

mathematica workshop

math21a, 11/17/2011

harvard university

oliver knill

- 5 problems for 5 percent
- time effort minimal
- no time extension beyond Dec 3
- electronic email submission
- will be graded by myself (Oliver)
- is important part of the course
- will make garden gallery



already users

newcomers

- installation
- the user interface
- getting started
- the assignment
- the garden problem
- questions&answers

installation

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

step 1: get the program

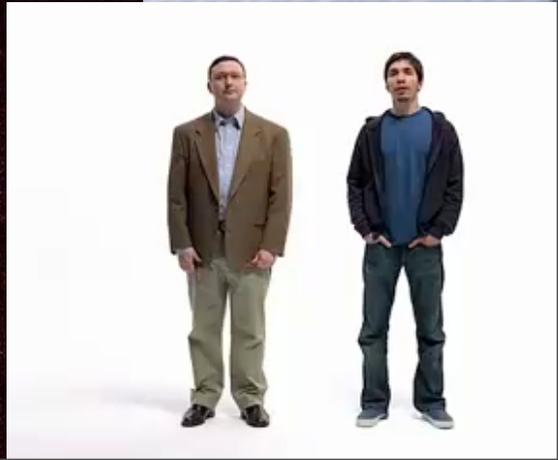
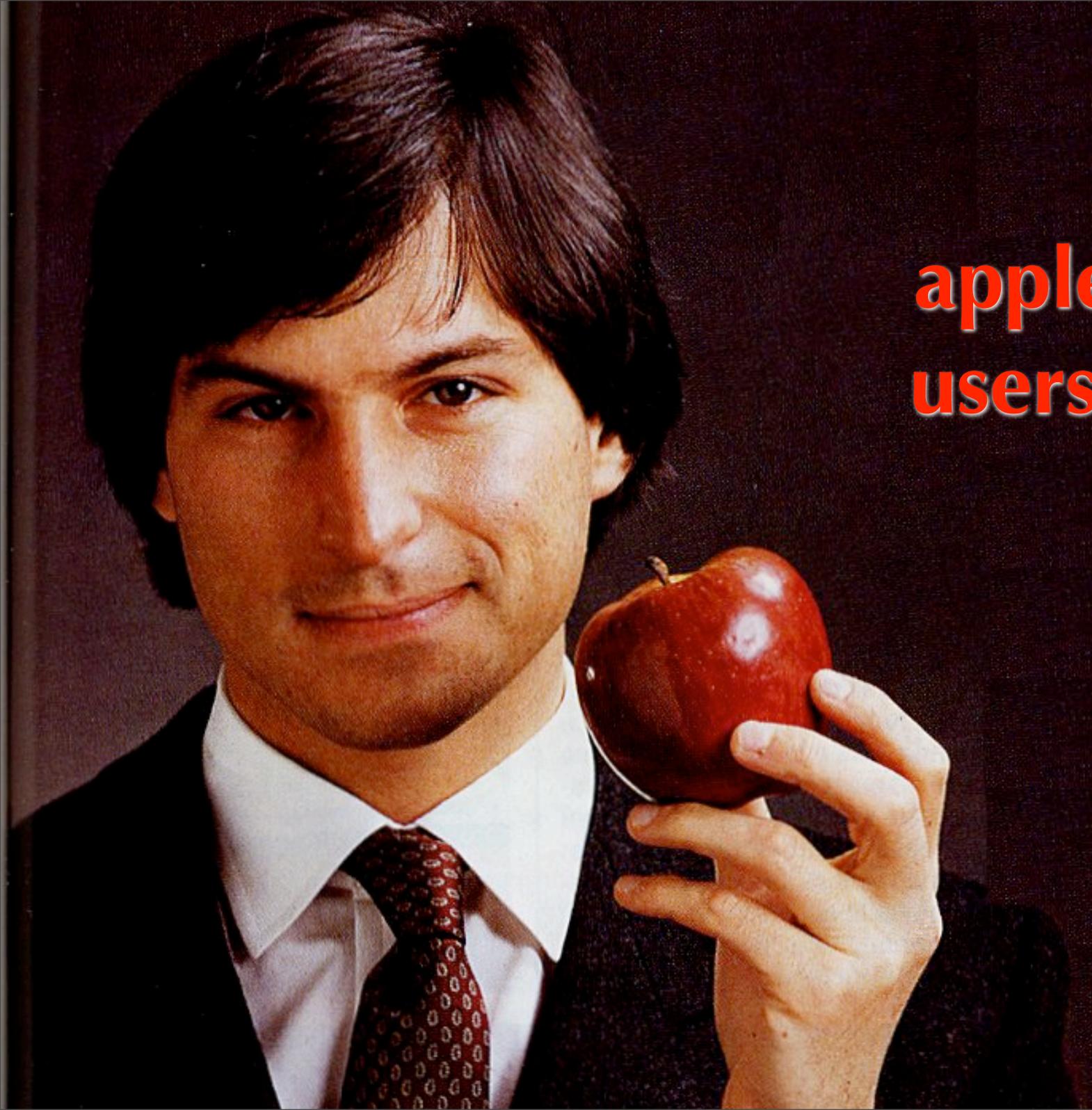
- you need a HUID and pin to access the page
- www.fas.harvard.edu/cgi-bin/software/download.pl

FAS Software Download (FAS Computer Services (HASC



<http://www.fas.harvard.edu/cgi-bin/software/download.pl>

**apple
users:**



download the program OS X

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Software Downloads | FAS Inform... +

LANdesk Support Agent



2

18.7Mb

MacOS X

LANdesk software enables FAS-IT to provide routine system and security patches, software updates, inventory control and remote IT support across the campus. For more information please see <http://isites.harvard.edu/LANdesk> Install on Harvard computers only. Not for personal use. Requires OSX, v10.4.11 to v10.5.8.

Logger Pro



3.6.1

184.7Mb

MacOS X

Data-collection and analysis software. Requires OSX, v10.3.9 or later.

Mail.app Configurer



3.1

0.5Mb

MacOS X

Use this script to configure Apple's OS X Mail.app for servers using SSL.

Maple



13.0

265.1Mb

MacOS X

Keyed

Mathematic software. Installer includes a script with instructions to select the Network License option and enter license1.fas.harvard.edu as the License Server. Requires OSX, v10.4.4 or later.

Mathematica

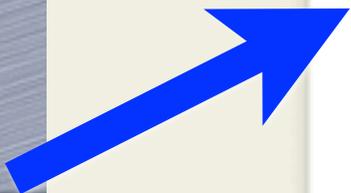


7.0.0

588.0Mb

MacOS X

Mathematic software. Student License Number: L2983-5986. Faculty/Staff License Number: L2482-2405. Please follow on-screen instructions to request a password and complete the installation. Password requests must be made using your Harvard email address. Expiring





**PC
users:**



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

Mathematic software. Student License Number: L2983-5986. Faculty/Staff License Number: 52-2405. 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

