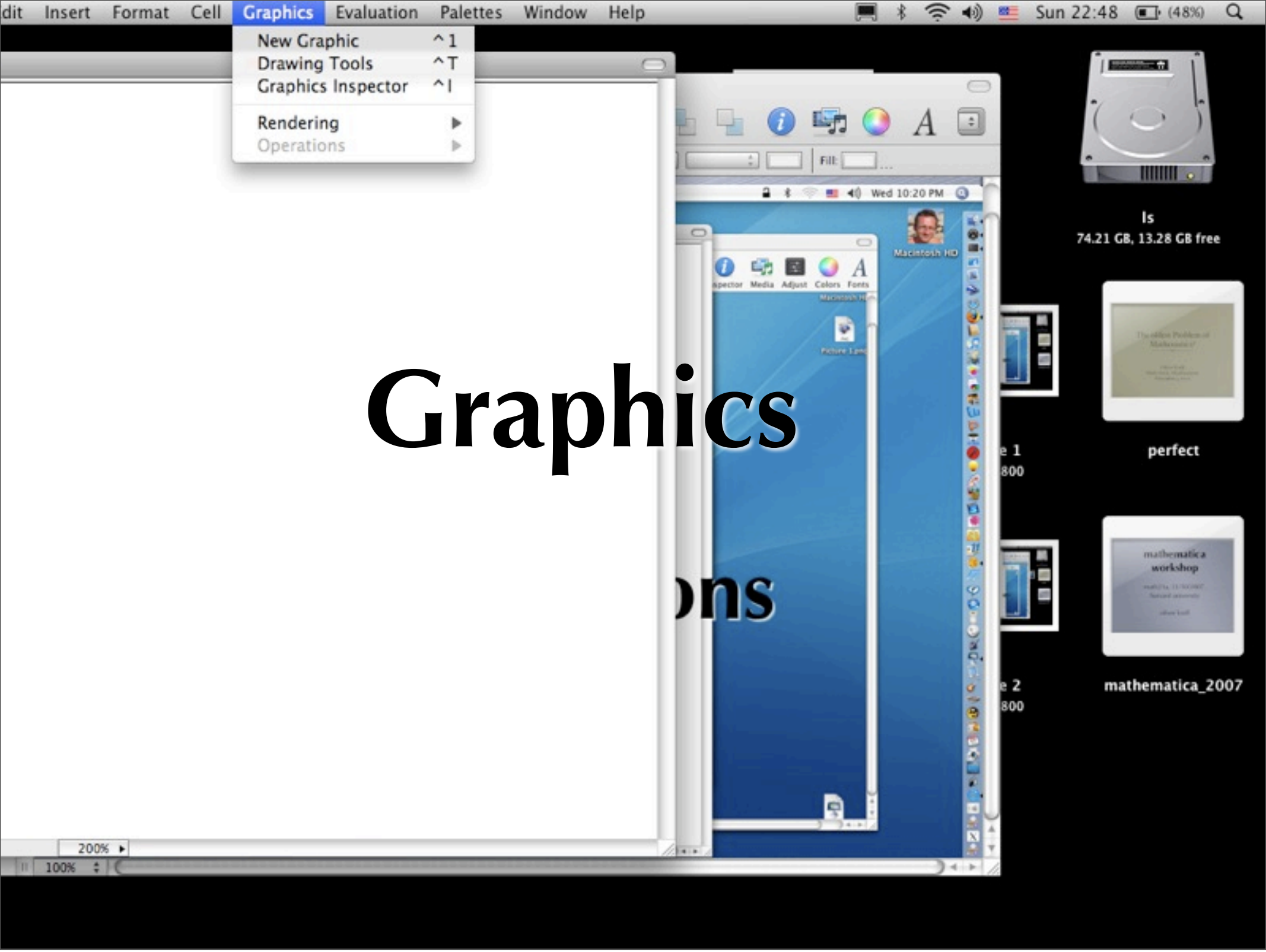
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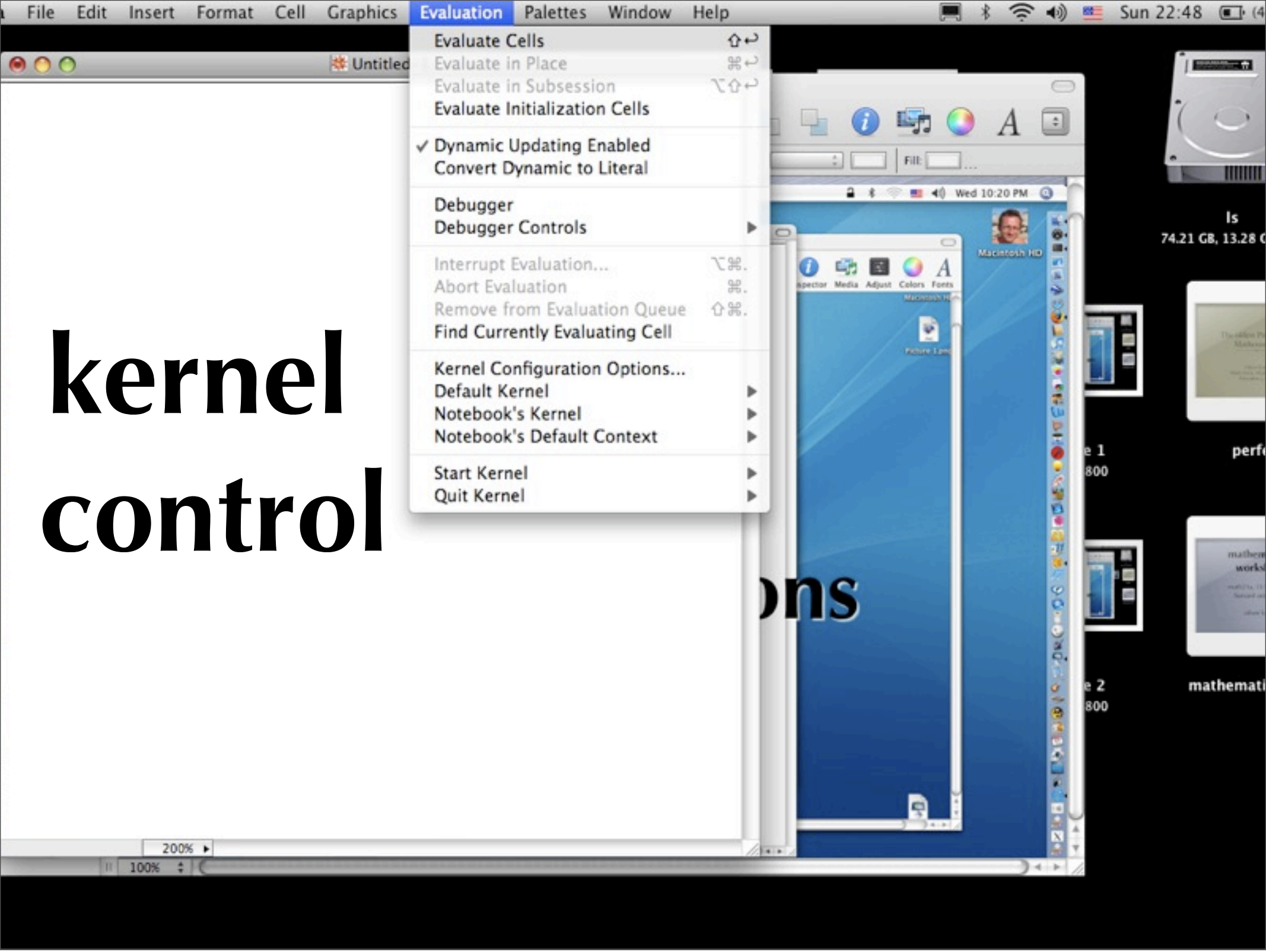
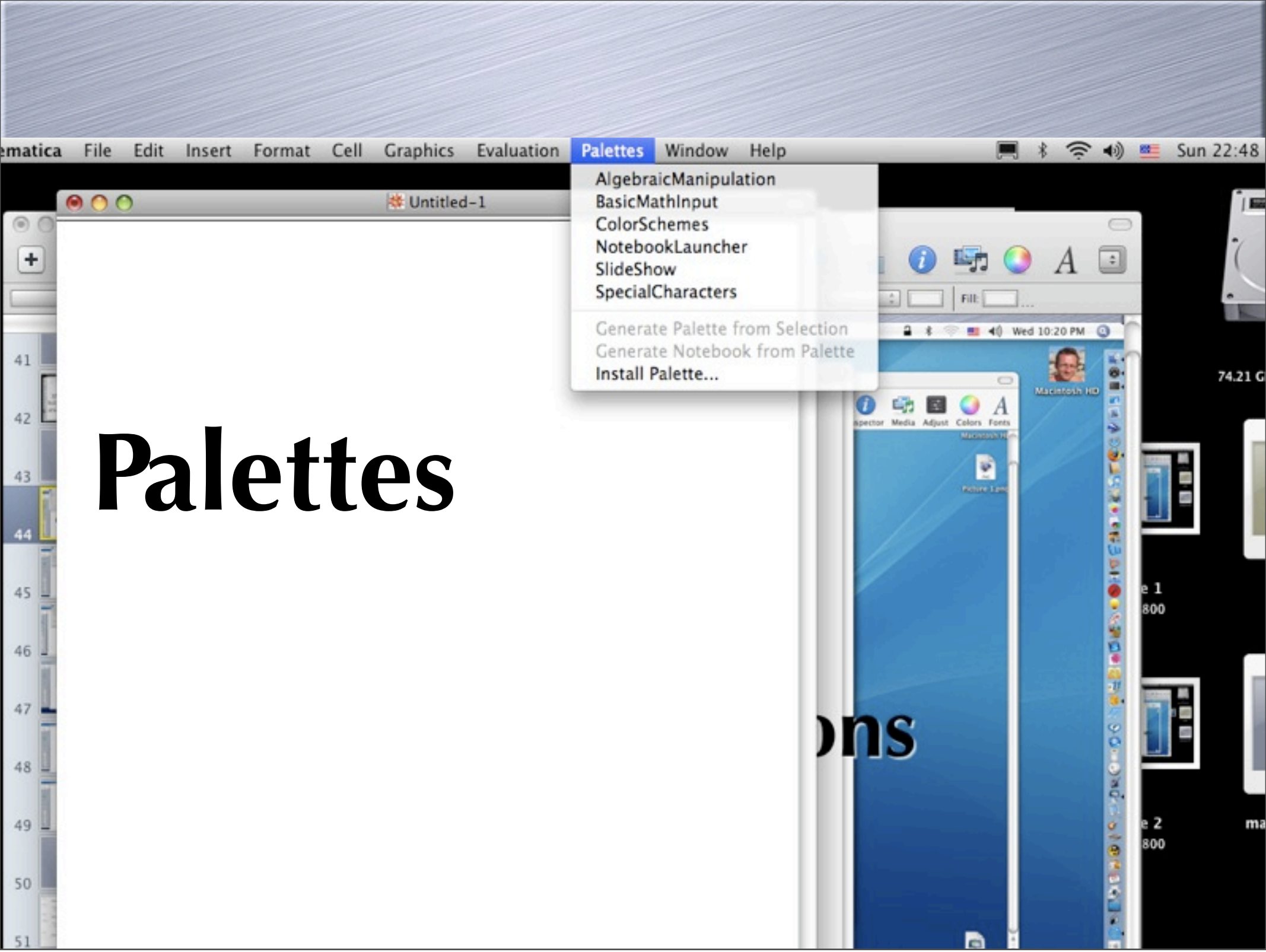

File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Sun 22:48
Evaluate Cells
Evaluate in Place
Evaluate in Subsession
Evaluate Initialization Cells
Dynamic Updating Enabled
Convert Dynamic to Literal
Debugger
Debugger Controls
Interrupt Evaluation...
Abort Evaluation
Remove from Evaluation Queue
Find Currently Evaluating Cell
Kernel Configuration Options...
Default Kernel
Notebook's Kernel
Notebook's Default Context
Start Kernel
Quit Kernel
kernel
control
200%
100%


ematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Sun 22:48
Untitled-1
AlgebraicManipulation
BasicMathInput
ColorSchemes
NotebookLauncher
SlideShow
SpecialCharacters
Generate Palette from Selection
Generate Notebook from Palette
Install Palette...
Palettes
Wed 10:20 PM
Macintosh HD
Inspector Media Adjust Colors Fonts
41
42
43
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49
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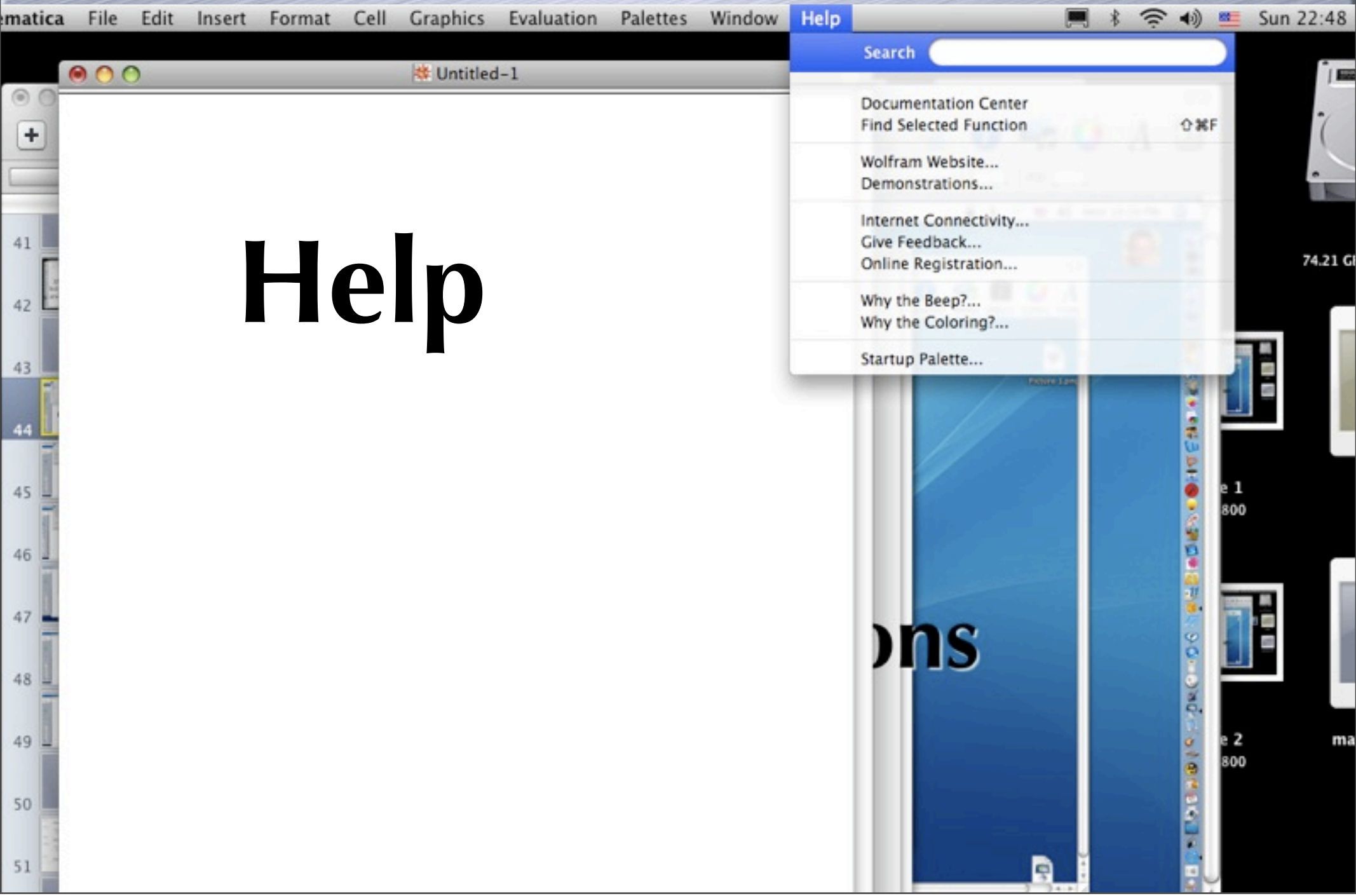
51


ematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help Sun 22:48
Untitled-1
Search
Documentation Center
Find Selected Function ⇧⌘F
Wolfram Website...
Demonstrations...
Internet Connectivity...
Give Feedback...
Online Registration...
Why the Beep?...
Why the Coloring?...
Startup Palette...
Help

stopping the kernel

Running...Untitled-1

In[1]:=

```
FactorInteger[2^(2^7) + 1]
```

Out[1]=

```
{{59649589127497217, 1},
 {5704689200685129054721, 1}}
```

In[2]:=

```
FactorInteger[2^(2^8) + 1]
```

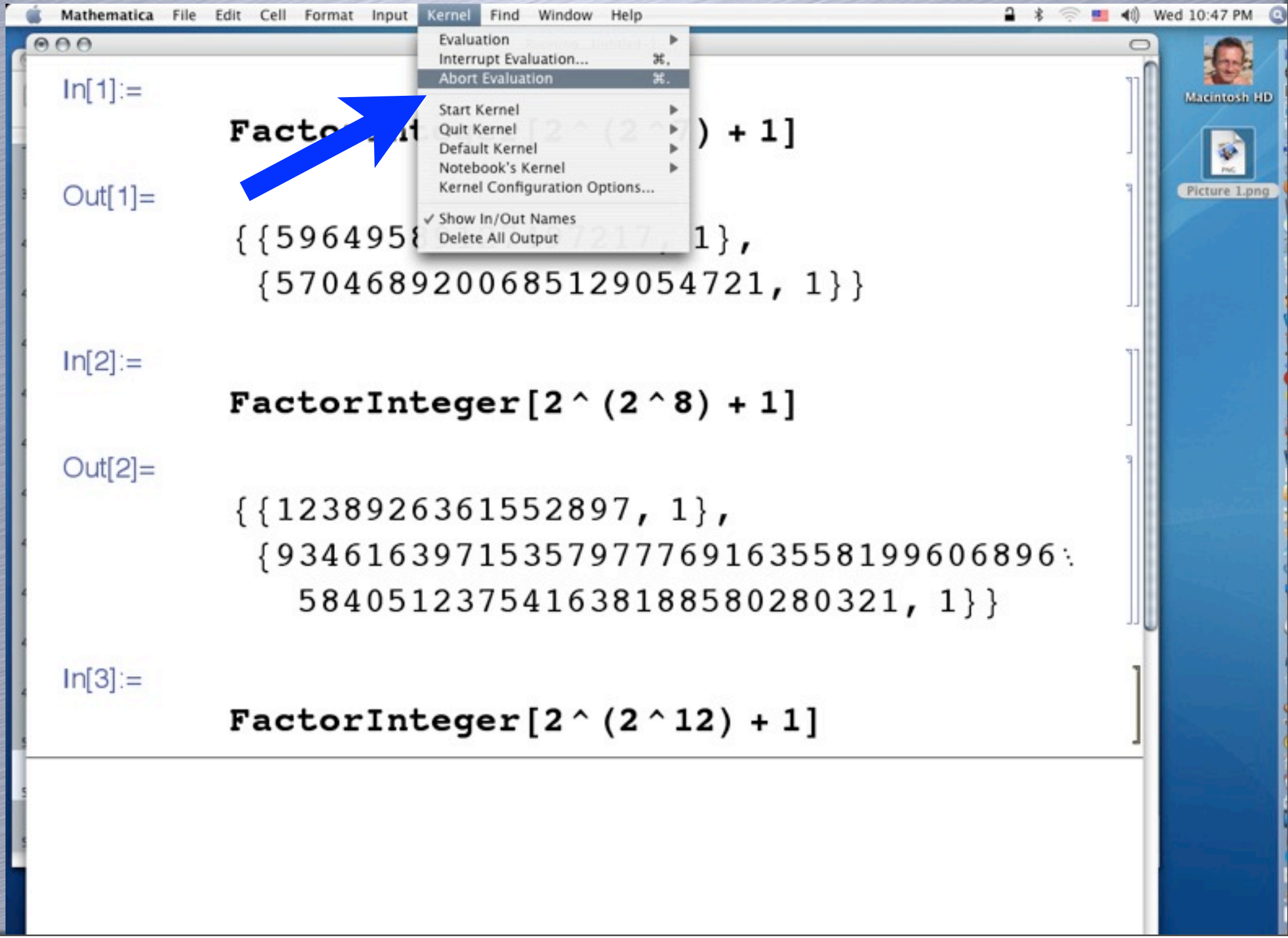
Out[2]=

```
{{1238926361552897, 1},
 {93461639715357977769163558199606896
   584051237541638188580280321, 1}}
```