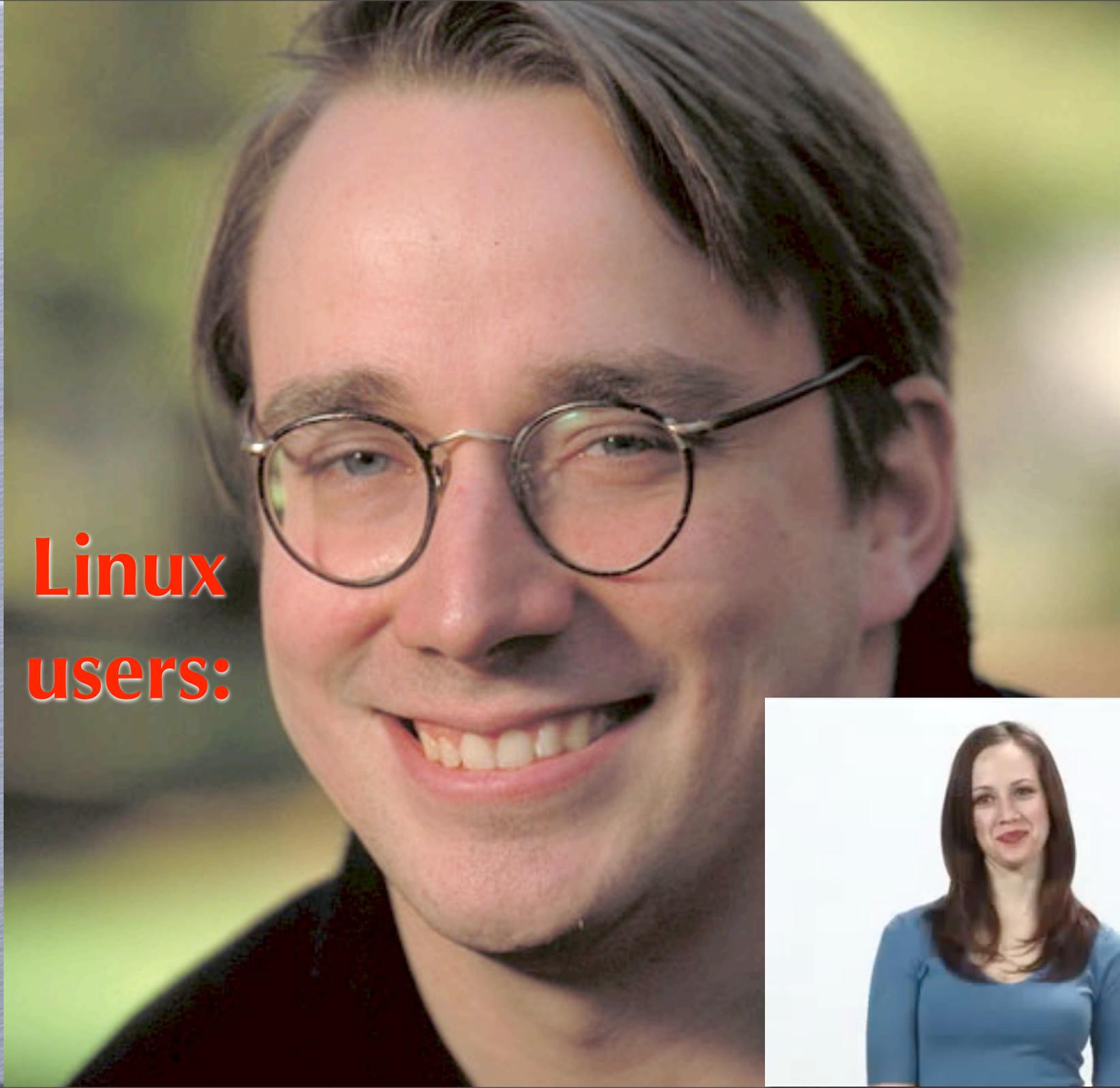
2048.0Mb

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



Search this site



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Software Downloads

This software is provided for the exclusive use of FAS Faculty, Staff and Students. Any distribution, copying, or transferring of this software is a violation of applicable copyright law.

- I accept
 I do not accept



**step 2:
install the
program**

step 3: request an activation key

WOLFRAM USER PORTAL

Mathematica Activation Key Request Form

Harvard University

Login With Wolfram ID

Wolfram ID (your email address)

Password

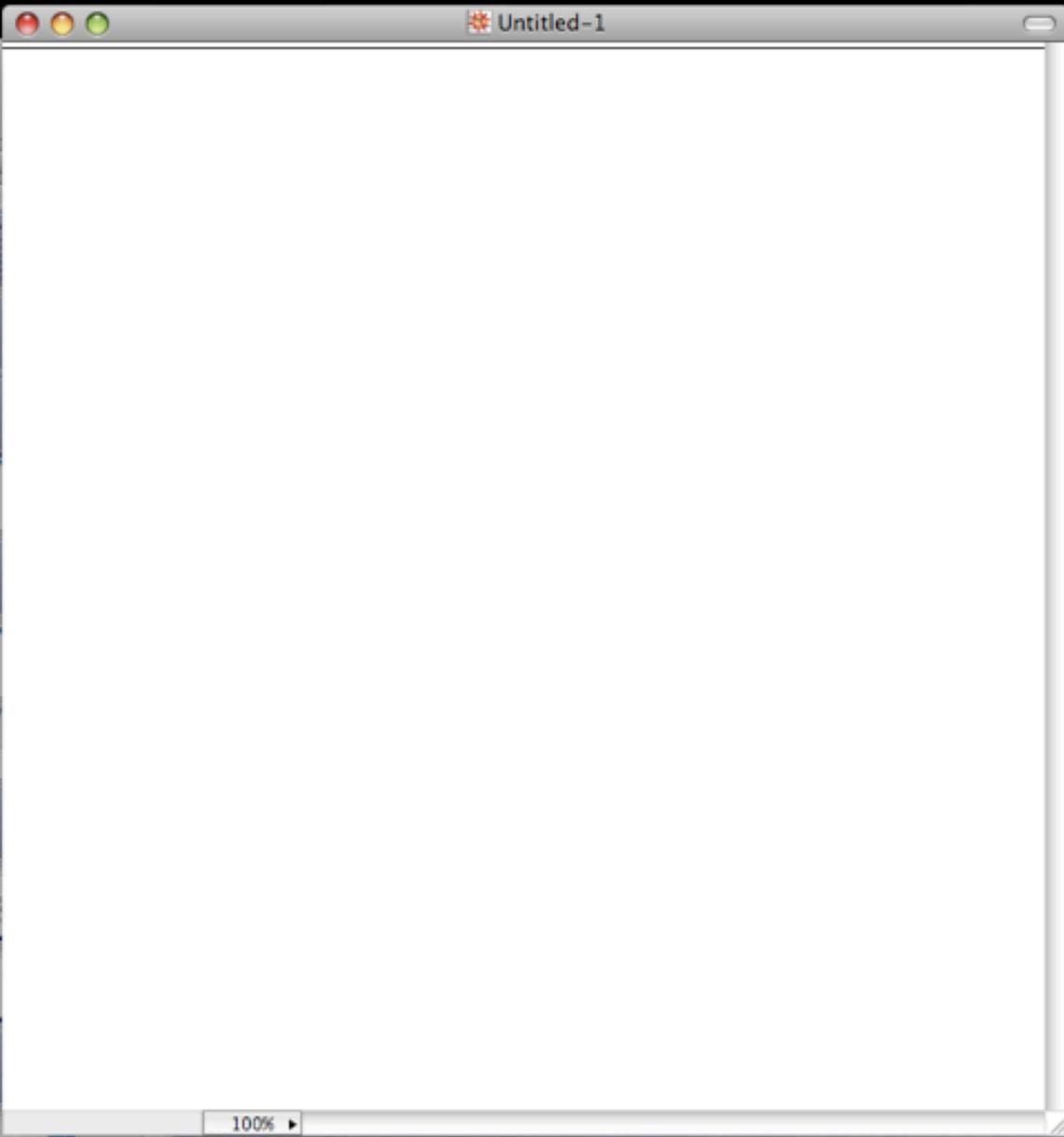
OR: [Continue without signing in](#)

**step 4:
enter the
activation key**

the user interface

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

notebooks



- Algebraic Manip...
- Expand[■]
- ExpandAll[■]
- Factor[■]
- Together[■]
- Apart[■]
- Cancel[■]
- Simplify[■]
- FullSimplify[■]
- FunctionExpand[■]
- TrigExpand[■]
- TrigFactor[■]
- TrigReduce[■]
- ExpToTrig[■]
- TrigToExp[■]
- PowerExpand[■]
- ComplexExpand[■]

Basic Math...

$\frac{d}{dx}$	$\frac{d}{dx}$			
$\sqrt{\quad}$	$\sqrt{\quad}$			
$\int \quad d\quad$	∂_{\quad}			
$\int_C \quad d\quad$	$\partial_{C,\quad}$			
$\sum_{C=1}^n \quad$	$\prod_{C=1}^n \quad$			
$\left(\begin{matrix} \square & \square \\ \square & \square \end{matrix}\right)$	$\left[\quad \right]$			
π	e	i	∞	\circ
\times	\div	\times	\rightarrow	\rightarrow
$=$	\neq	\leq	\geq	\in
\neg	\wedge	\vee	\cup	\cap
α	β	γ	δ	ϵ
ζ	η	θ	κ	λ
μ	ν	ξ	π	ρ
σ	τ	ϕ	φ	χ
ψ	ω	Γ	Δ	Θ
Λ	Ξ	Φ	Ψ	Ω
\square	\square	\square	\square	\square
\square	\square	\square	\square	\square

Special Characters

α	β	γ	δ	ϵ	ζ	η	θ
ι	κ	λ	μ	ν	ξ	\omicron	π
ρ	σ	τ	υ	υ	ϕ	χ	ψ
ω	ρ	σ	τ	υ	ϕ	χ	ψ
Λ	B	Γ	Δ	E	Z	H	Θ
I	K	Λ	M	N	Ξ	O	Π
P	Σ	T	Υ	Υ	Φ	X	Ψ
Ω	F	ϕ	ζ	ϑ			

Unicode:

Insert

Greek Letters

mathematica_2007

cells

Untitled-1

This is a cell, start typing

34
35
36
37
38
39
40
41
42
43
44

Clipboard Info Music Color A

Fill: ...

200%

100%

- Style ▶
 - Clear Formatting ⌘⇧⌘
 - Option Inspector... ⌘⇧O
 - Stylesheet ▶
 - Screen Environment ▶
 - Edit Stylesheet...
 - Show Fonts... ⌘T
 - Face ▶
 - Size ▶
 - Text Color ▶
 - Background Color ▶
 - Cell Dingbat ▶
 - 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
 - Subitem
 - InlineFormula
 - DisplayFormula
 - DisplayFormulaNumbered
 - Program
 - Other... ⌘0

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Fill: ...