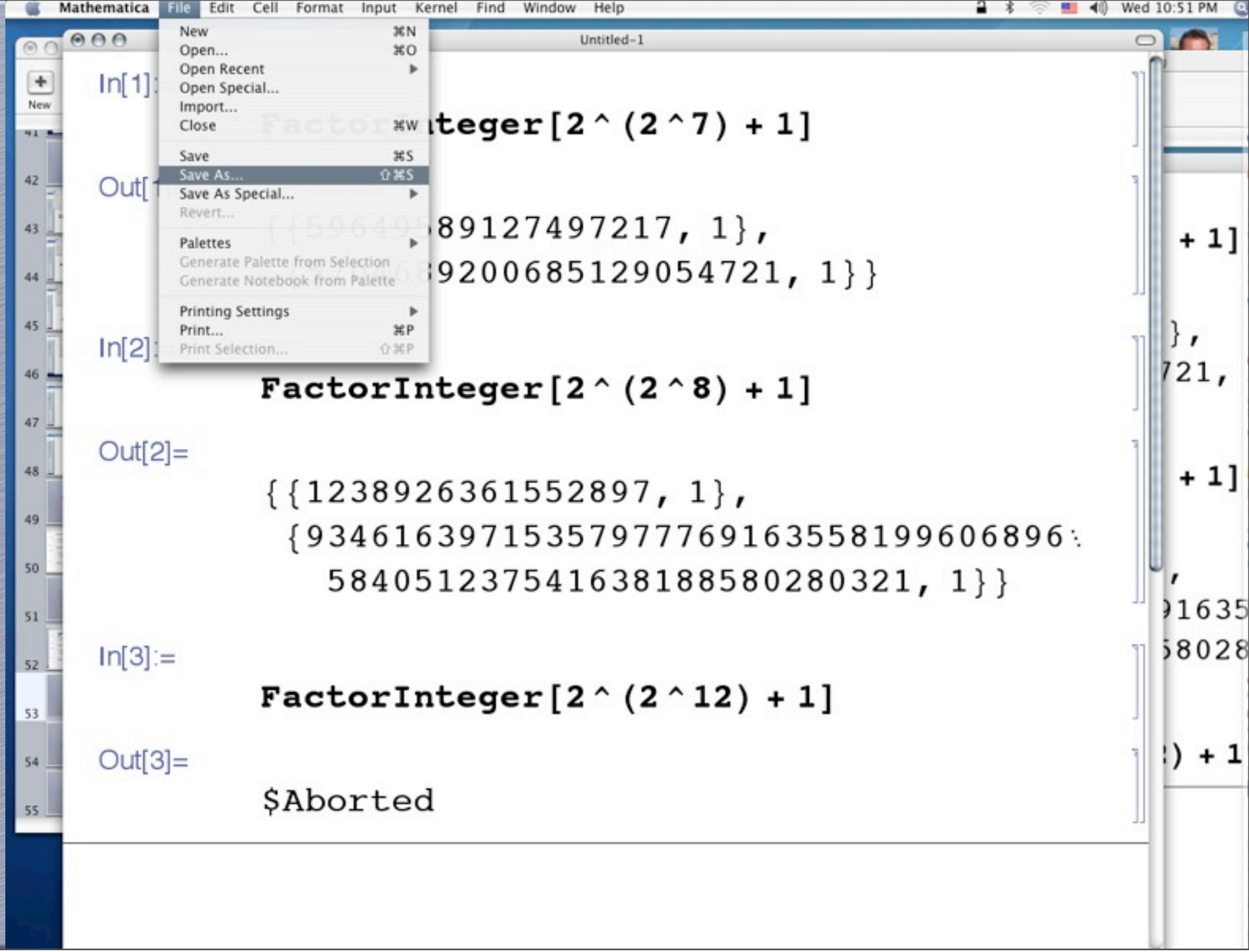
In[3]:=

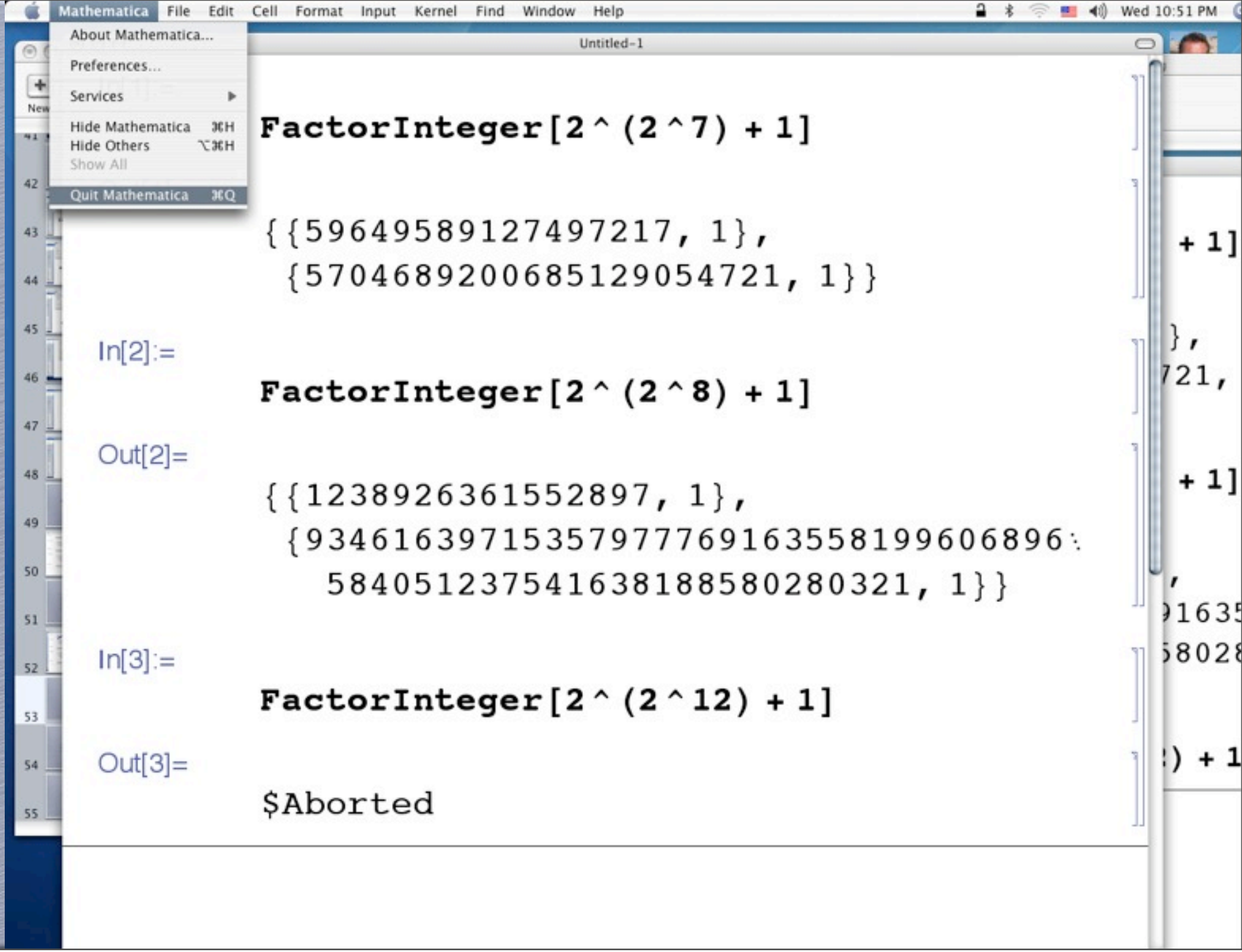
```
FactorInteger[2^(2^12) + 1]
```

- we are stuck
- the 12′th Fermat number has not yet been factored completely. Mathematica could try for years to factor it.
- We have to stop the kernel.


Mathematica File Edit Cell Format Input Kernel Find Window Help
Wed 10:47 PM
Evaluation
Interrupt Evaluation... ⌘,
Abort Evaluation ⌘.
Start Kernel
Quit Kernel
Default Kernel
Notebook's Kernel
Kernel Configuration Options...
✓ Show In/Out Names
Delete All Output
In[1]:=
Out[1]=
{{596495
1},
{5704689200685129054721, 1}}
In[2]:=
FactorInteger[2^(2^8) + 1]
Out[2]=
{{1238926361552897, 1},
{93461639715357977769163558199606896
584051237541638188580280321, 1}}
In[3]:=
FactorInteger[2^(2^12) + 1]
Macintosh HD
Picture 1.png

saving the notebook

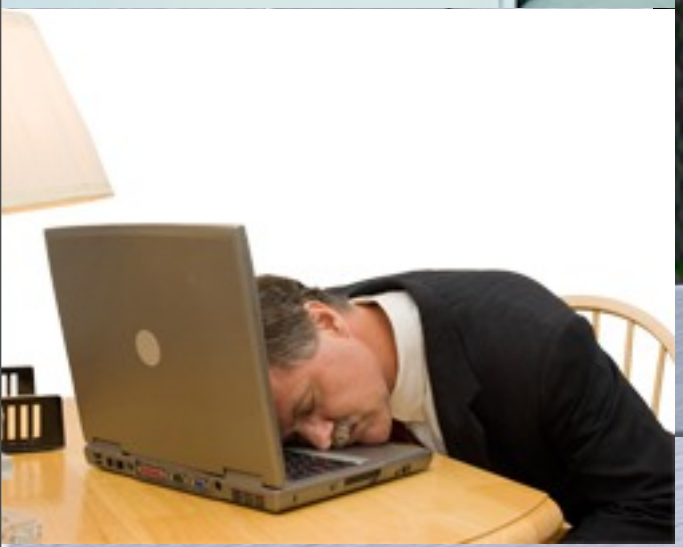

Mathematica File Edit Cell Format Input Kernel Find Window Help
Wed 10:51 PM
New ⌘N
Open... ⌘O
Open Recent
Open Special...
Import...
Close ⌘W
Save ⌘S
Save As... ⇧⌘S
Save As Special...
Revert...
Palettes
Generate Palette from Selection
Generate Notebook from Palette
Printing Settings
Print... ⌘P
Print Selection... ⇧⌘P
Untitled-1
In[1]:=
FactorInteger[2^(2^7) + 1]
Out[1]=
{{59649589127497217, 1},
{5704689200685129054721, 1}}
In[2]:=
FactorInteger[2^(2^8) + 1]
Out[2]=
{{1238926361552897, 1},
{93461639715357977769163558199606896584051237541638188580280321, 1}}
In[3]:=
FactorInteger[2^(2^12) + 1]
Out[3]=
$Aborted


Mathematica File Edit Cell Format Input Kernel Find Window Help
Wed 10:51 PM
About Mathematica...
Preferences...
Services
Hide Mathematica ⌘H
Hide Others ⌥⌘H
Show All
Quit Mathematica ⌘Q
Untitled-1
FactorInteger[2^(2^7) + 1]
{{59649589127497217, 1},
{5704689200685129054721, 1}}
In[2]:=
FactorInteger[2^(2^8) + 1]
Out[2]=
{{1238926361552897, 1},
{93461639715357977769163558199606896
584051237541638188580280321, 1}}
In[3]:=
FactorInteger[2^(2^12) + 1]
Out[3]=
$Aborted

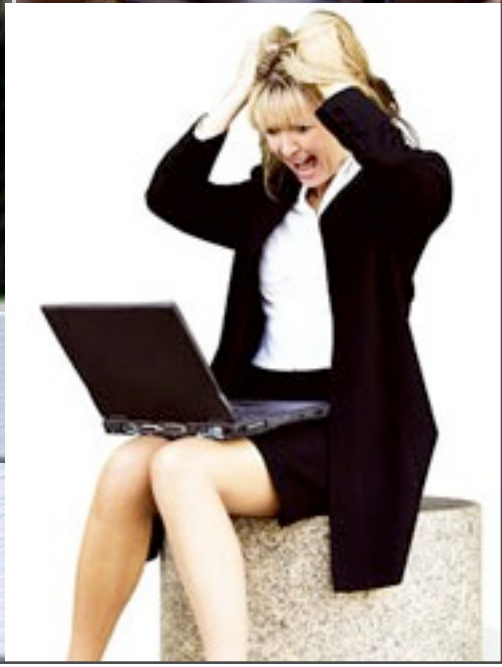
Remember Murphy's law

Anything that can go wrong, will.

Murphy was an optimist!



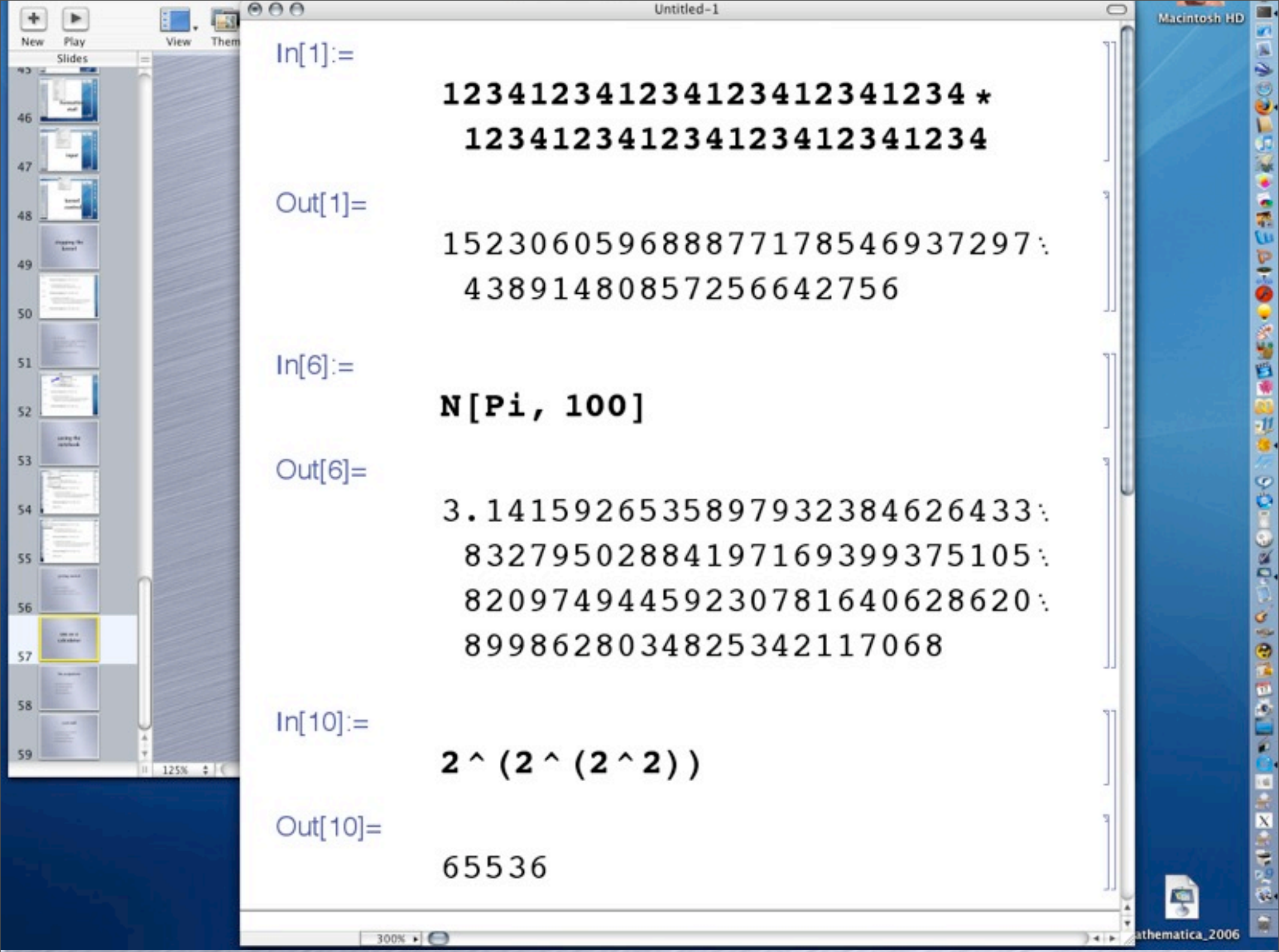
Movie source: ABCD group Harvard



getting started

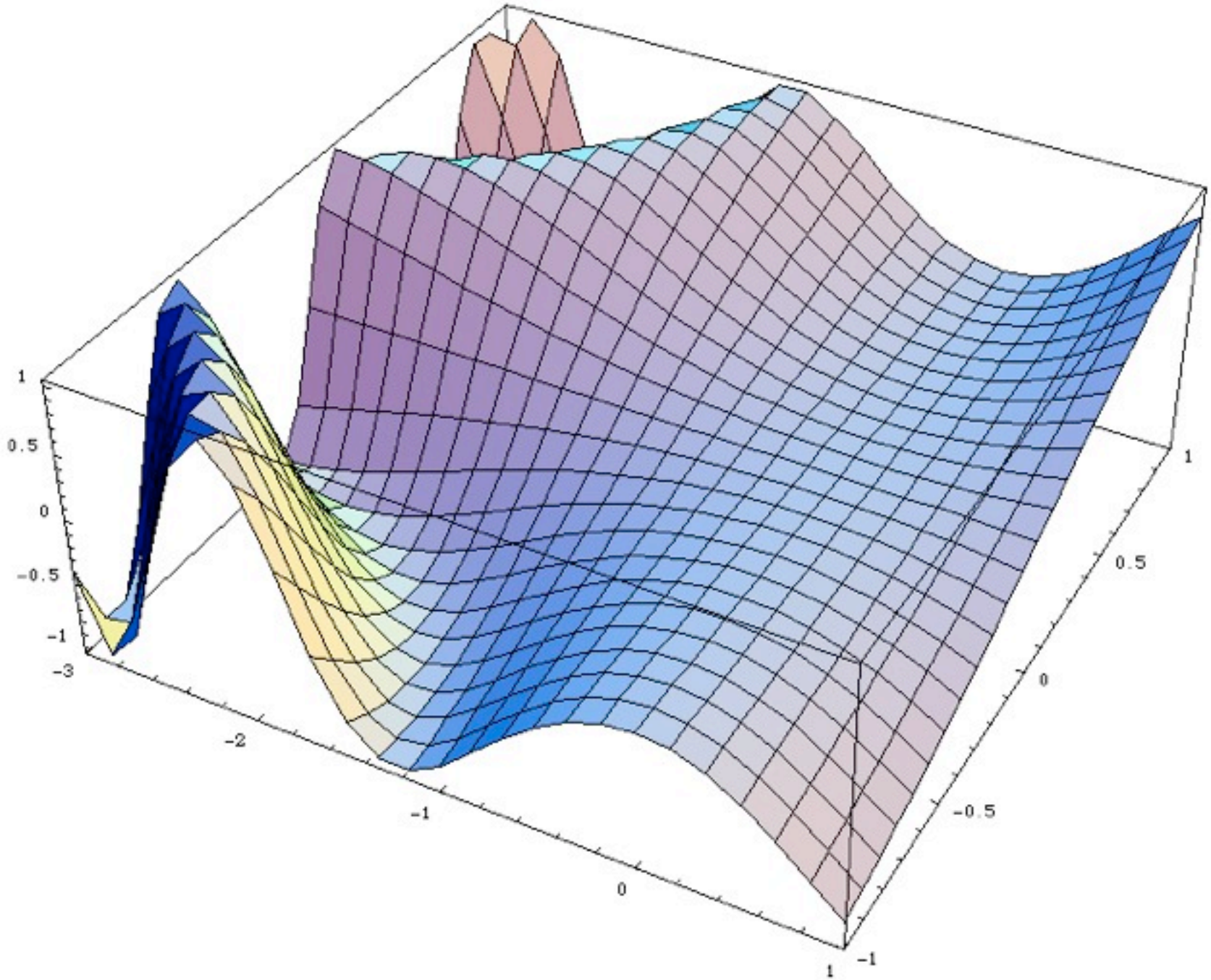
- use as a calculator
- use as a graphing calculator
- use as a computer algebra system

use as a calculator


New
Play
View
Slides
Untitled-1
In[1]:=
1234123412341234123412341234*
1234123412341234123412341234
Out[1]=
152306059688771785469372975:
4389148085725664275 6
In[6]:=
N[Pi, 100]
Out[6]=
3.14159265358979323846264335:
8327950288419716939937510 5:
8209749445923078164062862 0:
8998628034825342117068
In[10]:=
2^(2^(2^2))
Out[10]=
65536
300%
Macintosh HD
Mathematica_2006

use as graphing calculator

In[6]:= `Plot3D[ Sin[x^2 y], {x, -3, 1}, {y, -1, 1}]`



Out[6]= - SurfaceGraphics -

use as computer algebra system

In[9]:=
```
Integrate[Sin[x + y]^10, {x, 0, Pi/2}, {y, 0, Pi/2}]
```

Out[9]=
$$\frac{21}{50} + \frac{63\,\pi^2}{1024}$$

In[10]:=
```
Integrate[Sin[Sqrt[x]], x]
```

Out[10]=
$$-2\sqrt{x}\,\text{Cos}\left[\sqrt{x}\right] + 2\,\text{Sin}\left[\sqrt{x}\right]$$

In[11]:=
```
f[x_, y_, z_] := Log[x y] + Sin[Cos[x^2 + y]]
D[f[x, y, z], {x, 2}] + D[f[x, y, z], {y, 2}] +
 D[f[x, y, z], {z, 2}]
```

Out[12]=
$$-\frac{1}{x^2} - \frac{1}{y^2} - \text{Cos}[x^2+y]\,\text{Cos}[\text{Cos}[x^2+y]] -$$
$$4x^2\,\text{Cos}[x^2+y]\,\text{Cos}[\text{Cos}[x^2+y]] -$$
$$2\,\text{Cos}[\text{Cos}[x^2+y]]\,\text{Sin}[x^2+y] - \text{Sin}[x^2+y]^2\,\text{Sin}[\text{Cos}[x^2+y]] -$$
$$4x^2\,\text{Sin}[x^2+y]^2\,\text{Sin}[\text{Cos}[x^2+y]]$$

In[20]:=
```
Series[ Cos[ Pi (x + 1)] + Sin[x], {x, 0, 4}]
```

Out[20]=
$$-1 + x + \frac{\pi^2 x^2}{2} - \frac{x^3}{6} - \frac{\pi^4 x^4}{24} + O[x]^5$$

the assignment

- getting the assignment
- walk through
- the actual problems
- tips for working
- fine tuning graphics

getting the file

http://www.courses.fas.harvard.edu/~math21a/

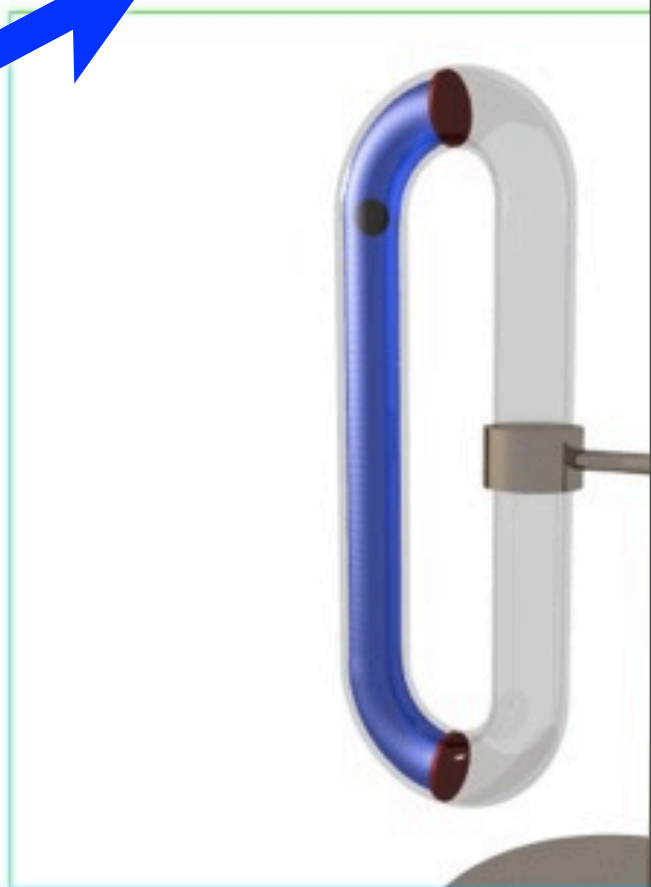
News

21a HARVARD

Course he
Offic
Email: knill@ma

NEW | SYLLABUS | CALENDAR | SECTION | HOMEWORK | EXAM | EXHIBIT | HANDOUT | LAB | TWITTER | FAQ | LINKS

- We have a Mathematica workshop on Thursday, November 19th from 7-8:30 PM in Hall D.
- The Mathematica assignment is now available here. (You have to save the file onto your desktop, then open it in Mathematica). There are three problems at the end of the notebook. The assignment is due during the last lecture of the semester. In print. Here are some interface templates to get started with problem 3. Even so the assignment can be done in a relatively modest amount of time (2-3 hours), start early!
- The final exam exam on Saturday December 19 2009 takes place at 2 PM. See the Exam schedule.



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Lab

http://www.courses.fas.harvard.edu/~math21a/labs/index.html

Google

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Lab

MA TH 21a HARVARD

6760, Math 21a, Fall 2

Mathematica project Math 21a, Multivariable Calcu

L

Course head: Oliver

Office: SciCtr

Email: knill@math.harvard

NEW | SYLLABUS | CALENDAR | SECTION | HOMEWORK | EXAM | EXHIBIT | HANDOUT | LAB | TWITTER | FAQ | LINKS

install Mathematica 7 on your own computer, get the program here. start up the application and follow the instructions. You need the **Harvard icence number L2482-2405**. The from your computer generated **Machine ID** will need to be entered into the Mathematica Registration page. In retu u will be sent a password by email. This is what you see during installation in

- Mac OSX.
- Windows XP.

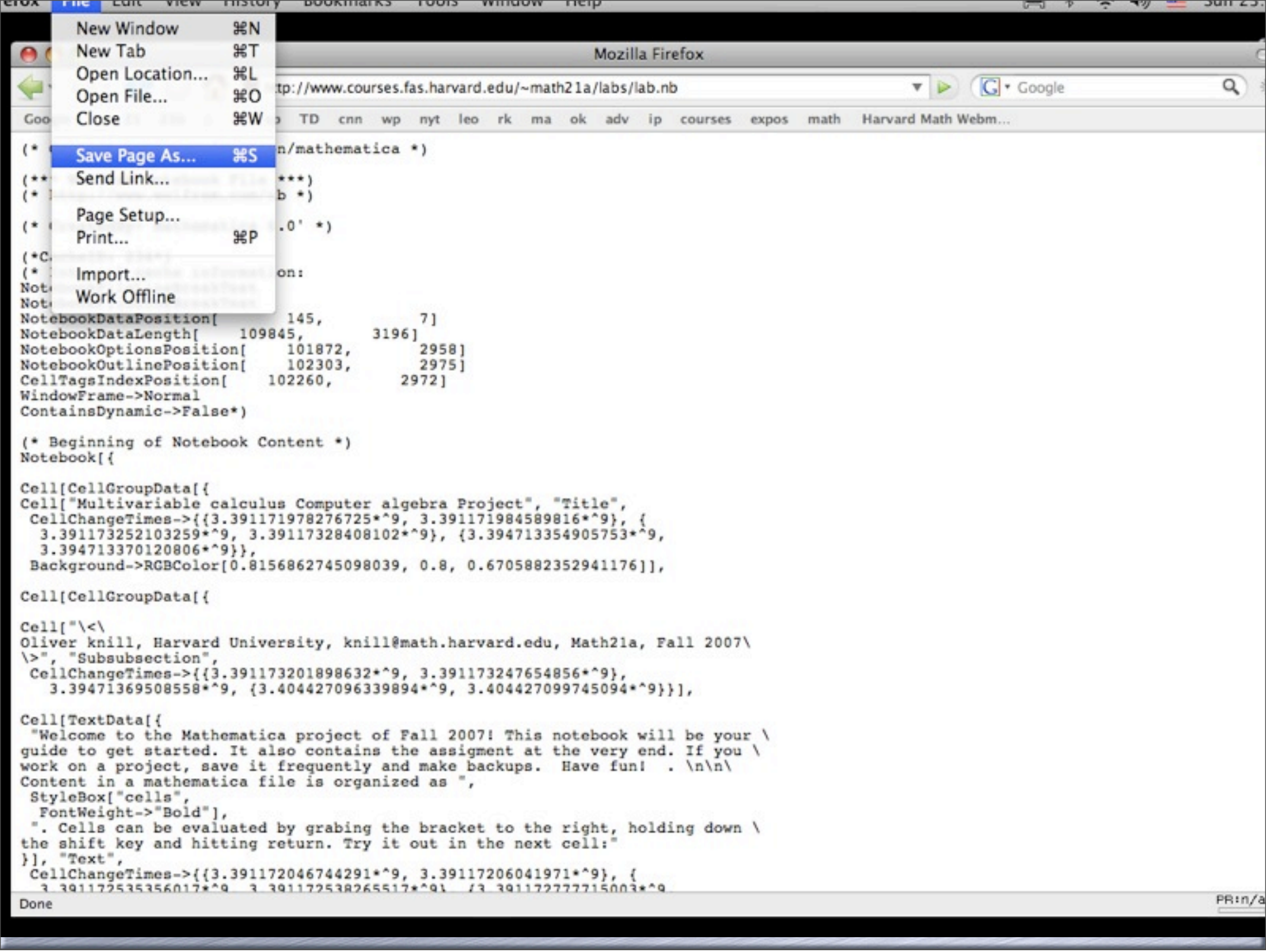
ntact Oliver if you plan to use Mathematica on a Linux system.

he Mathematica assignment is available here. (You have to save this file on your desktop and then open it with Mathematica). Here are examples of emonstration ideas for the third "creative" problem.

athematica is launched like any other application r Macintoshs or PC's. On Linux, just type "mathematica" to start the notebook version, or "mat start the terminal version. Example code: Here is ath atica code to classify critical points:

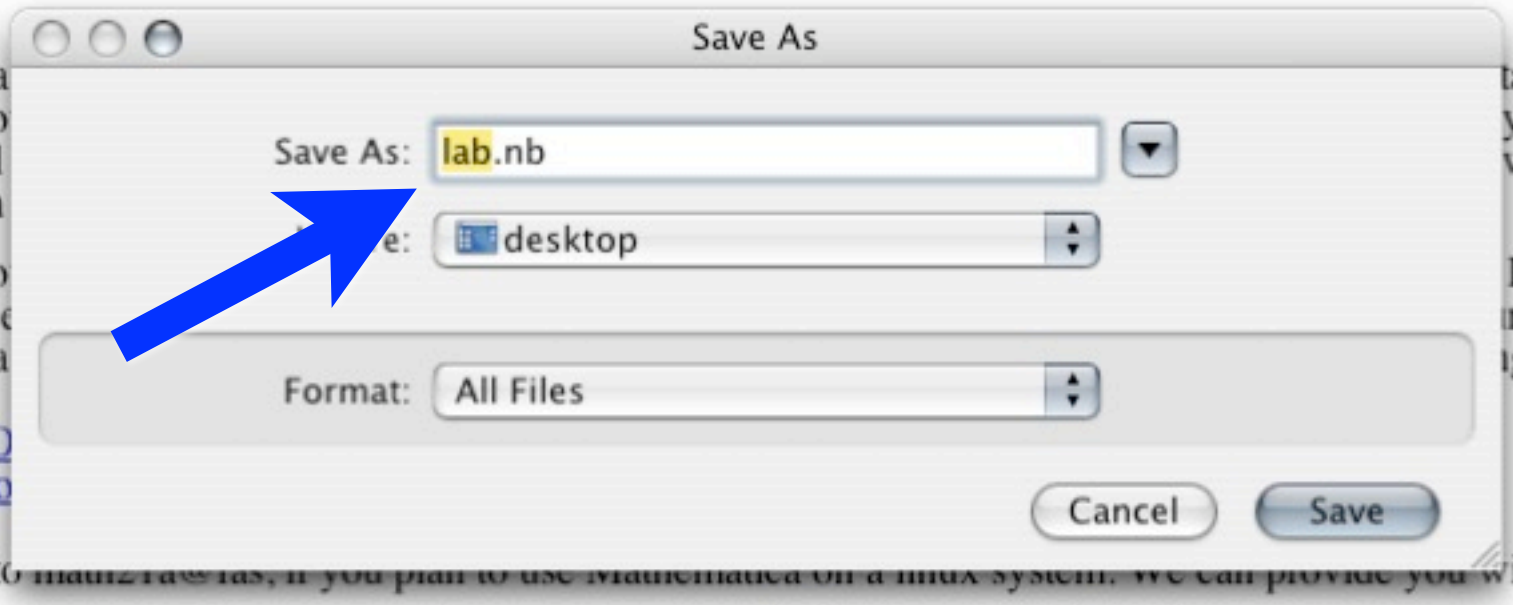
```
f[x_,y_]:=4 x y - x^3 y - x y^3;
a[x_,y_]:=D[f[u,v],u] /. {u->x,v->y}; b[x_,y_]:=D[f[u,v],v] /. {u->x,v->y};
A=Solve[{a[x,y]==0,b[x,y]==0},{x,y}];
CriticalPoints=Table[{A[[i,1,2]],A[[i,2,2]]},{i,Length[A]}];
H[{x_,y_}]:={{D[f[u,v],{u,2}],D[D[f[u,v],v],u]},{D[D[f[u,v],u],v],D[f[u,v],{v,2}]}} /. {u->x,v->y};
F[A_]:=A[[1,1]]; Discriminant=Map[Det,Map[H,CriticalPoints]]
FirstEntry=Map[F,Map[H,CriticalPoints]]
Decide[B_]:=If[Det[B]<0,"saddle",If[B[[1,1]]<0,"max","min"]];
Analysis=Map[Decide, Map[H,CriticalPoints]];
Table[{CriticalPoints[[i]],Analysis[[i]]},{i,Length[CriticalPoints]}]
```