e 1

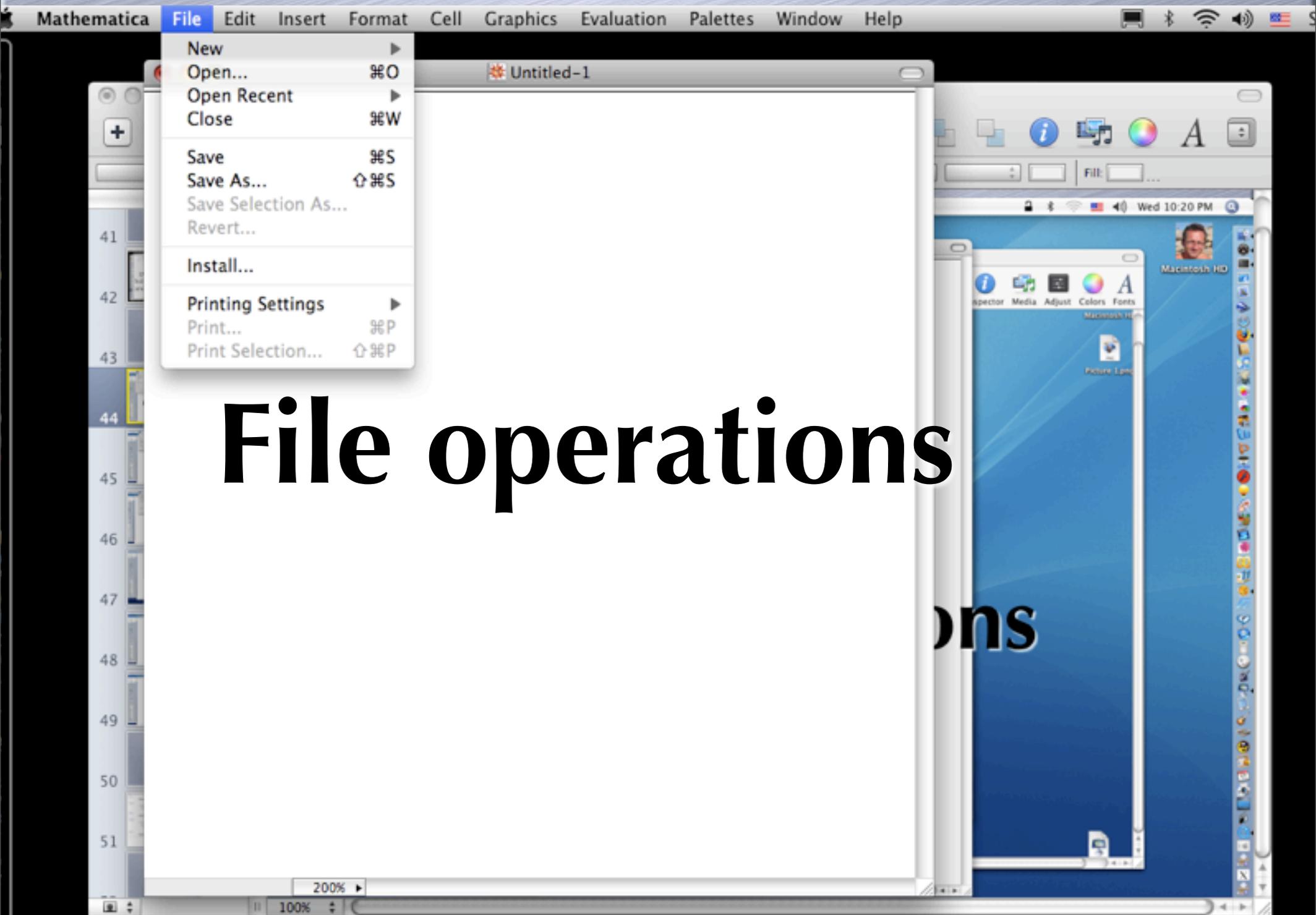
800

submitting commands

In[1]:= **Sin**[0.2343]
Out[1]= 0.232162

grab bracket,
hold <shift> key
and hit <return>

the menu



File operations

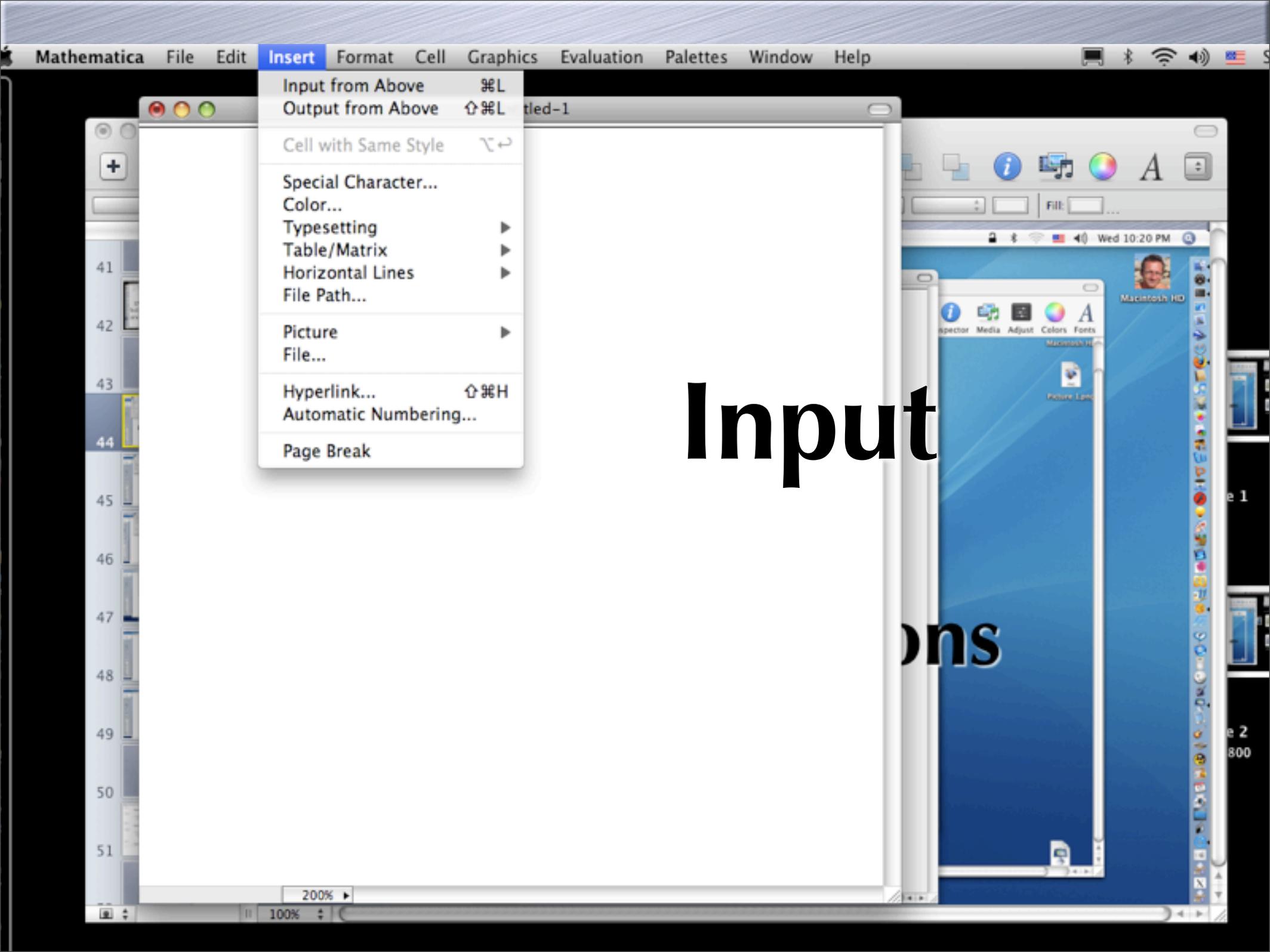
ons

- 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... ⌘;



Editing tools

ons



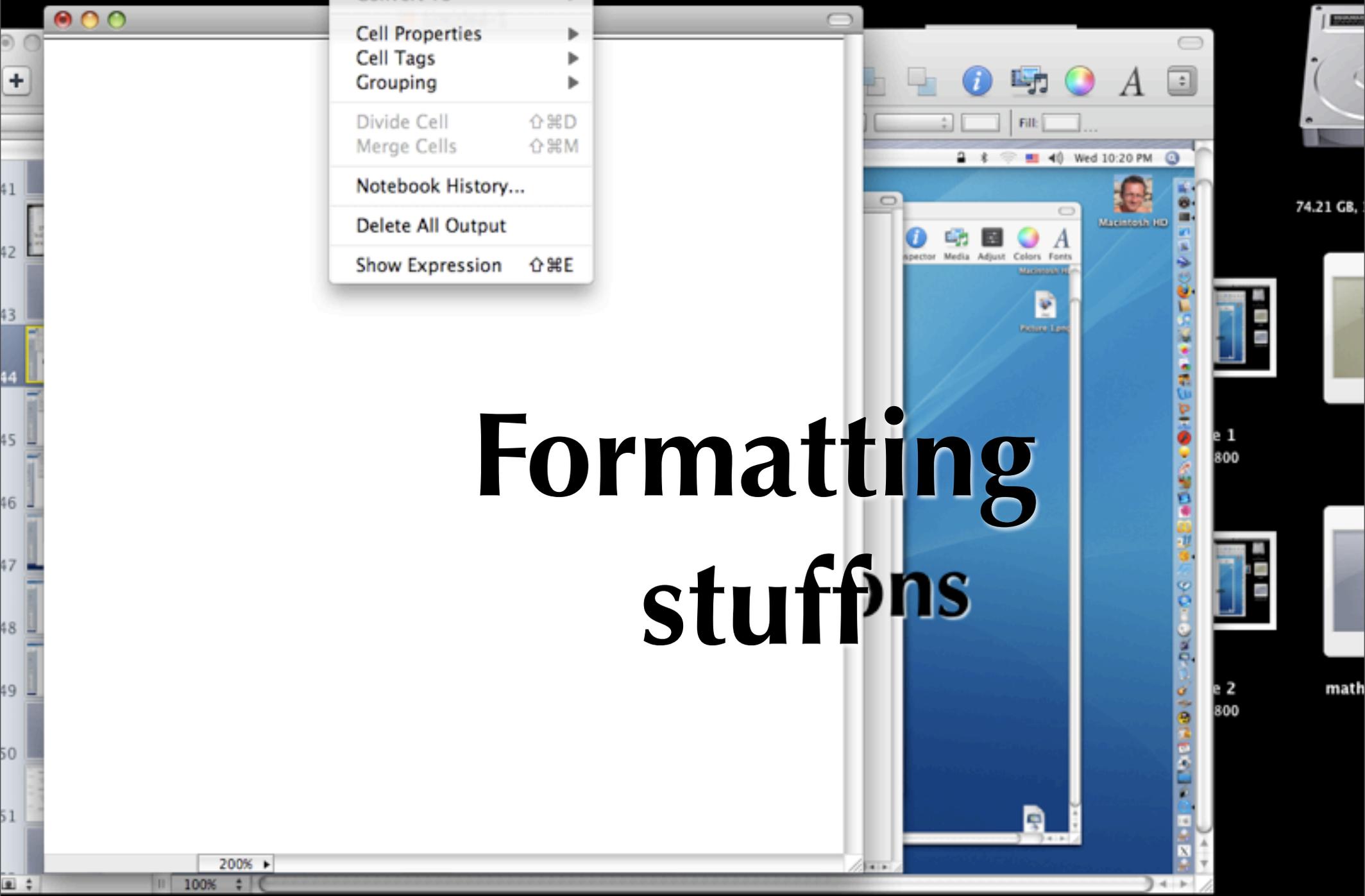
- Input from Above ⌘L
- Output from Above ⇧⌘L
- Cell with Same Style ⇧⇧
- Special Character...
- Color...
- Typesetting ▶
- Table/Matrix ▶
- Horizontal Lines ▶
- File Path...
- Picture ▶
- File...
- Hyperlink... ⇧⌘H
- Automatic Numbering...
- Page Break

Input

ons

- Convert To
- Cell Properties
- Cell Tags
- Grouping
- Divide Cell ⌘D
- Merge Cells ⌘M
- Notebook History...
- Delete All Output
- Show Expression ⌘E

Formatting stuffns



- New Graphic ^1
- Drawing Tools ^T
- Graphics Inspector ^I
- Rendering >
- Operations >

Graphics

ons



Is
74.21 GB, 13.28 GB free



e 1
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perfect



e 2
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mathematica_2007

200%

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- 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



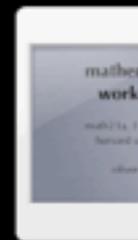
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100%

- AlgebraicManipulation
- BasicMathInput
- ColorSchemes
- NotebookLauncher
- SlideShow
- SpecialCharacters
- Generate Palette from Selection
- Generate Notebook from Palette
- Install Palette...