p://www.courses.fas.harvard.edu/~math21a/labs/lab.nb



Friday, November 20, 2009

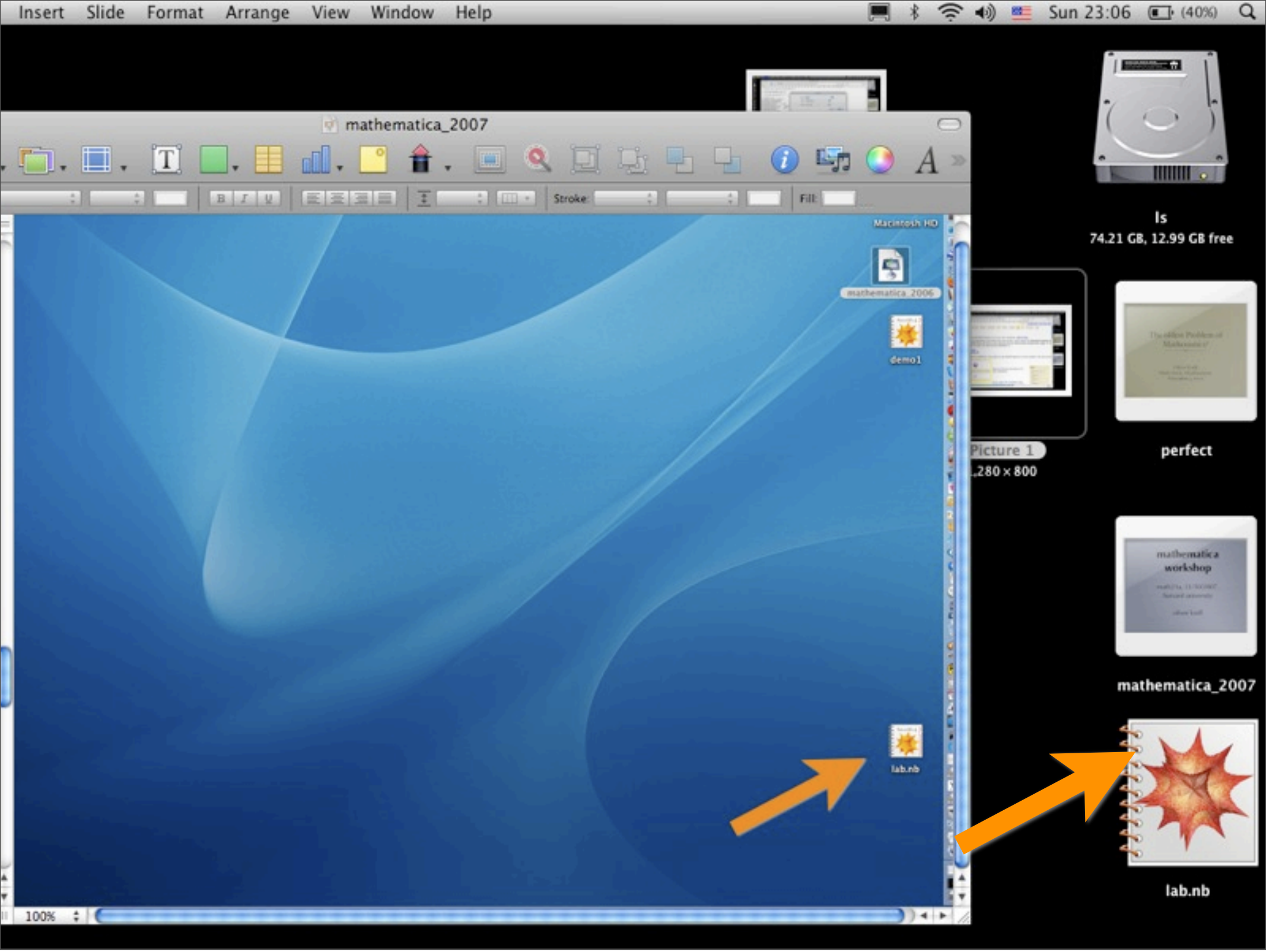
Important: Save with .nb not .txt



- The Mathematica laboratory assignment is now available. Download it here!

```
(* Mathematica code to classify critical points, O. Knill, 2000 *)
f[x_,y_]:=4 x y - x^3 y - x y^3;
a[x_,y_]:=D[f[u,v],u] /. {u->x,v->y}; b[x_,y_]:=D[f[u,v],v] /. {u->x,v->y};
A=Solve[{a[x,y]==0,b[x,y]==0},{x,y}];
CriticalPoints=Table[{A[[i,1,2]],A[[i,2,2]]},{i,Length[A]}];
H[{x_,y_}]:={{D[f[u,v],{u,2}],D[D[f[u,v],v],u]},{D[D[f[u,v],u],v],D[f[u,v],{v,2}]}} /. {u->x,v->y};
F[A_]:=A[[1,1]]; Discriminant=Map[Det,Map[H,CriticalPoints]]
FirstEntry=Map[F,Map[H,CriticalPoints]]
Decide[B_]:=If[Det[B]<0,"saddle",If[B[[1,1]]<0,"max","min"]];
Analysis=Map[Decide, Map[H,CriticalPoints]];
Table[{CriticalPoints[[i]],Analysis[[i]]},{i,Length[CriticalPoints]}]
```

Here is a slicker code, doing the same and even presenting it as a nice table (credit: Matt Leingang, 2006)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Picture 1
280 × 800
perfect
mathematica
workshop
mathematica_2007
lab.nb

walk through

Multivariable Calculus Computer Algebra Project

Oliver knill, Harvard University, knill@math.harvard.edu, Math21a, Fall 2008

Welcome to the Mathematica project of Fall 2008! This notebook will be your guide to get started. It also contains the assignement at the very end. If you work on a project, save it frequently and make backups. Have fun!

Content in a mathematica file is organized as **cells**. Cells can be evaluated by grabbing the bracket to the right, holding down the shift key and hitting return. Try it out in the next cell, the "Devils graph":

```
Plot[ Sin[1 / x], {x, -1, 1}]
```

After evaluating the cell, an output cell has been added to the input cell. The output cell can be made interactive as in the following example:

```
Manipulate[Plot[Sin[1 / x], {x, -c, c}], {c, 0.1, 1}]
```

Lets get started. I suggest you read through the examples and evaluate the ones you are interested in which are hopefully all. If you are unpatient, grab the most outer bracket to the right which contains the entire notebook and evaluate it. All the cells will be evaluated.

A calculator

Anything you can do on a graphics calculator you can do with a computer algebra system, only better and more accurately. Here is an example to compute a numerical expression

```
234^10 + Sin[Pi / 3]^3 + Sqrt[5]
```

It did not compute it numerically and left square roots of integers untouched. To get a numerical value or a numerical value or a value with accuracy 200 digits, access the previous expression (called %) and

```
N[%, 200]
```

Lets play with this:

```
Manipulate[N[Sqrt[5], digits], {digits, 1, 1000}]
```

Or look at the list of prime numbers

```
Manipulate[Prime[Floor[n]], {n, 1, 300000000}]
```

or binominal expressions

```
Manipulate[Expand[(x + y)^Floor[n]], {n, 1, 60}]
```

the problems

```
A = P[[1, 1]];
```

We get the (red,green,blue) color values for the pixel at position (3,4) as follows

```
A[[3, 4]]
```

Lets do some woodoo on Oliver and invert the colors:

```
U = 255 - A; Show[Graphics[Raster[U, P[[1, 2]], P[[1, 3]], P[[1, 4]]], P[[2]], P[[3]]]]
```

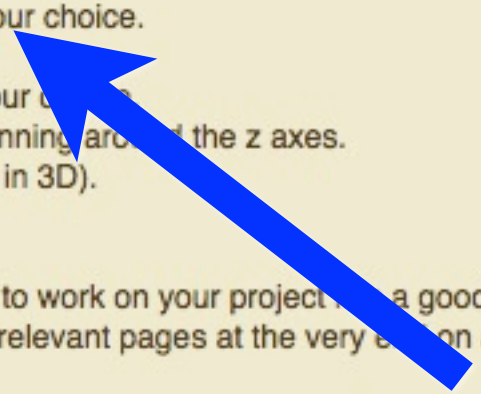
Assignment

To get full credit for this Mathematica assignment, you have to hand in :

1) (2 points) A printout of a parametric surface r (u, v) = (x (u, v), y (u, v), z (u, v)) of your choice.
2) (2 points) A printout of a spherical plot or an implicit surface of your choice.
3) (2 points) Make a molecule-plot, a stock-data plot or a text word-analysis-plot of your
4) (2 points) Compute numerically the moment of inertia of a body x^4+y^4+z^4<1 spinning ar the z axes.
5) (2 points) Produce graphics object of your choice (you can include pictures or work in 3D).
Your examples should be different from any example which appear in this notebook.

If you find something cool during your experiments, feel free to include it also.In order to work on your project a good idea to save this notebook fi as a different document, do the assignment directly in that notebook and print out the relevant pages at the very on a printer.The assignments ha to be printed out and turned in the last class.

Oliver Knill, November 18, 2008, email: knill@math.harvard.edu



5 problems

3 problems

- **Assignment**

To get full credit for this Mathematica assignment, you

1) (2 points) A printout of a parametric surface r (u, v)
2) (2 points) A printout of a spherical plot or an implici
3) (2 points) Make a molecule-plot, a stock-data plot
4) (2 points) Compute numerically the moment of iner
around the z axes.
5) (2 points) Produce graphics object of your choice (y
Your examples should be different from any example

tips

tips

tips

- save frequently

tips

- save frequently
- start a new notebook

tips

- save frequently
- start a new notebook
- careful with parameters

tips

- save frequently
- start a new notebook
- careful with parameters
- make backups

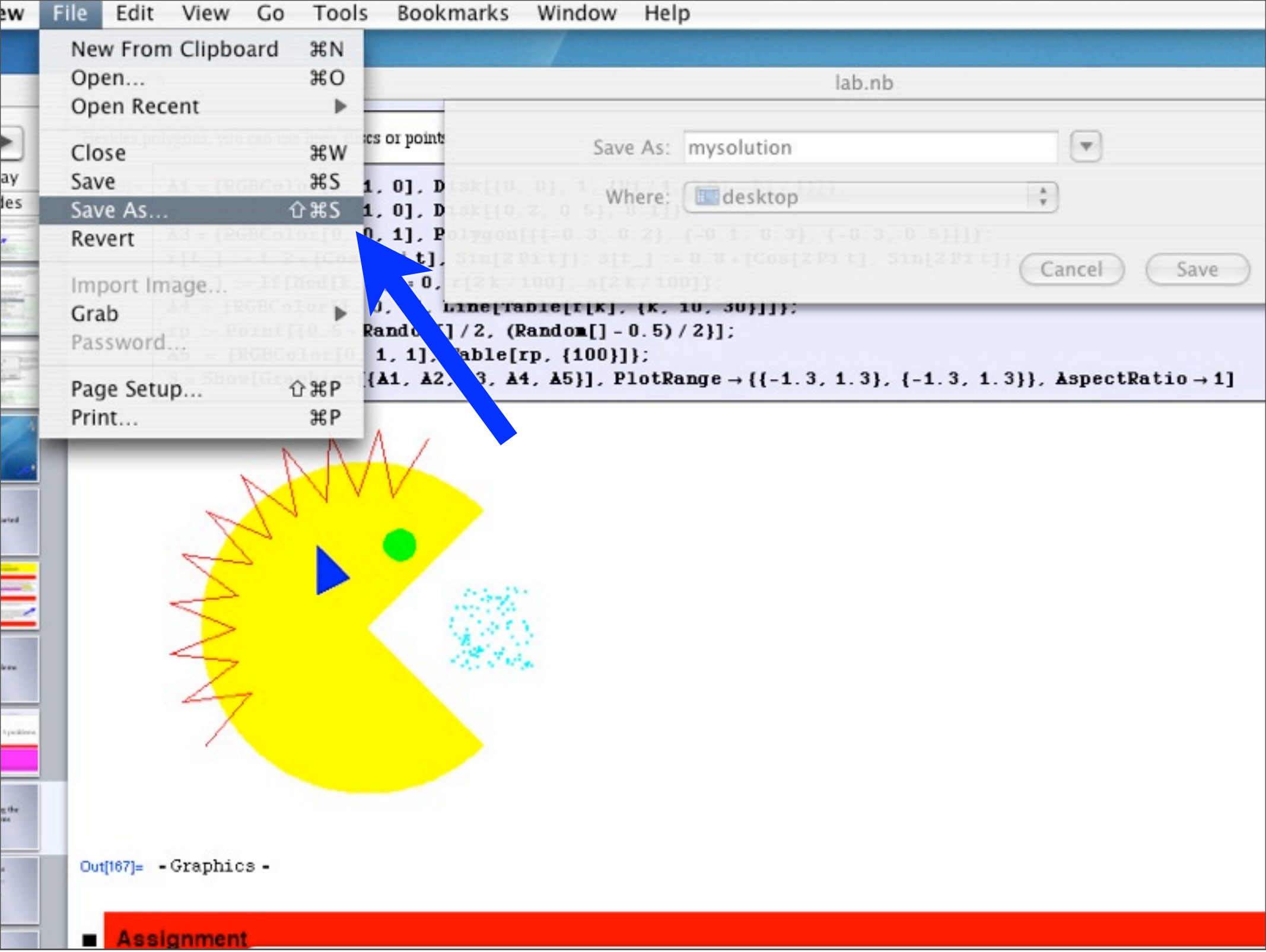
tips

- save frequently
- start a new notebook
- careful with parameters
- make backups
- print early

tips

- save frequently
- start a new notebook
- careful with parameters
- make backups
- print early
- start a week early

submitting the problems


File
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View
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Tools
Bookmarks
Window
Help
New From Clipboard ⌘N
Open... ⌘O
Open Recent
Close ⌘W
Save ⌘S
Save As... ⇧⌘S
Revert
Import Image...
Grab
Password...
Page Setup... ⇧⌘P
Print... ⌘P
lab.nb
Save As: mysolution
Where: desktop
Cancel
Save
Out[167]= -Graphics-
Assignment

lab.nb

Save As: mysolution

Where: desktop

Cancel Save

Besides polygons, you can use lines, discs or point

```
In[159]:= A1 = {RGBColor[1, 1, 0], D
          A2 = {RGBColor[0, 1, 0], D
          A3 = {RGBColor[0, 0, 1], P
          r[t_] := 1.2 + {Cos[2 Pi t],
          f[k_] := If[Mod[k, 2] == 0,
          A4 = {RGBColor[1, 0, 0], Line[Table[r[k], {k, 10, 30}]]};
          rp := Point[{0.5 + Random[] / 2, (Random[] - 0.5) / 2}];
          A5 = {RGBColor[0, 1, 1], Table[rp, {100}]};
          S = Show[Graphics[{A1, A2, A3, A4, A5}], PlotRange → {{-1.3, 1.3}, {-1.3, 1.3}}, AspectRatio → 1]
```

Out[167]= -Graphics-

Assignment

To get full credit for this Mathematica assignment you have to hand in:

1) A printout of a graph of a function f(x,y) of two variables of your choice.

2) A printout of a parametric surface r(u,v) = (x(u,v),y(u,v),z(u,v)) of your choice.

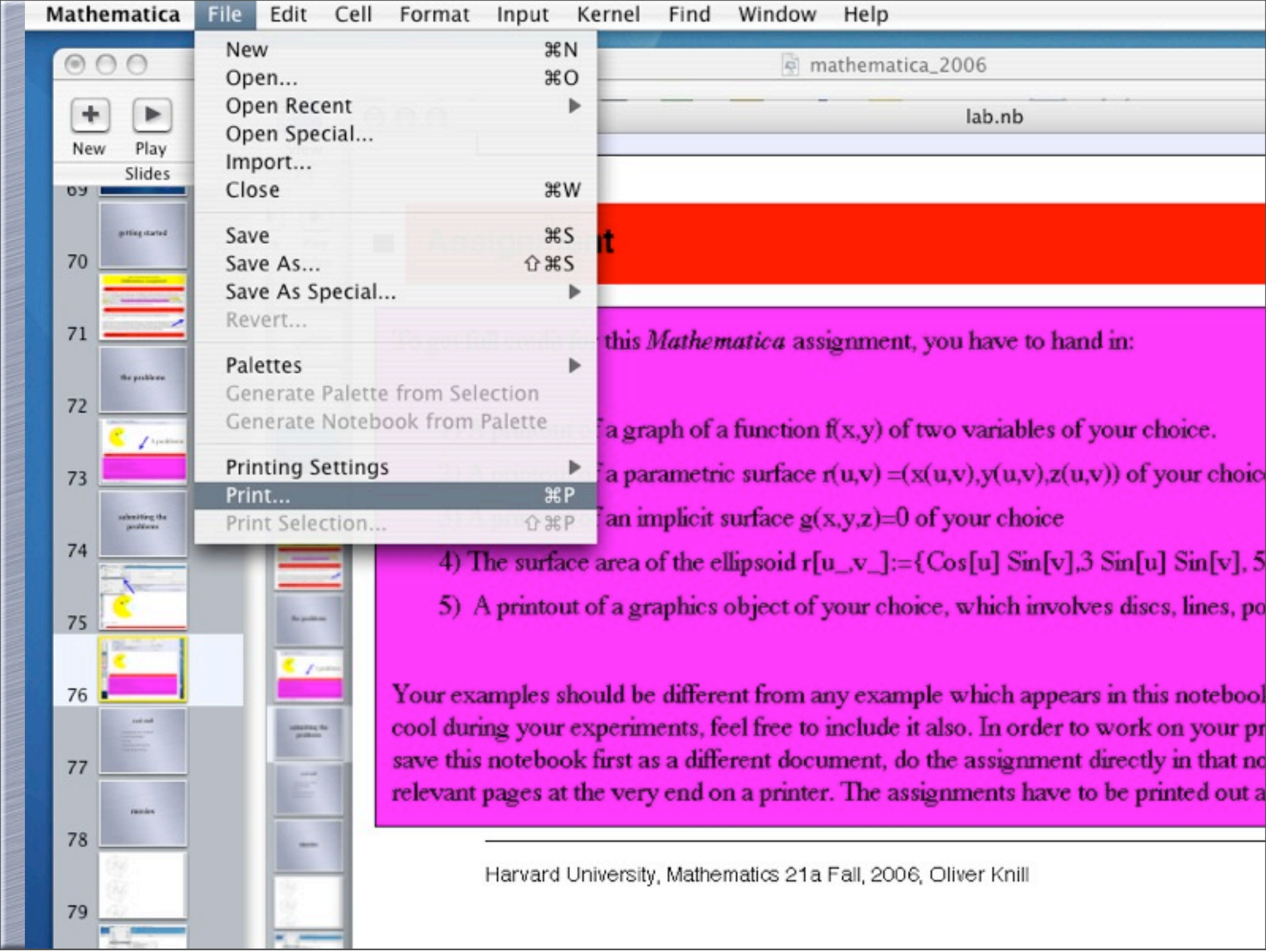
3) A printout of an implicit surface g(x,y,z)=0 of your choice.

4) The surface area of the ellipsoid r[u_,v_] = {Cos[u] Sin[v],3 Sin[u] Sin[v], 5 Cos[v]}.

5) A printout of a graphics object of your choice, which involves discs, lines, polygons or points.

Your examples should be different from any example which appears in this notebook. If you find something cool during your experiments, feel free to include it also. In order to work on your project it is a good idea to save this notebook first as a different document, do the assignment directly in that notebook and print out the relevant pages at the very end on a printer. The assignments have to be printed out and turned in the last class.

Harvard University, Mathematics 21a Fall, 2006, Oliver Knill


Mathematica
File
Edit
Cell
Format
Input
Kernel
Find
Window
Help
New ⌘N
Open... ⌘O
Open Recent
Open Special...
Import...
Close ⌘W
Save ⌘S
Save As... ⇧⌘S
Save As Special...
Revert...
Palettes
Generate Palette from Selection
Generate Notebook from Palette
Printing Settings
Print... ⌘P
Print Selection... ⇧⌘P
mathematica_2006
lab.nb
New
Play
Slides
this Mathematica assignment, you have to hand in:
a graph of a function f(x,y) of two variables of your choice.
a parametric surface r(u,v) =(x(u,v),y(u,v),z(u,v)) of your choic
an implicit surface g(x,y,z)=0 of your choice
4) The surface area of the ellipsoid r[u_,v_]:={Cos[u] Sin[v],3 Sin[u] Sin[v], 5
5) A printout of a graphics object of your choice, which involves discs, lines, po
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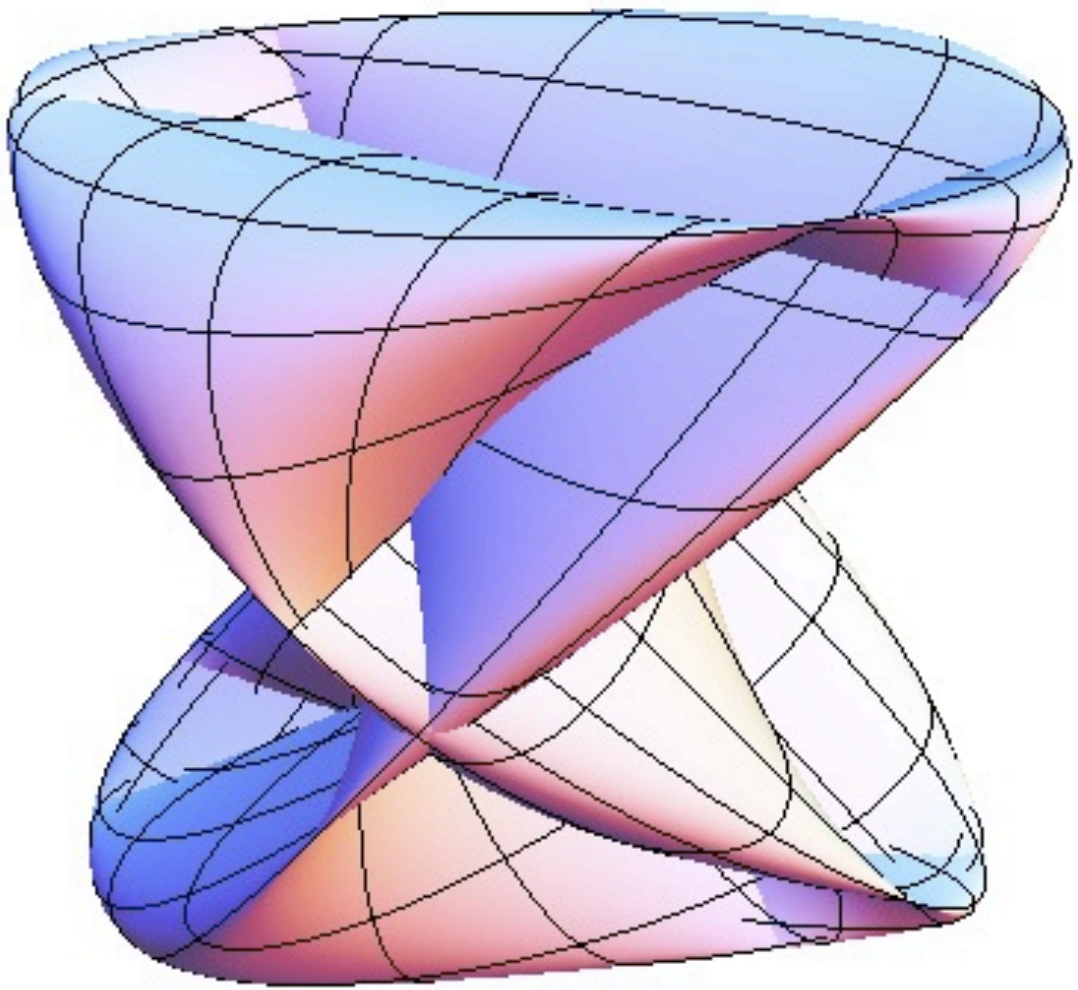
save this notebook first as a different document, do the assignment directly in that no
relevant pages at the very end on a printer. The assignments have to be printed out a
Harvard University, Mathematics 21a Fall, 2006, Oliver Knill

tricks for assignment

- parameters, parameters paramers
- pepping up graphics
- simple programming

animation for exploration



Paste Snapshot

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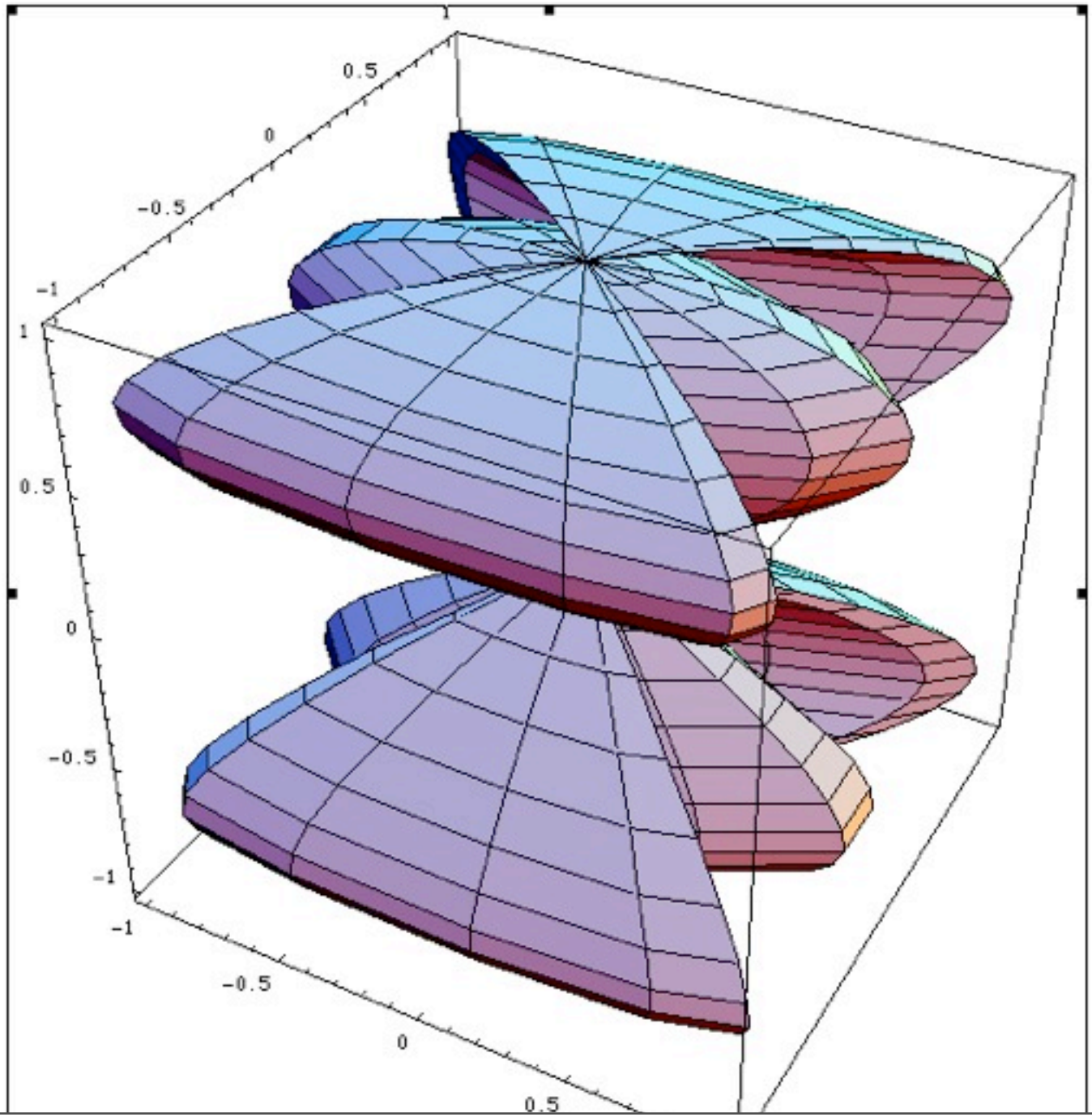
Animate Bookmarks

Autorun

pepping up graphics

```
ParametricPlot3D[{ Sin[2 v] Cos[3 u], Sin[2 v] Sin[u], Cos[v]},
 {u, 0, 2 Pi}, {v, 0, Pi}]
```



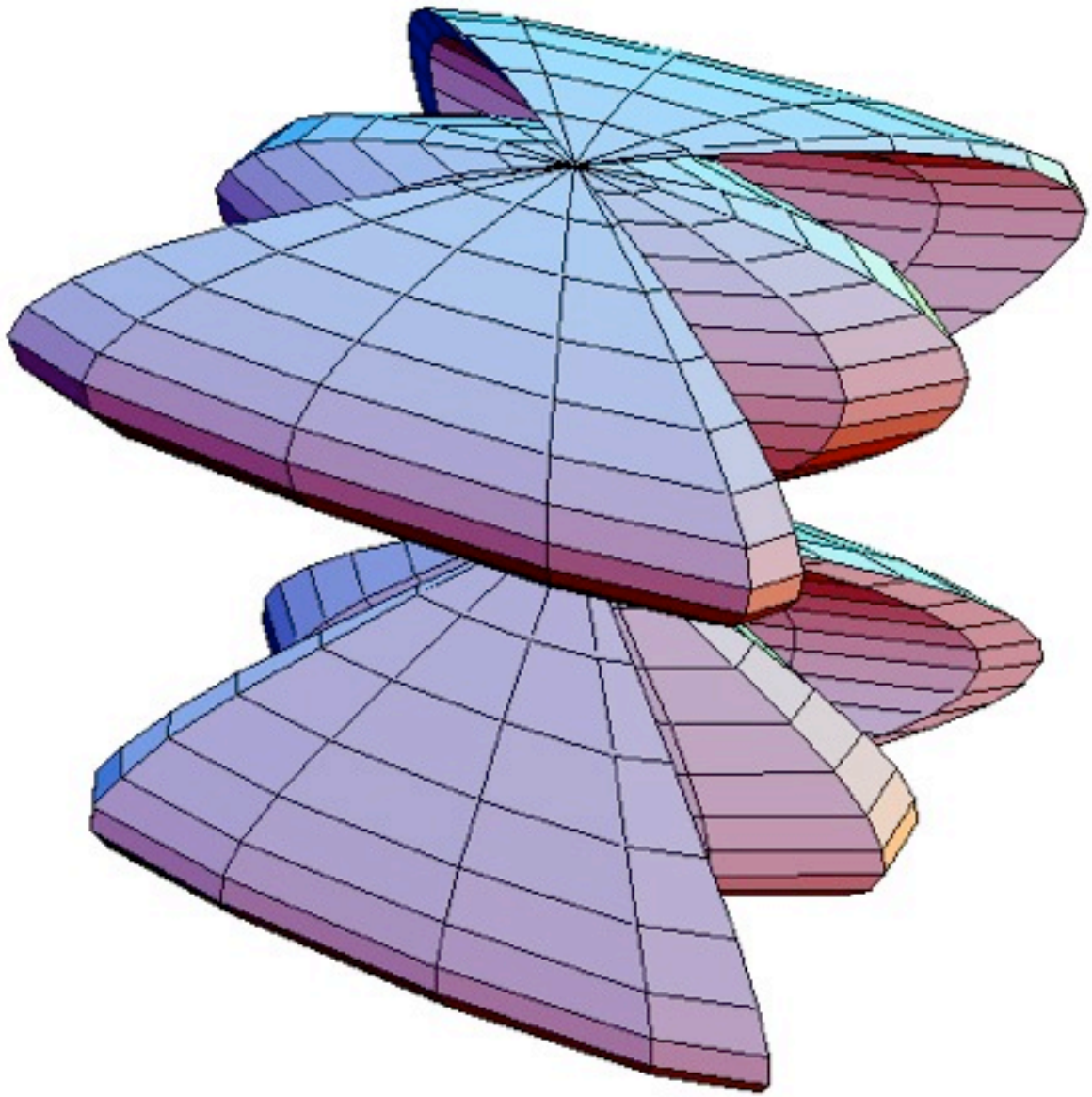
? ParametricPlot3D

```
ParametricPlot3D[{fx, fy, fz}, {u, umin, umax}] produces a three-dimensional
   space curve parametrized by a variable u which runs from umin to
   umax. ParametricPlot3D[{fx, fy, fz}, {u, umin, umax}, {v, vmin,
   vmax}] produces a three-dimensional surface parametrized by u and v.
   ParametricPlot3D[{fx, fy, fz, s}, ... ] shades the plot according
   to the color specification s. ParametricPlot3D[{{fx, fy, fz},
   {gx, gy, gz}, ... }, ... ] plots several objects together. More...
```

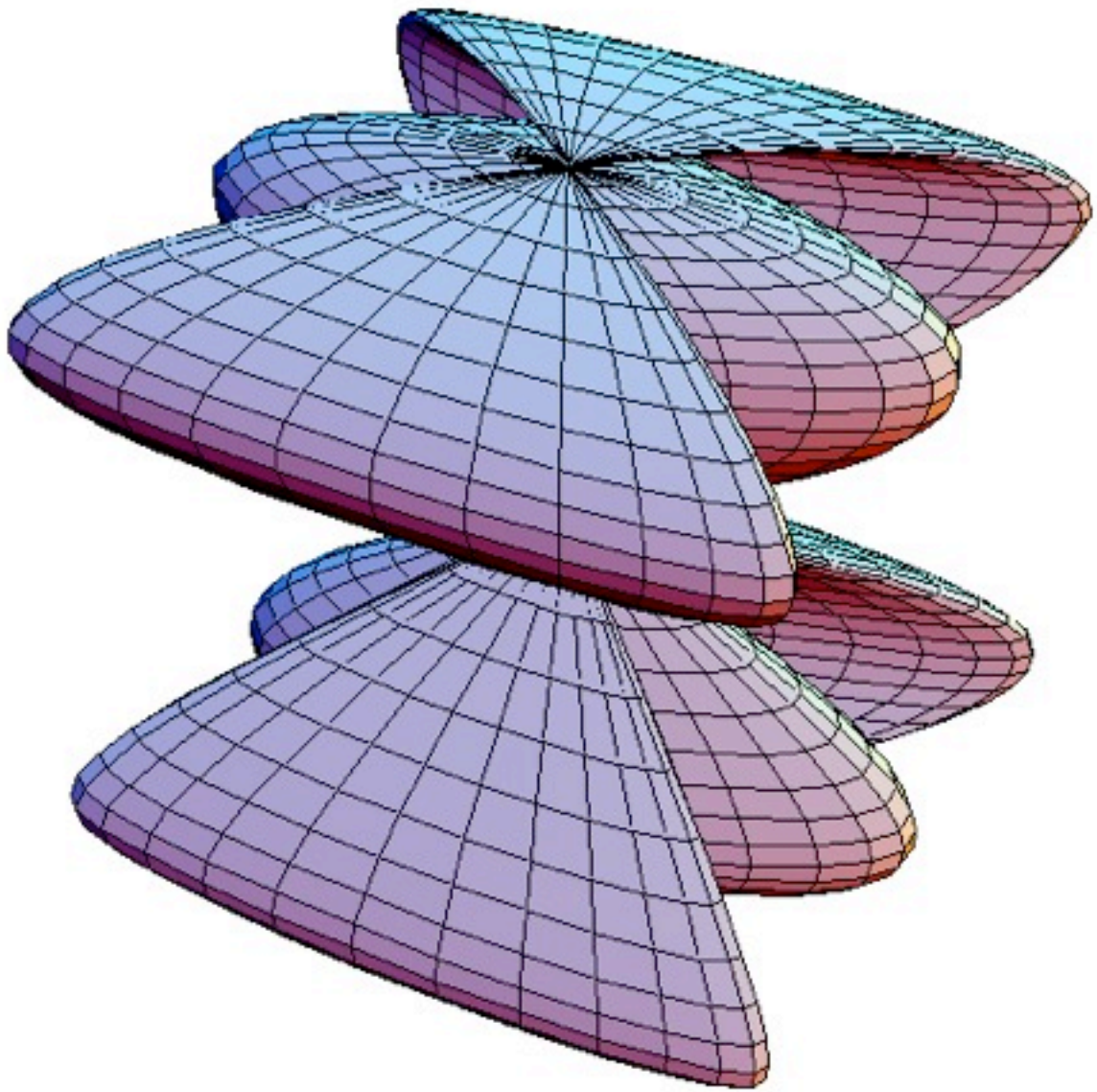
?? ParametricPlot3D

```
Attributes[ParametricPlot3D] = {HoldAll, Protected}


Options[ParametricPlot3D] =
 {AmbientLight → GrayLevel[0.], AspectRatio → Automatic, Axes → True,
  AxesEdge → Automatic, AxesLabel → None, AxesStyle → Automatic,
  Background → Automatic, Boxed → True, BoxRatios → Automatic,
  BoxStyle → Automatic, ColorOutput → Automatic, Compiled → True,
  DefaultColor → Automatic, DefaultFont :→ $DefaultFont,
  DisplayFunction :→ $DisplayFunction, Epilog → {}, FaceGrids → None,
  FormatType :→ $FormatType, ImageSize → Automatic, Lighting → True,
  LightSources → {{{1., 0., 1.}, RGBColor[1, 0, 0]},
    {{1., 1., 1.}, RGBColor[0, 1, 0]}, {{0., 1., 1.}, RGBColor[0, 0, 1]}},
  Plot3Matrix → Automatic, PlotLabel → None, PlotPoints → Automatic,
  PlotRange → Automatic, PlotRegion → Automatic, PolygonIntersections → True,
  Prolog → {}, RenderAll → True, Shading → True, SphericalRegion → False,
  TextStyle :→ $TextStyle, Ticks → Automatic, ViewCenter → Automatic,
  ViewPoint → {1.3, -2.4, 2.}, ViewVertical → {0., 0., 1.}}
```