Palettes

ons

Untitled-1

Help

- Search
- Documentation Center
- Find Selected Function ⇧⌘F
- Wolfram Website...
- Demonstrations...
- Internet Connectivity...
- Give Feedback...
- Online Registration...
- Why the Beep?...
- Why the Coloring?...
- Startup Palette...

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**stopping the
kernel**

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.

In[1]:=

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

Out[1]=

{{596495821, 1},
{5704689200685129054721, 1}}

In[2]:=

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

Out[2]=

{{1238926361552897, 1},
{93461639715357977769163558199606896:
584051237541638188580280321, 1}}

In[3]:=

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



- Evaluation
- Interrupt Evaluation... ⌘.
- Abort Evaluation ⌘.
- Start Kernel
- Quit Kernel
- Default Kernel
- Notebook's Kernel
- Kernel Configuration Options...
- ✓ Show In/Out Names
- Delete All Output



saving the notebook

- 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

In[1]:

$$\text{FactorInteger}[2^{(2^7)} + 1]$$

Out[1]=

$$\{\{59649589127497217, 1\}, \\ \{689200685129054721, 1\}\}$$

In[2]:

$$\text{FactorInteger}[2^{(2^8)} + 1]$$

Out[2]=

$$\{\{1238926361552897, 1\}, \\ \{93461639715357977769163558199606896 \\ 584051237541638188580280321, 1\}\}$$

In[3]:=

$$\text{FactorInteger}[2^{(2^{12})} + 1]$$

Out[3]=

$$\$Aborted$$

- About Mathematica...
- Preferences...
- Services
- Hide Mathematica ⌘H
- Hide Others ⌘⇧H
- Show All
- Quit Mathematica ⌘Q

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!



getting started

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

**use as a
calculator**

New Play View Them

Slides

43
46
47
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125%

In[1]:=

```
123412341234123412341234 *  
123412341234123412341234
```

Out[1]=

```
152306059688877178546937297 :  
43891480857256642756
```

In[6]:=

```
N[Pi, 100]
```

Out[6]=

```
3.1415926535897932384626433 :  
83279502884197169399375105 :  
82097494459230781640628620 :  
8998628034825342117068
```

In[10]:=

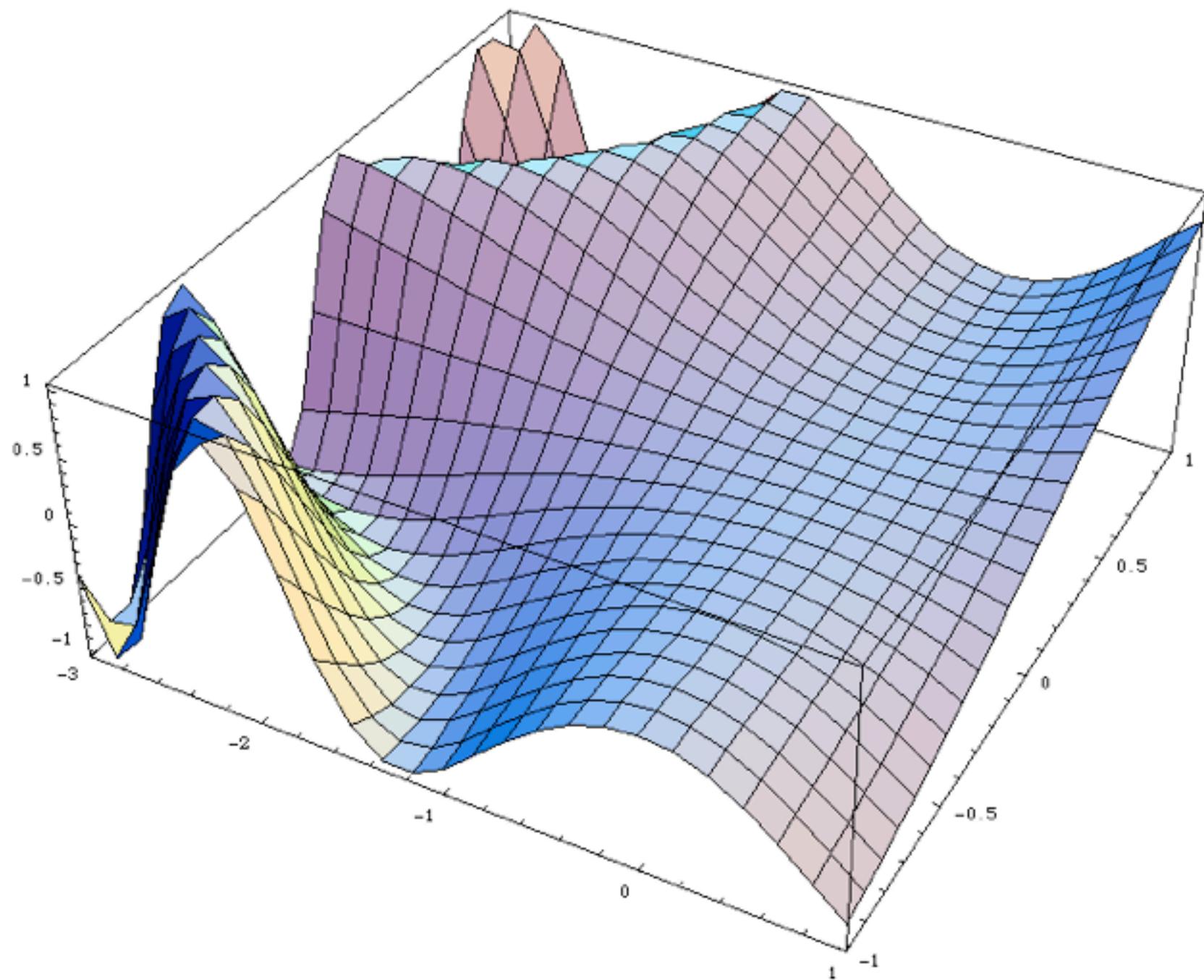
```
2 ^ (2 ^ (2 ^ 2))
```

Out[10]=

```
65536
```

**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}]

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

In[10]=

Integrate [Sin [Sqrt [x]], x]

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

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}]

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

In[20]=

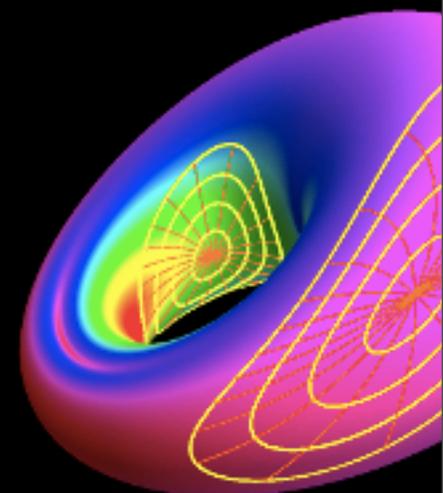
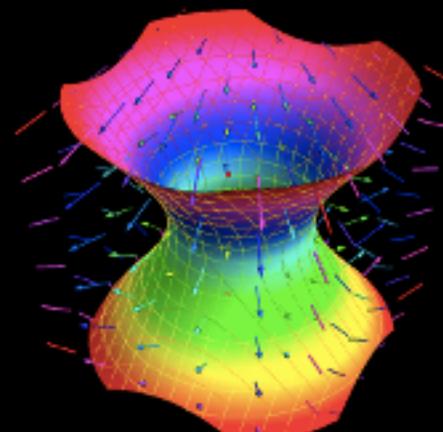
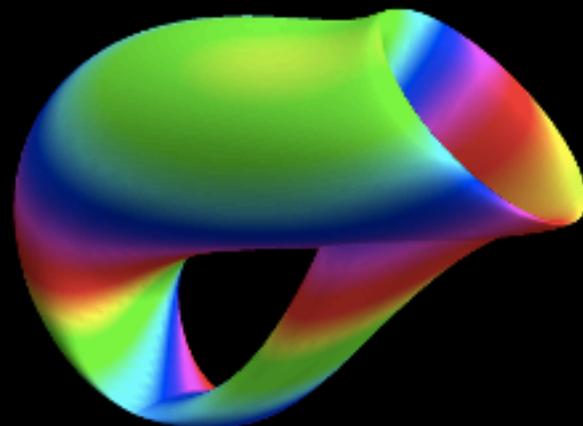
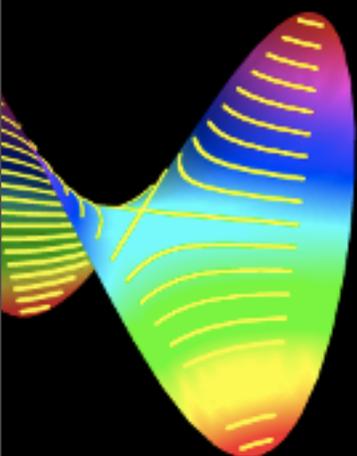
Series [Cos [Pi (x + 1)] + Sin [x], {x, 0, 4}]

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

the assignment

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

getting the file



[yll](#)

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[Exhibit](#)

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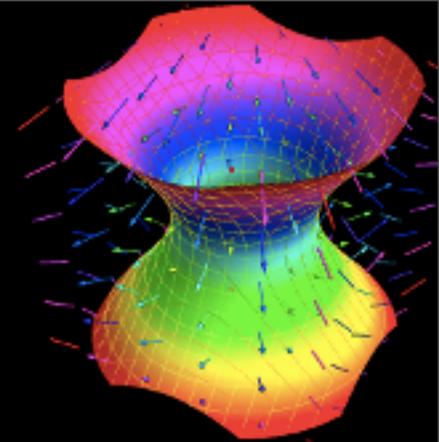
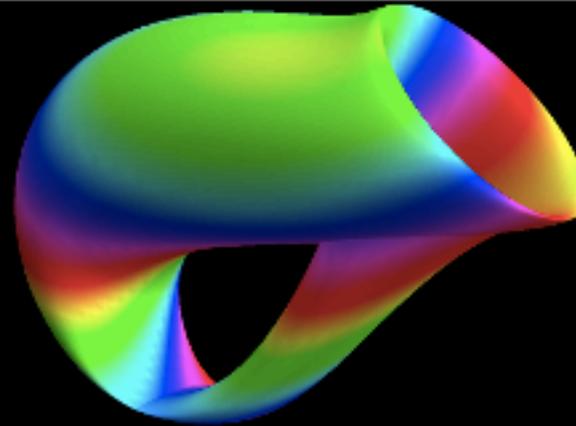
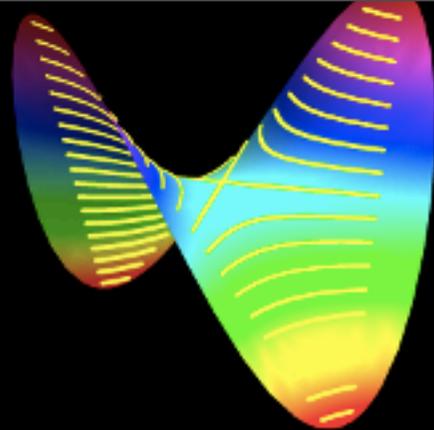
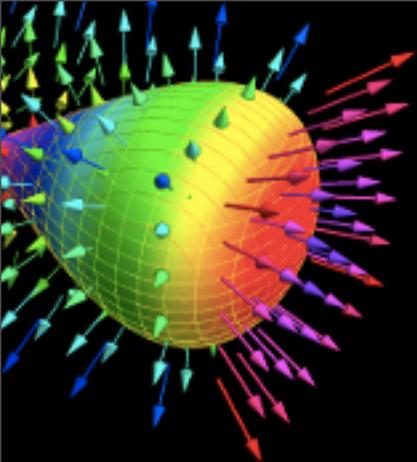
[Twitter](#)

[Link](#)

ts



- Have a good long weekend. Enjoy 11.11.11 at 11:11:11
- Good time now to install Mathematica. If you should need Mathematica for Lin Oliver
- The mathematica project is available. If you clicked on the above link, you might see some text gibberish. This is because the Mathematica file is a text file. You have to open this within Mathematica. To do so, right click at the link to save it, then click on it to open it in Mathematica. If you want to open it the cool way, open a terminal in Linux and type "curl http://www.courses.fas.harvard.edu/~math21a/mathematica/lab.nb" and then open lab.nb"
- We have a Mathematica workshop on Thursday, November 17, from 8-9 PM in



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[Exhibit](#)

[Doc](#)

[Lab](#)

[Team](#)

[Fa](#)

Mathematica Laboratory

Availability

Mathematica for OSX and Windows can be obtained [here](#). The current version is Mathematica 8.04 (the installation you will be prompted for an Activation Key. [Students](#) [Faculty/Staff](#). Creation of a Wolfram ID is required to provide your Harvard email address. Contact me (knill@math.harvard.edu) if you plan to use Mathematica.

Getting the notebook

- The Mathematica laboratory will be available [here](#). Save this text file as "lab.m" and open it. The assignment is at the end.

Running mathematica

Mathematica is started like any other application on Macintoshes or PC's. On Mac OS X, just type "mathematica" in the Spotlight search. On Linux, just type "mathematica" in the terminal. On Windows, just type "mathematica" in the command prompt.

Some frequently used commands:

Plot[Sin[5 t], {t, 0, 10}]

Graph function of

- New Window ⌘N
- New Tab ⌘T
- Open Location... ⌘L
- Open File... ⌘O
- Close ⌘W

- Save Page As... ⌘S
- Send Link...
- Page Setup...
- Print... ⌘P
- Import...
- Work Offline

Mozilla Firefox

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

Google

TD cnn wp nyt leo rk ma ok adv ip courses expos math Harvard Math Webm...