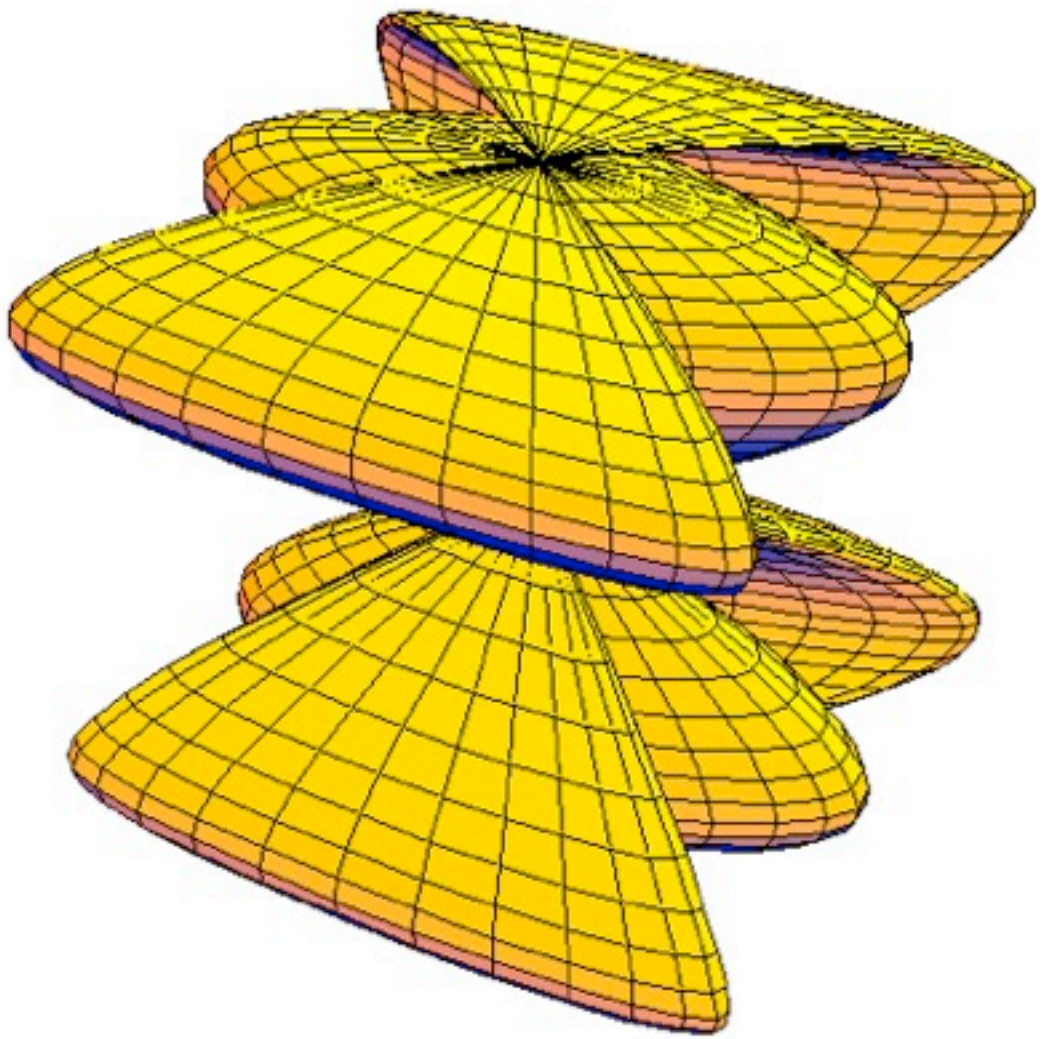
```
ParametricPlot3D[{ Sin[2 v] Cos[3 u], Sin[2 v] Sin[u], Cos[v]},
 {u, 0, 2 Pi}, {v, 0, Pi}, Boxed → False, Axes → False]
```



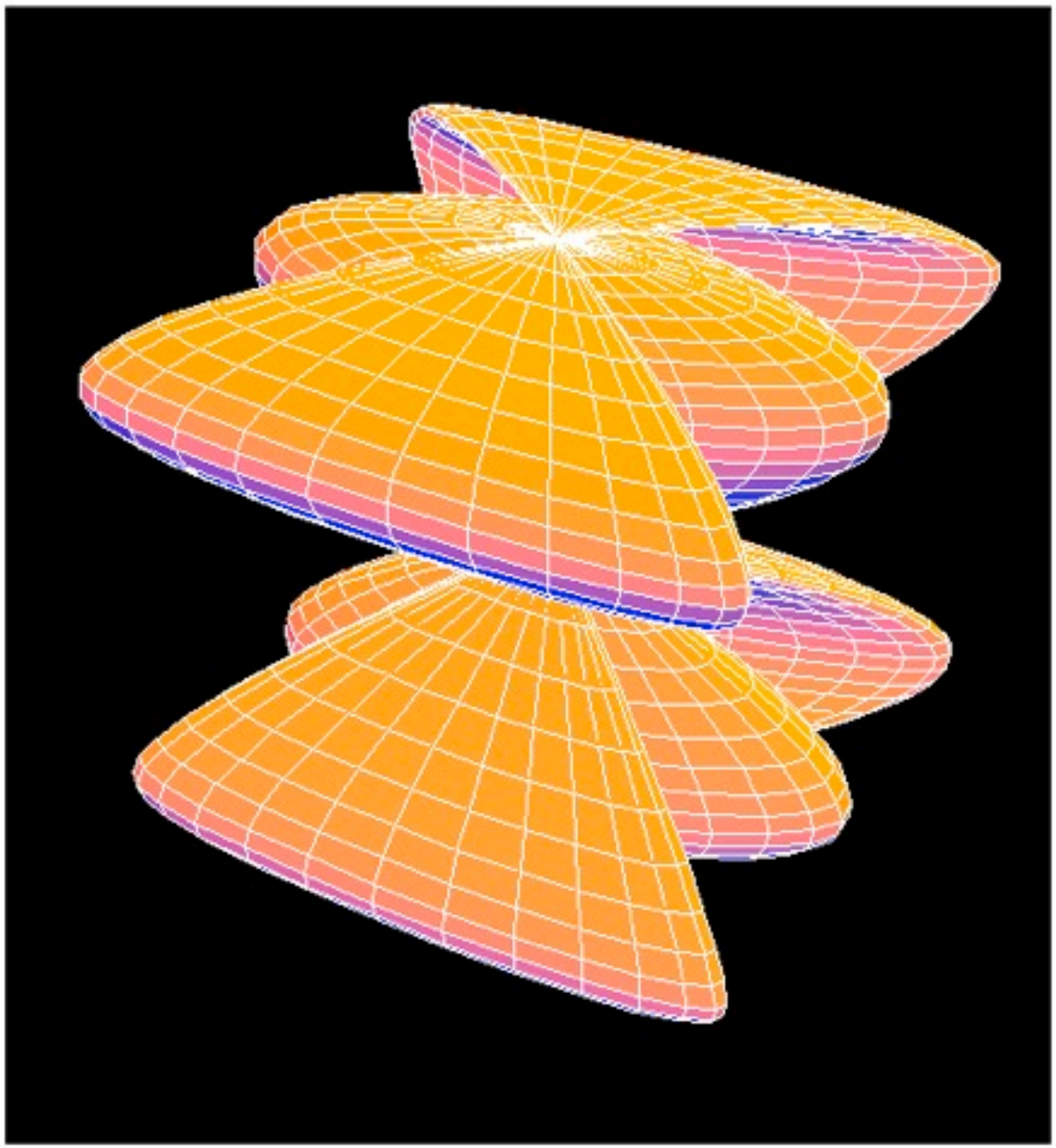
In[182]:=
```
ParametricPlot3D[{ Sin[2 v] Cos[3 u], Sin[2 v] Sin[u], Cos[v]},
 {u, 0, 2 Pi}, {v, 0, Pi}, Boxed → False, Axes → False,
 PlotPoints → {80, 40}]
```

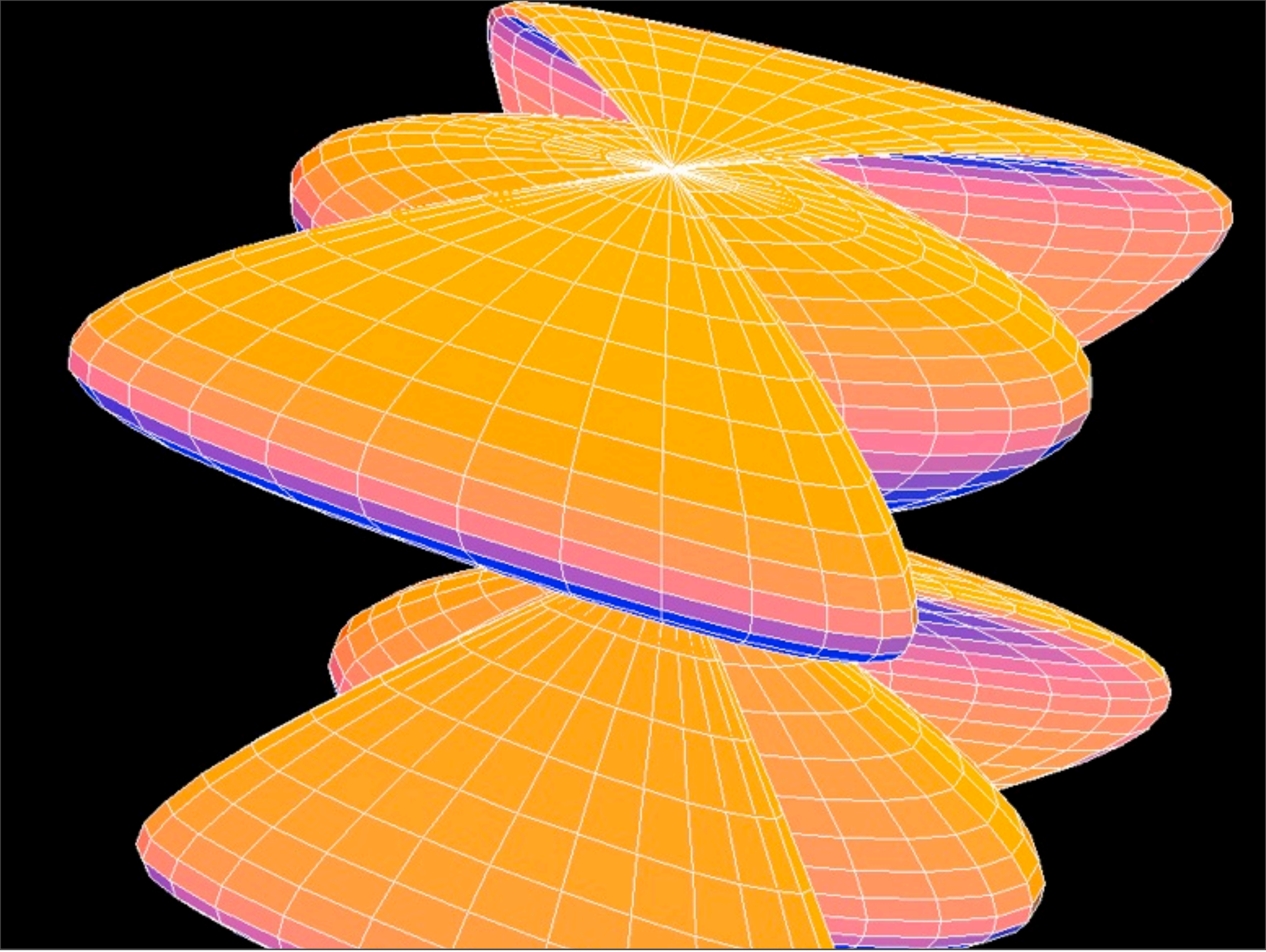


```
ParametricPlot3D[{ Sin[2 v] Cos[3 u], Sin[2 v] Sin[u], Cos[v]},
 {u, 0, 2 Pi}, {v, 0, Pi}, Boxed → False, Axes → False,
 LightSources → {
    {{1, 2, 3},    RGBColor[1, 1, 0]},
    {{0, 1, 1},    RGBColor[1, 0, 0]},
    {{-1, -3, 0}, RGBColor[0, 0, 1]}}, PlotPoints → {80, 40}]
```

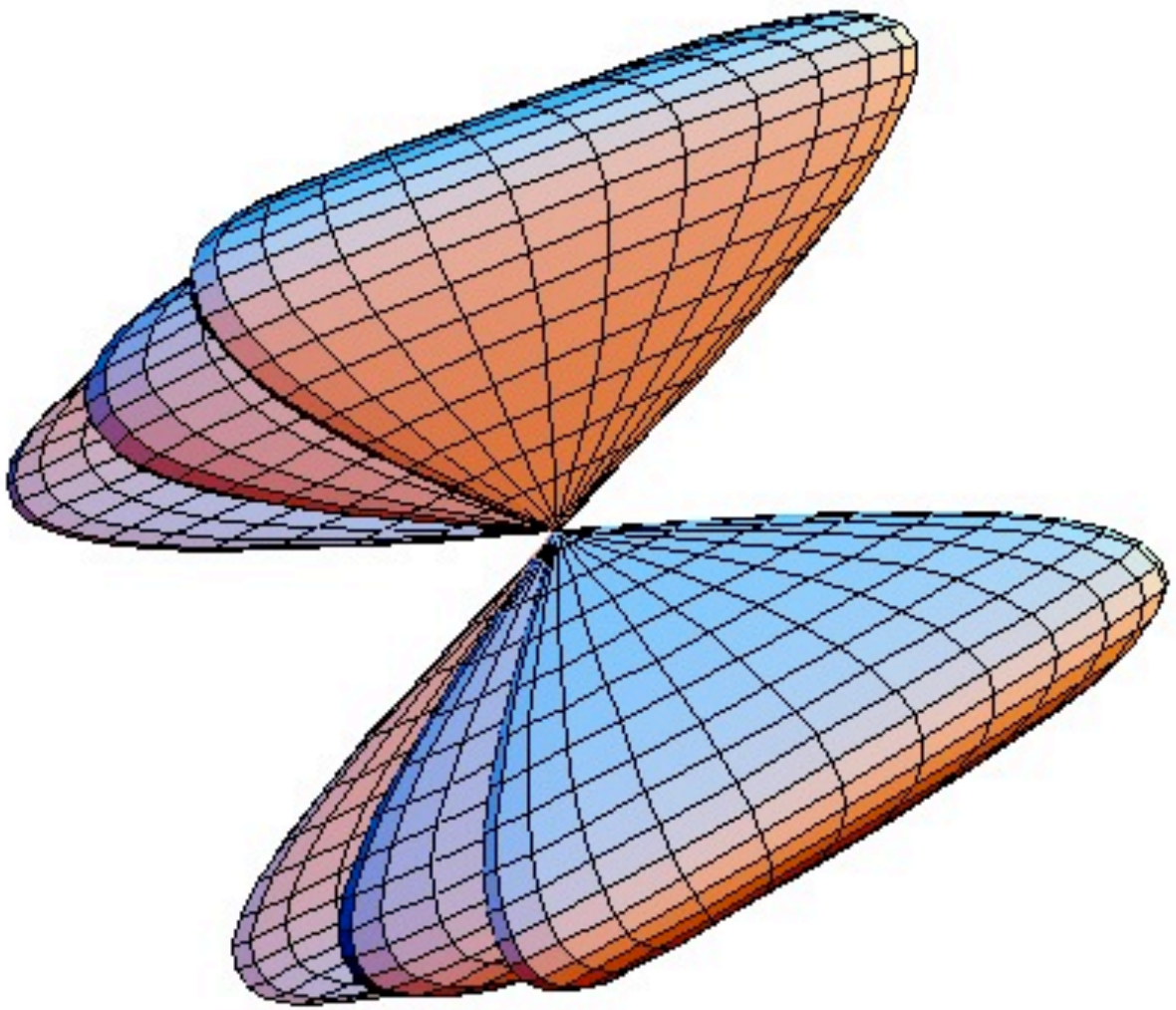


```
ightSources → {
 {{1, 2, 3},    RGBColor[1, 0.7, 0]},
 {{0, 1, 1},    RGBColor[1, 0, 0]},
 {{-1, -3, 0.8}, RGBColor[0, 0, 1]}}, PlotPoints → {80, 40}]
```





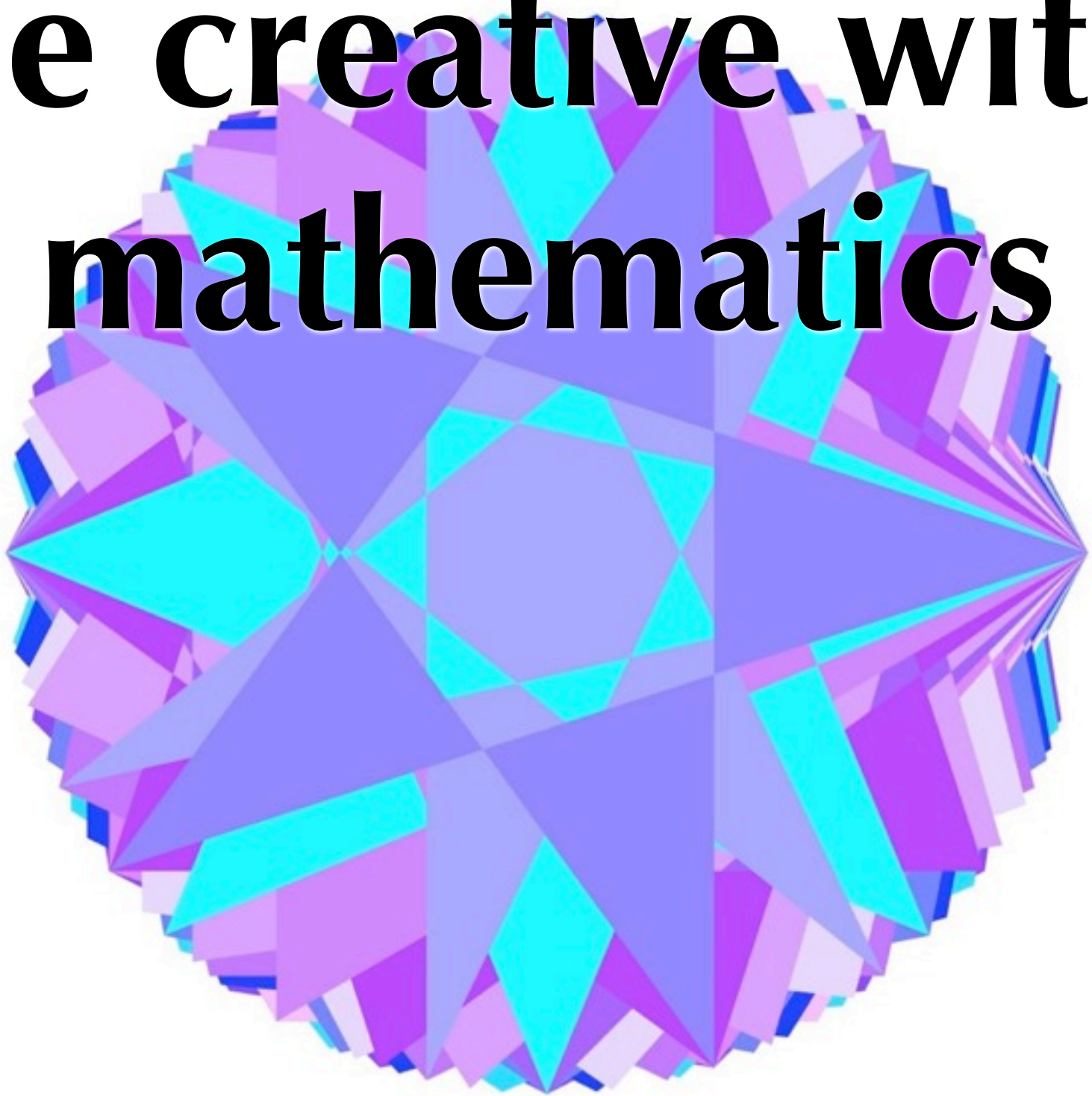
```
ParametricPlot3D[{ Sin[2 v] Cos[3 u],  Sin[2 v] Sin[u],
 {u, 0, 2 Pi}, {v, 0, Pi}, Boxed → False, Axes → False,
 ViewPoint → {1.3, 2.4, 0}, ViewVertical → {0, 1, 1}, Pl
```



drawing

- there is built in graphics drawing help.
- Don't use it. Its not forbidden but it can produce huge code.

be creative with mathematics



fun

- sound and images
- movies
- external files
- simple programming
- demonstration project

sound

```
PlaySong[hull_, tune_, name_, ground_] :=
 Module[{}, u = ToCharacterCode[name];
  soundfilename = FromCharacterCode[
    Join[u, {46, 119, 97, 118}]];
  scale[n_] := ground * 2^(n / 12); beatlength = 1 / 5;
  songlength = Length[tune] * beatlength;
  frequency[x_] := tune[[1 + Floor[x / beatlength]]];
  song[t_] := hull[scale[frequency[t]] * t];
  P = Play[song[t], {t, 0, songlength}];
  Export[soundfilename, P, "WAV"];]

t1 = {0, 0, 4, 4, 7, 7, 5, 4, 2, 2, 0, 4, 7, 4, 0, 0, 0, 0, 0, 2, 0};
f1[x_] := Sin[x]; n1 = "sin"; g1 = 2000;
PlaySong[f1, t1, n1, g1]
```

In[21]:=

```
Play[Sin[2 Pi 6000 x], {x, 0, 5}]
```

Out[21]= - Sound -

In[20]:=

```
Play[Random[], {x, 0, 1}]
```

```
In[24]:= a = Import["desktop/mathematica_2006/jane.wav"];

In[25]:= type = a[[1, 2]]; n = Length[a[[1, 1, 1]]];
         song = {Table[a[[1, 1, 1, n - k]] / 2, {k, 0, n - 1}],
            Table[a[[1, 1, 2, n - k]] / 2, {k, 0, n - 1}]};

         c = Sound[SampledSoundList[song, type]];
         Export["desktop/jane_reversed.wav", c, "WAV"]
```

image

```
A=Import["desktop/mathematica_2006/alig.jpg"];
ApplyFilter[F_,A_]:=Graphics[Raster[F[A[[1,1]]],A[[1,2]],A[[1,3]],A[[1,4]]],A[[2]],A[[3]],A[[4]]]

Dim[x_]:=Round[x/2]; B1=ApplyFilter[Dim,A];
Brighten[x_]:=Round[120+2x/3]; B2=ApplyFilter[Brighten,A];
red[{r_,g_,b_}]:={r,0,0}; Rred[S_]:=Table[red[S[[i,j]]],{i,Length[S]},{j,Length[S[[1]]]}];
green[{r_,g_,b_}]:={0,g,0}; Ggreen[S_]:=Table[green[S[[i,j]]],{i,Length[S]},{j,Length[S[[1]]]}];
blue[{r_,g_,b_}]:={0,0,b}; Bblue[S_]:=Table[blue[S[[i,j]]],{i,Length[S]},{j,Length[S[[1]]]}];
rotate[{r_,g_,b_}]:={b,r,g}; Rotate[S_]:=Table[rotate[S[[i,j]]],{i,Length[S]},{j,Length[S[[1]]]}]
reflect[{r_,g_,b_}]:={255-r,255-g,255-b}; Reflect[S_]:=Table[reflect[S[[i,j]]],{i,Length[S]},{j,L

Show[ApplyFilter[Dim,A]]
Show[ApplyFilter[Rred,A]];
Show[ApplyFilter[Ggreen,A]];
Show[ApplyFilter[Reflect,A]];

- Graphics -
```

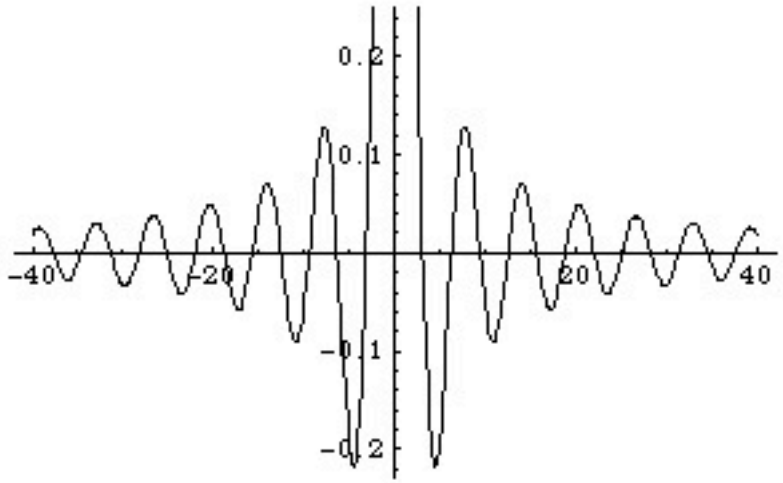
Combine

```
A1=Import["desktop/mathematica_2006/alig.jpg"]; A2=Import["desktop/mathematica_2006/borat.jpg"];
Combine[F_,U_,V_]:=Graphics[Raster[F[U[[1,1]],V[[1,1]]],U[[1,2]],U[[1,3]],U[[1,4]]],U[[2]],U[[3]]
LinearCombination[a_]:=Function[{x,y},(1-a)*x+a*y];

Do[Show[Combine[LinearCombination[k/10],A1,A2]],{k,10}]
```

importing, exporting files

Save as JPG

```
In[2]:= S = Plot[Sin[x] / x, {x, -40, 40}]
```




```
Out[2]= - Graphics -
```

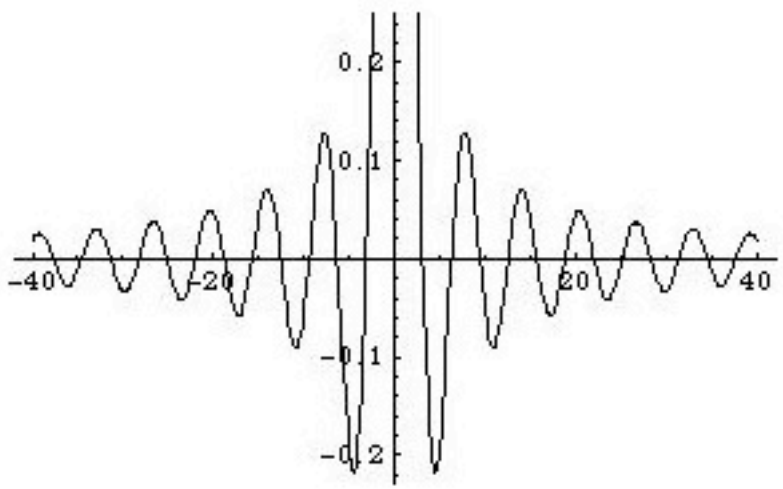
```
In[3]:= Display["picture.jpg", S, "JPG"]
```

```
Out[3]= - Graphics -
```

```
In[4]:=
A = Import["picture.jpg"]
```

```
Out[4]= - Graphics -
```

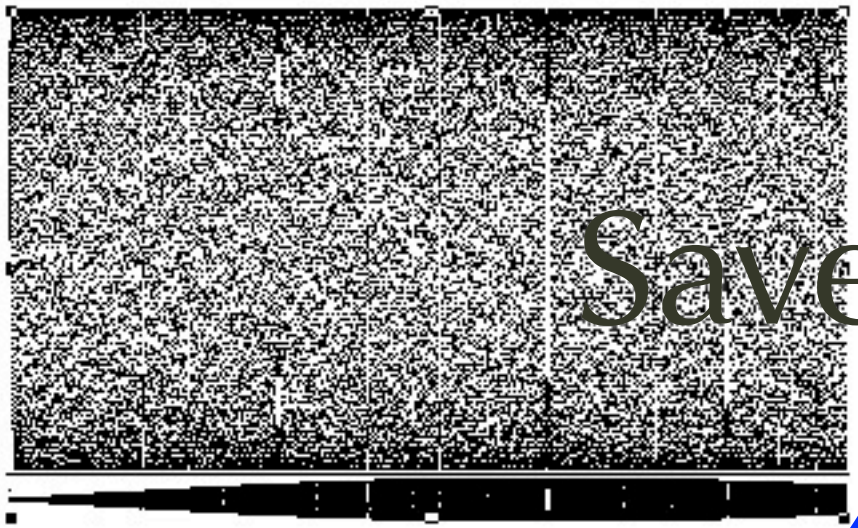
```
In[5]:= Show[A]
```




```
Out[5]= - Graphics -
```

Save as Wave

```
In[6]:= S = Play[Sin[4000 x^2], {x, 0, 5}]
```

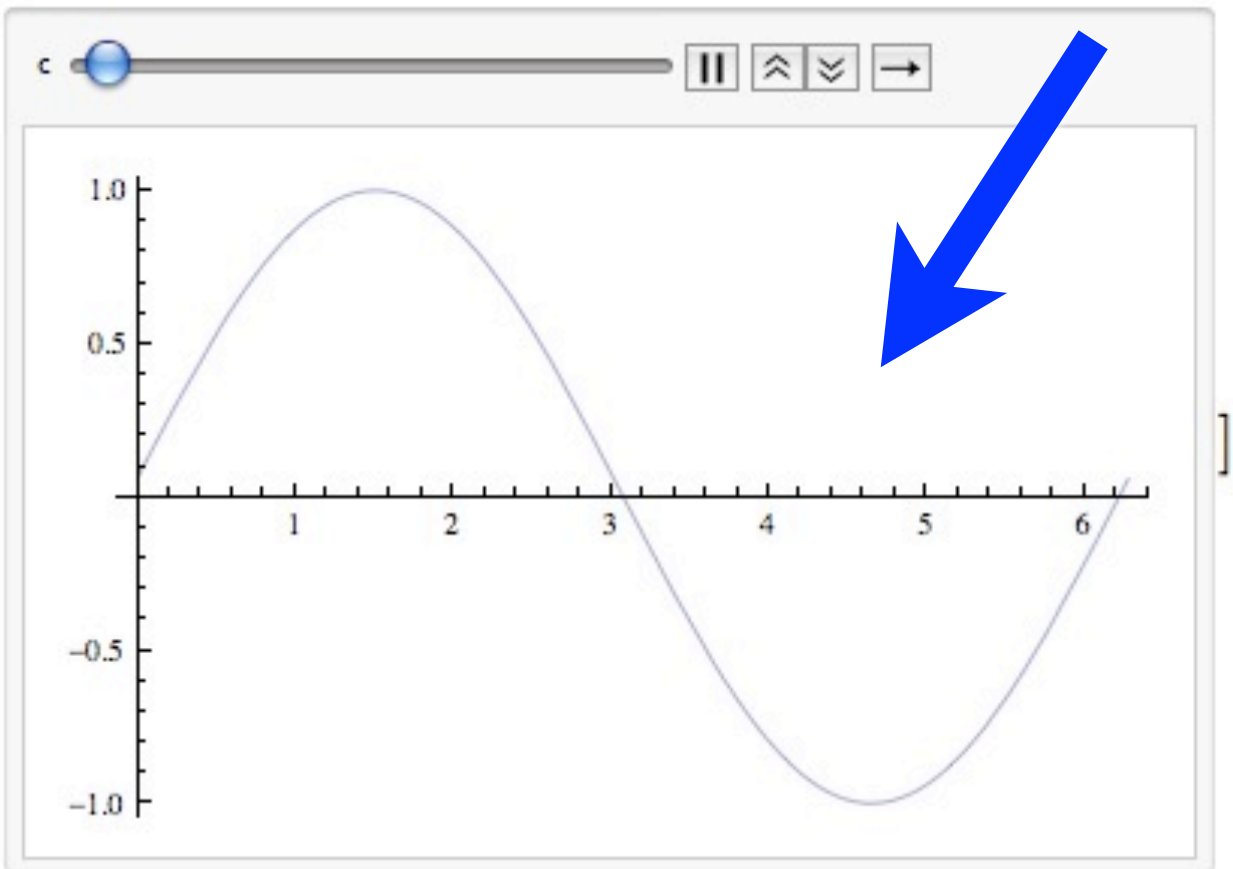


```
Out[6]= - Sound -

In[8]:=
Export["sound.wav", S, "WAV"]

Out[8]= sound.wav

In[9]:=
A = Import["sound.wav"]

Out[9]= - Sound -

In[13]:=
Run["open sound.wav"]
```