(* Mathematica notebook content *)

(** Send Link... (***)

(* Page Setup... (* b *)

(* Print... (* .0' *)

(* Import... (* on:

(* Work Offline

NotebookDataPosition[145, 7]

NotebookDataLength[109845, 3196]

NotebookOptionsPosition[101872, 2958]

NotebookOutlinePosition[102303, 2975]

CellTagsIndexPosition[102260, 2972]

WindowFrame->Normal

ContainsDynamic->False*)

(* Beginning of Notebook Content *)

Notebook[{

```
Cell[CellGroupData[{
Cell["Multivariable calculus Computer algebra Project", "Title",
CellChangeTimes->{{3.391171978276725*^9, 3.391171984589816*^9}, {
3.391173252103259*^9, 3.39117328408102*^9}, {3.394713354905753*^9,
3.394713370120806*^9}},
Background->RGBColor[0.8156862745098039, 0.8, 0.6705882352941176]],
Cell[CellGroupData[{
```

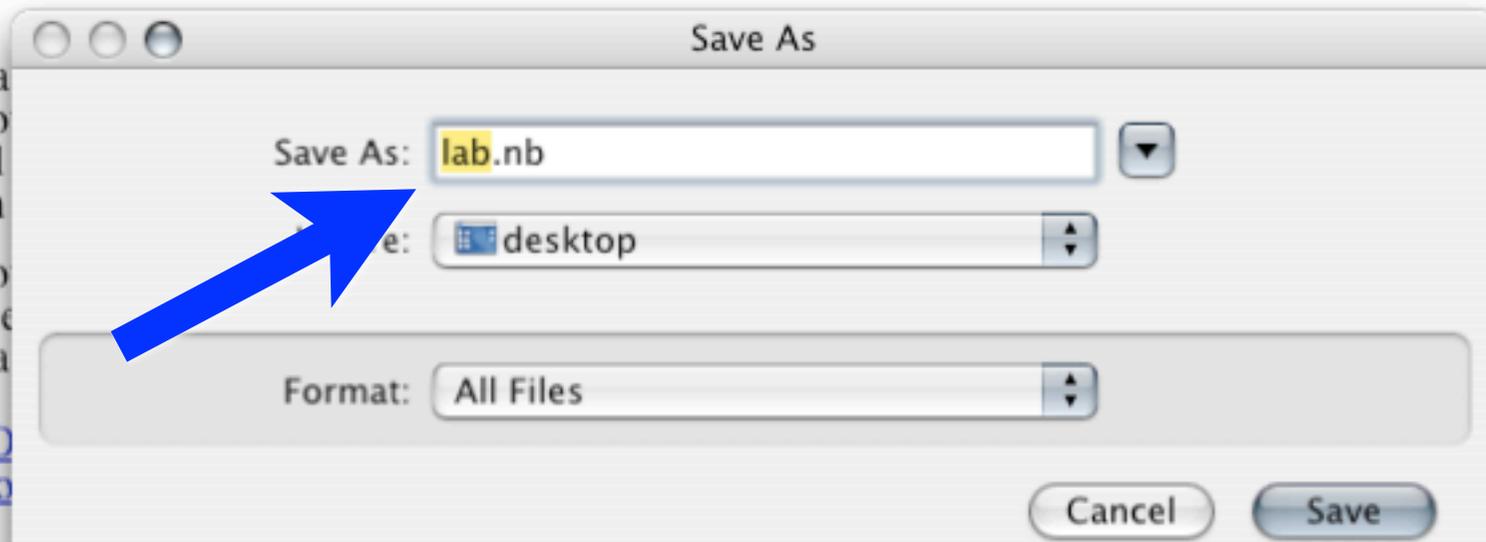
```
Cell["\<\\
Oliver knill, Harvard University, knill@math.harvard.edu, Math21a, Fall 2007\\
>", "Subsubsection",
CellChangeTimes->{{3.391173201898632*^9, 3.391173247654856*^9},
3.39471369508558*^9, {3.404427096339894*^9, 3.404427099745094*^9}}],
```

```
Cell[TextData[{
"Welcome to the Mathematica project of Fall 2007! This notebook will be your \
guide to get started. It also contains the assignment at the very end. If you \
work on a project, save it frequently and make backups. Have fun! . \n\n\
Content in a mathematica file is organized as ",
StyleBox["cells",
FontWeight->"Bold"],
". 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:"
}], "Text",
CellChangeTimes->{{3.391172046744291*^9, 3.39117206041971*^9}, {
3.391172535356017*^9, 3.391172538265517*^9}, {3.391172777715003*^9,
```

Done

PR:n/a

Important: Save with .nb not .txt



- [Mac OS](#)
- [Windows](#)

and email to mathlab@fas.harvard.edu, if you plan to use Mathematica on a Linux system. We can provide you with a CD.

- The Mathematica laboratory assignment is now [available](#). Download it [here](#)!

Mathematica is started like any other application on Macintoshes or PC's. On Linux, just type "mathematica" to start the notebook version, or "math" to start the terminal version.

```
(* 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[f[u,v],v],u},{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)

Example how to check homework: change the function and get

mathematica_2007

Macintosh HD
mathematica_2006
demo1
lab.nb

100%



Is
74.21 GB, 12.99 GB free



Picture 1
_280 x 800



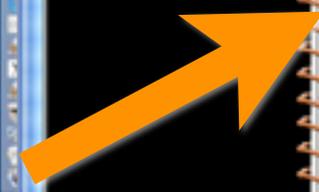
perfect



mathematica_2007



lab.nb



walk through

Multivariable Calculus Computer Algebra Project

- Oliver knill, Harvard University, knill@math.harvard.edu, Math 21a, Fall 2011

This assignment uses *Mathematica* 8. **The assignment at the very end.** You find templates for all 5 problems in this notebook. The project is **due December 3, 2011**. Please electronically by email to knill@math.harvard.edu (Choose Cell->DeleteAllOutput in the above menu first if the file is too large). Your project is only considered successfully submitted if you receive an acknowledgement email within a couple of hours. Otherwise, resubmit. If you use textures, make sure that the texture is available on a public website or submit the *Mathematica* file. There is a *Mathematica* workshop on **November 17, 2011, from 8-9 PM in Hall D**.

Content in a mathematica file is organized as **cells**. To evaluate, grab the bracket to the right, holding down the shift key and hit return.

```
Plot[Sin[x^2/(1-x)], {x, -1, 3}]
```

After evaluating the cell, an output cell has been added to the input cell. You can make it interactive as in the following example:

```
Manipulate[Plot[Sin[x^2/(1-x)], {x, 1-c, 1+c}], {c, 0.1, 1}]
```

Lets get started. Just 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 of the entire notebook and evaluate it. All the cells will be evaluated.

The function Plot is quite flexible. Here is an example, which shows how to plot two functions at once and fill the part between them:

```
Plot[{Sin[x], Cos[x]}, {x, 0, 10}, Filling -> True, FillingStyle -> {RGBColor[1, 1, 0]}]
```

Here is a 3D plot with a picture as a texture. We get a nice Harvard napkin:

```
picture = Import["http://www.courses.fas.harvard.edu/~math21a/images/harvard.png"];
Plot3D[Sin[x y], {x, -2, 2}, {y, -2, 2}, Lighting -> "Neutral", Mesh -> False, PlotPoints -> 40, TextureCoordinateFunction -> ({#1, #2} &),
PlotStyle -> {Texture[picture]}, Boxed -> False, Axes -> False]
```

Lets now look at weather data, and plot the average temperatures of the last 66 years in Boston. Your computer will have to look up some data first:

```
T = WeatherData["KBOS", "MeanTemperature", {{1945}, {2011}, "Year"}];
d = Table[{T[[k, 1, 1]], T[[k, 2]]}, {k, Length[T]}; f = Fit[d, {1, x}, x];
Show[{Plot[f /. x -> y, {y, 1945, 2010}, PlotStyle -> {RGBColor[1, 0, 0], Thickness[0.01]}],
Graphics[{PointSize[0.02], RGBColor[0, 0, 1], Map[Point, d]}], PlotRange -> All]
```

One of the problems asks you to produce a plant of your choice. Here is example code for a "Strawberry" which uses texture to produce:

```
strawberry[t_, s_] := {Sin[t] Sin[s]^2, Cos[t] Sin[s], Cos[s] - (1/(1+s^2)) - 1/(1+(s-Pi)^2)};
picture = Import["http://www.courses.fas.harvard.edu/~math21a/images/strawberry.jpg"];
S = ParametricPlot3D[strawberry[t, s], {s, 0, Pi}, {t, 0, 2 Pi}, Lighting -> "Neutral", Mesh -> False, PlotPoints -> 40,
TextureCoordinateFunction -> ({#1, #2} &), PlotStyle -> {Texture[picture]}, ViewPoint -> {2.25, 0.0, 0.2}
```

the problems

Flower Problem

```

c = Floor[100 * (Q2[[1]] * Q4[[2]] - Q4[[1]] * Q2[[2]])];
{RGBColor[0, 0, 1], Disk[Q2, 0.1]}, {RGBColor[1, 0, 0], Disk[Q4, 0.1]}, {RGBColor[0, 1, 0], PointSize[0.04], Point[Q1]},
{RGBColor[1, 0, 0], Thickness[0.01], Dynamic[Arrow[{Q1, Q2}]]}, {RGBColor[0, 0, 1], Thickness[0.01], Dynamic[Arrow[{Q1,
{RGBColor[1, 1, 0], Dynamic[Polygon[{Q1, Q2, Q3, Q4, Q1}]]]}, Locator[Dynamic[Q2], ImageSize -> 40], Locator[Dynamic[Q4], ImageSize -> 40],
{FontSize -> 40, Text["Cross Product", {0, 1.8}]}], PlotRange -> {{-2, 2}, {-2, 2}}, {{Q2, {1, 0}}, {-1, -1}, {1, 1}}, ControlType -> None}]]

```

■ Assignment

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

- 1) (2 points) Compute numerically the surface area of the surface $r(u,v) = \langle u^4-v, u^2+v^2, u-v \rangle$, where $0 < u < 2$, $1 < v < 4$.
- 2) (2 points) Find the flux of $F(x,y,z) = \langle x^{10}+y^{10}, y-x, \sin(x^2+z^2) \rangle$ through the surface $r(u,v) = \langle \cos(u) \sin(v) + \sin(u)^3, \sin(u) \sin(v), \cos(v) \rangle$, where $0 < u < 2\pi$, $0 < v < \pi$.
- 3) (2 points) Plot the surface given in spherical coordinates as $\rho(s,t) = 2 + \sin(\sin(s-t))$
- 4) (2 points) Find the volume of the solid given in spherical coordinates as $\rho(s,t) < 2 + \sin(\sin(s-t))$
- 5) (2 points) Produce an plant, fruit, leaf, grass etc of your choice. We will build a "garden" with the best submissions.

We will have a workshop on Thursday, November 17, from 8-9 PM in Hall D, where more about this assignment is said and tips and tricks as well as more templates.

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 file.

The assignment has to be submitted electronically until Monday December 3/2011

- **Oliver Knill, Nov 4 2011, email: knill@math.harvard.edu**

tips

- save frequently
- start a new notebook
- careful with parameters
- make backups
- google stuff and network
- start a week early

**submitting the
problems**

tricks for assignment

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

animation for exploration

**pepping up
graphics**

drawing

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

fun

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

sound

image

**importing,
exporting files**

simple programming

demonstration projects

Conversion

<http://>

www.wolfram.com/

[solutions/](http://www.wolfram.com/solutions/)

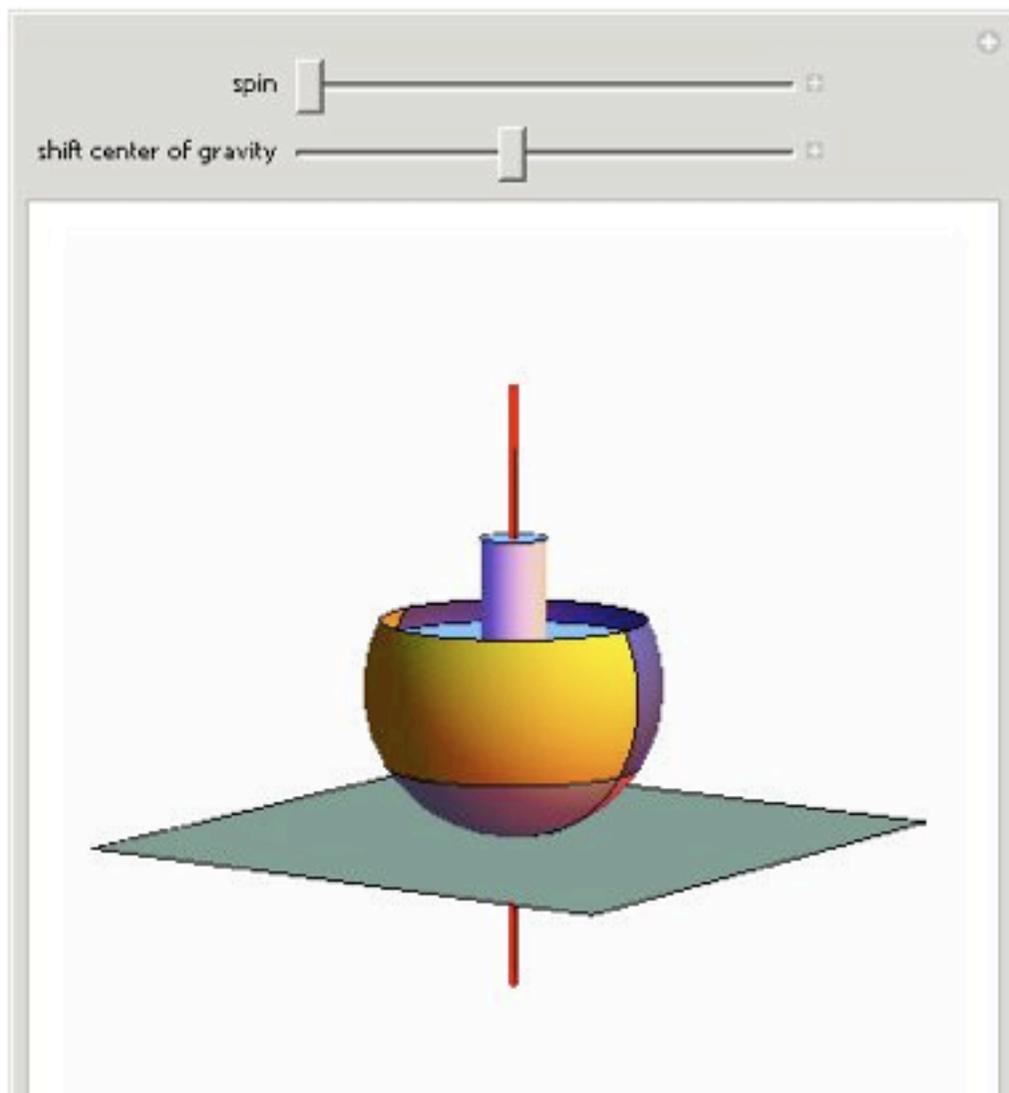
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**turn the project
in on time!**