Save as Flash

saveanimation

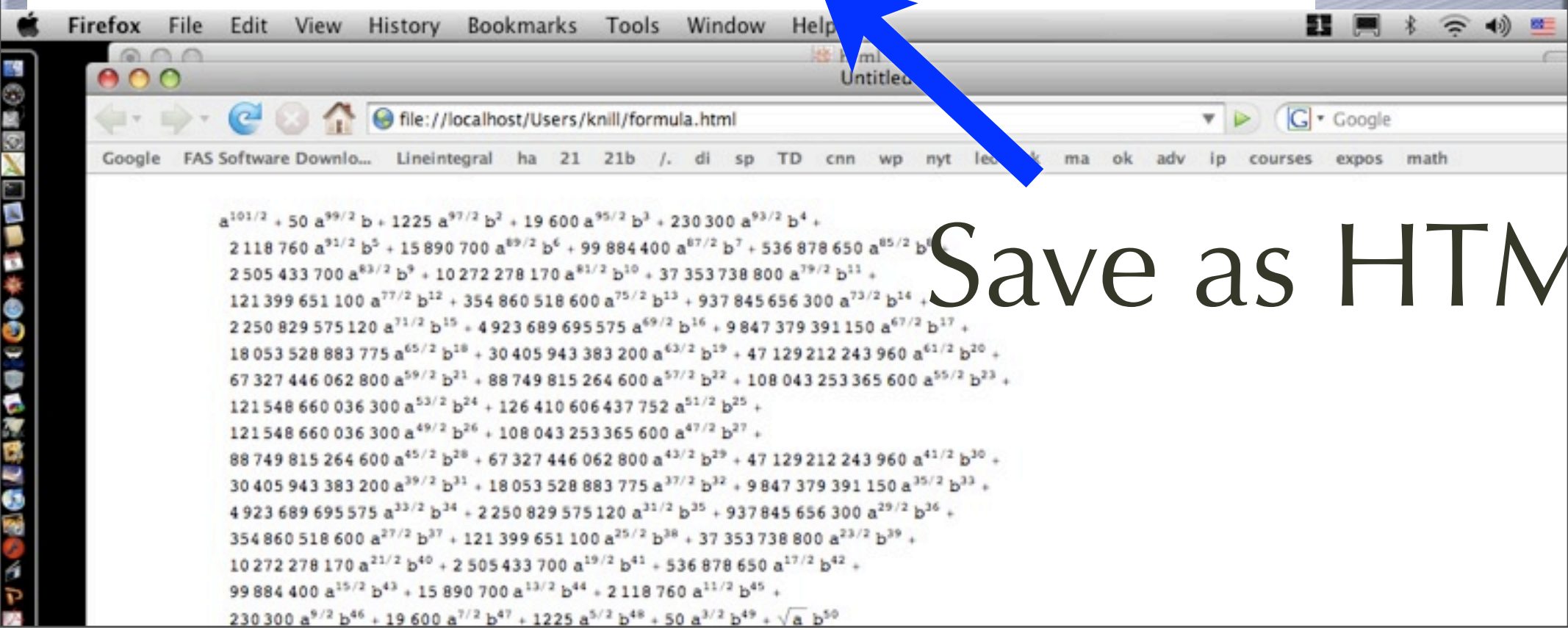
```
In[28]:= Animate[Plot[Sin[x + c], {x, 0, 2 Pi}], {c, 0, 2 Pi}]

In[29]:= Export["sin.swf",
```




```
Out[29]= sin.swf
```

```
A = Import["http://www.cnn.com", "Data"];

InputForm[A]

Export["formula.html",
 Expand[(a + b)^50 Sqrt[a]]]
```

import HTML



Save as HTM

simple programming

```
In[56]:= RandomDots := Module[{}, s = {};
          Do[
            {x, y} = {Random[], Random[]}; l = Random[] / 20;
            {r, g, b} = {Random[], Random[], Random[]};
           If[(x - 1 / 2) ^ 2 + (y - 1 / 2) ^ 2 < 1 / 4,
             s = Append[s, {RGBColor[r, g, b], Disk[{x, y}, l]}]],
            {i, 1, 300}
          ];
          Show[Graphics[s], AspectRatio → 1, PlotRange → {{-0.2, 1.2}, {-0.2, 1.2}},
           ImageSize → 600]];

In[57]:= RandomDots
```

demonstration projects

Conversion

http://www.wolfram.com/solutions/interactivedeployment/publish/

Tippe Top

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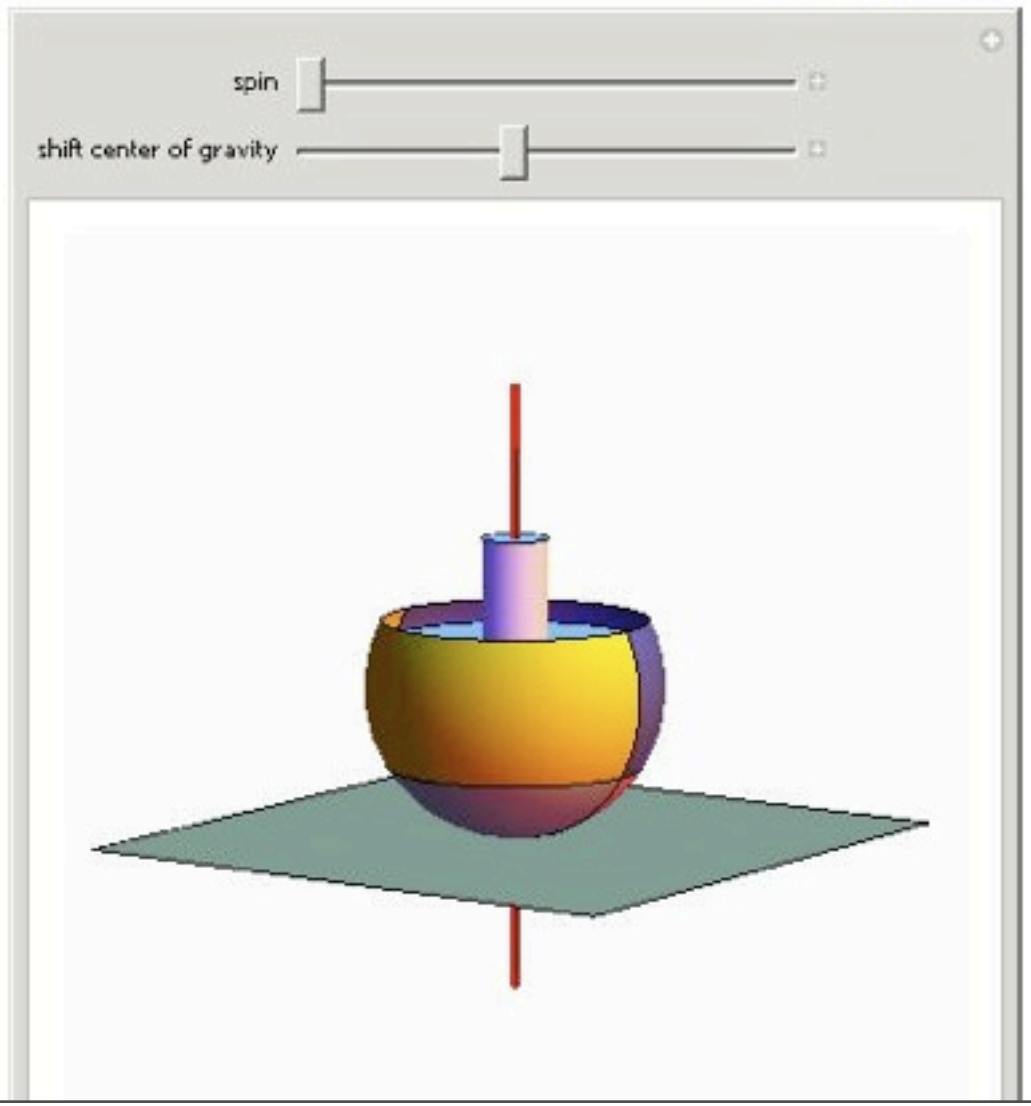
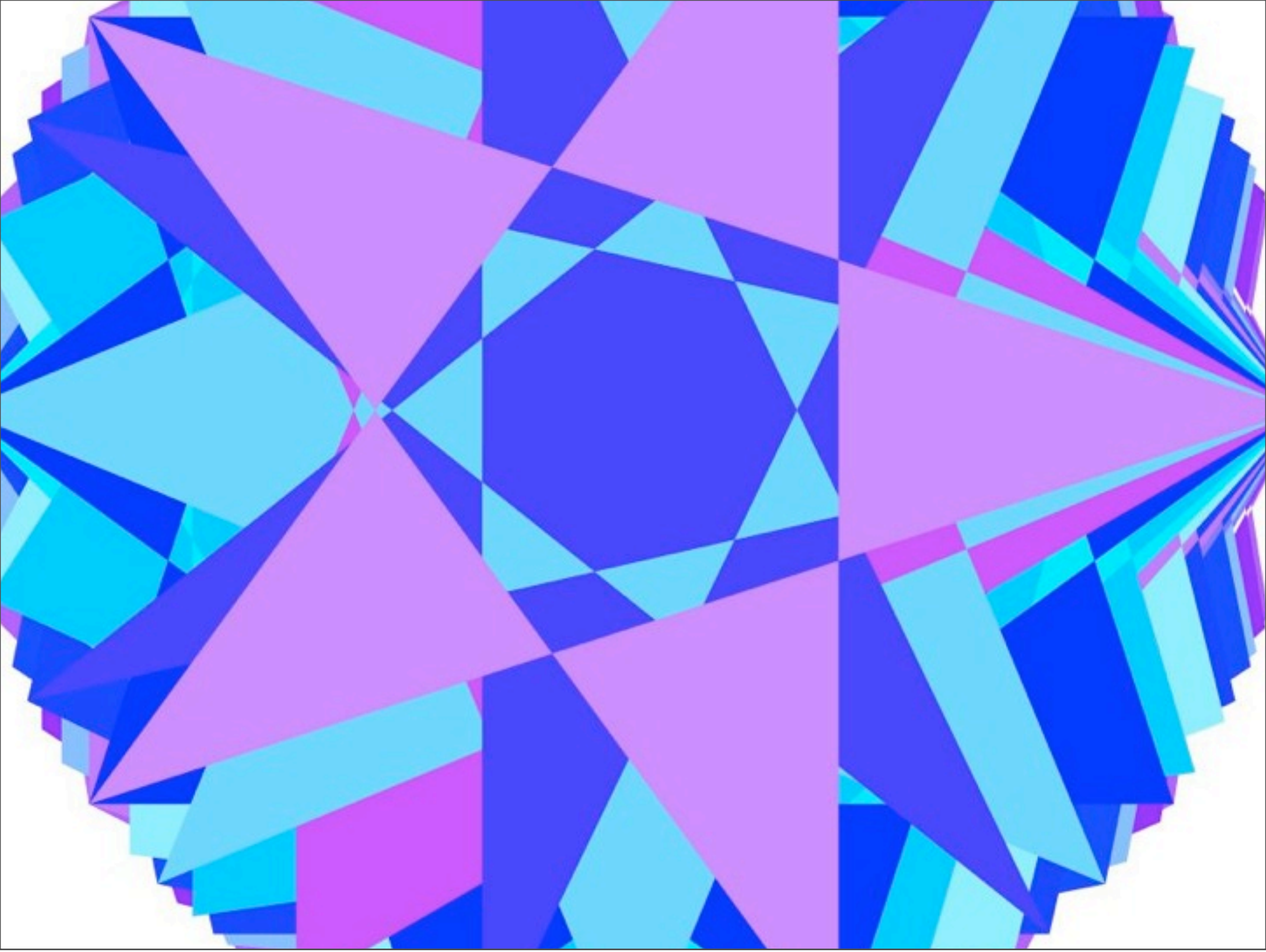


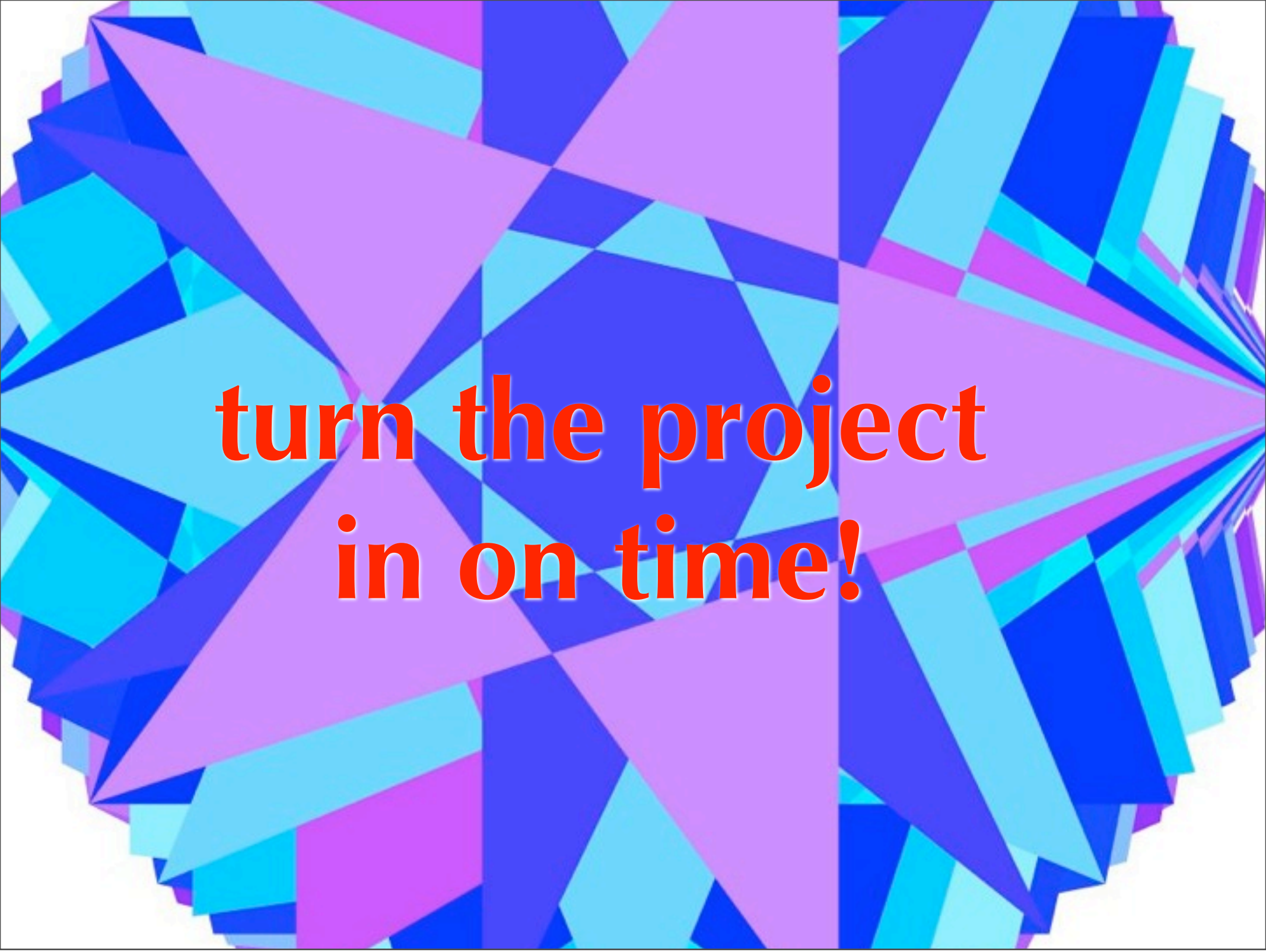
Related Topics

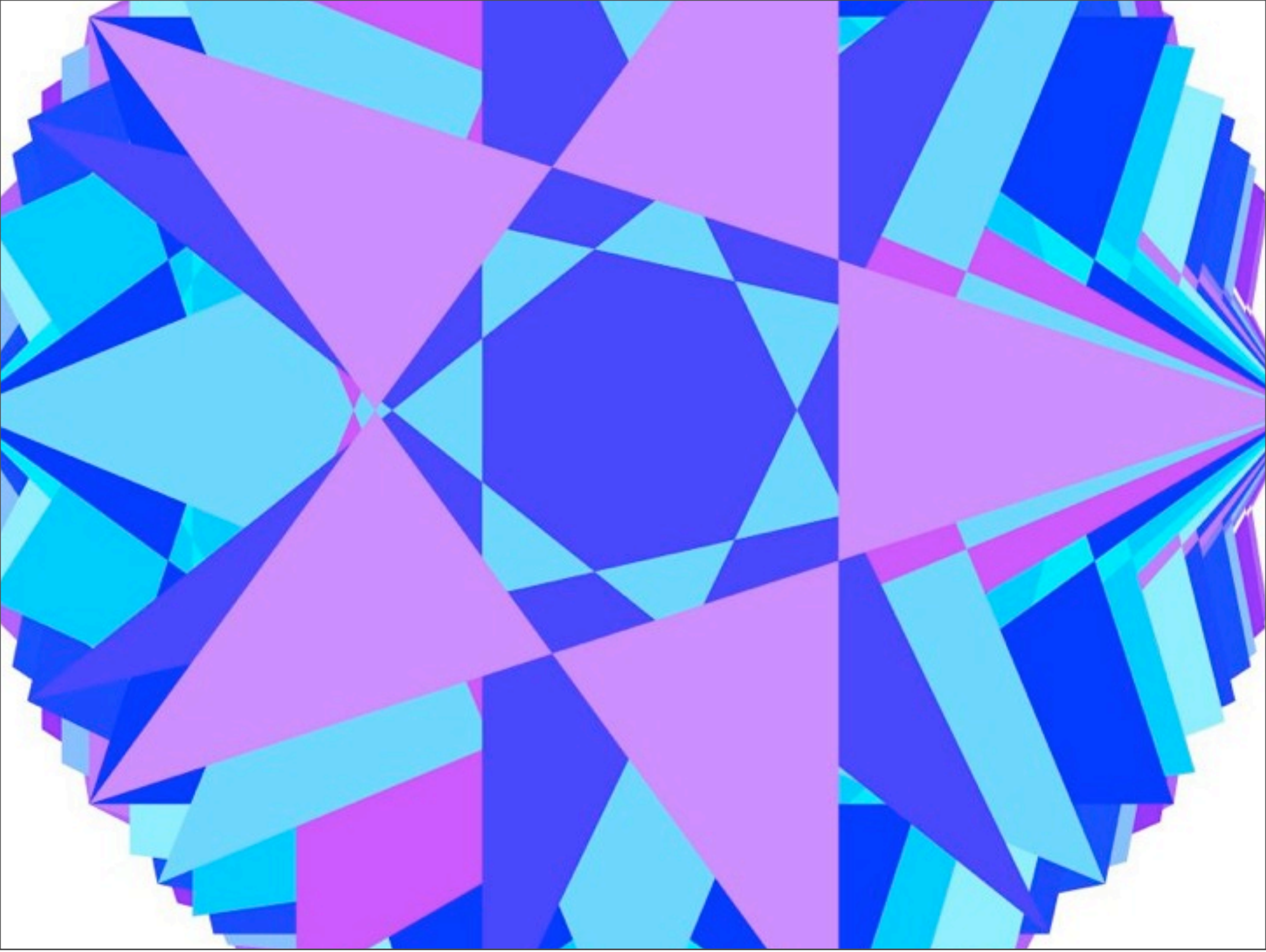
- 3D Graphics
- College Physics
- Mechanics
- Physics

Some Related Demonstrations

- Rotary to Linear Motion
- Foucault's Pendulum
- Driven Damped Oscillator
- Throw off a Cliff
- Forces on a Simple Pendulum
- Time Evolution of a Four-Spring Three-Mass System
- Anharmonic Oscillator Phase Space Trajectories 2D
- Synchronization of Coupled Phase Oscillators
- Classical Particle in a




turn the project
in on time!



the end