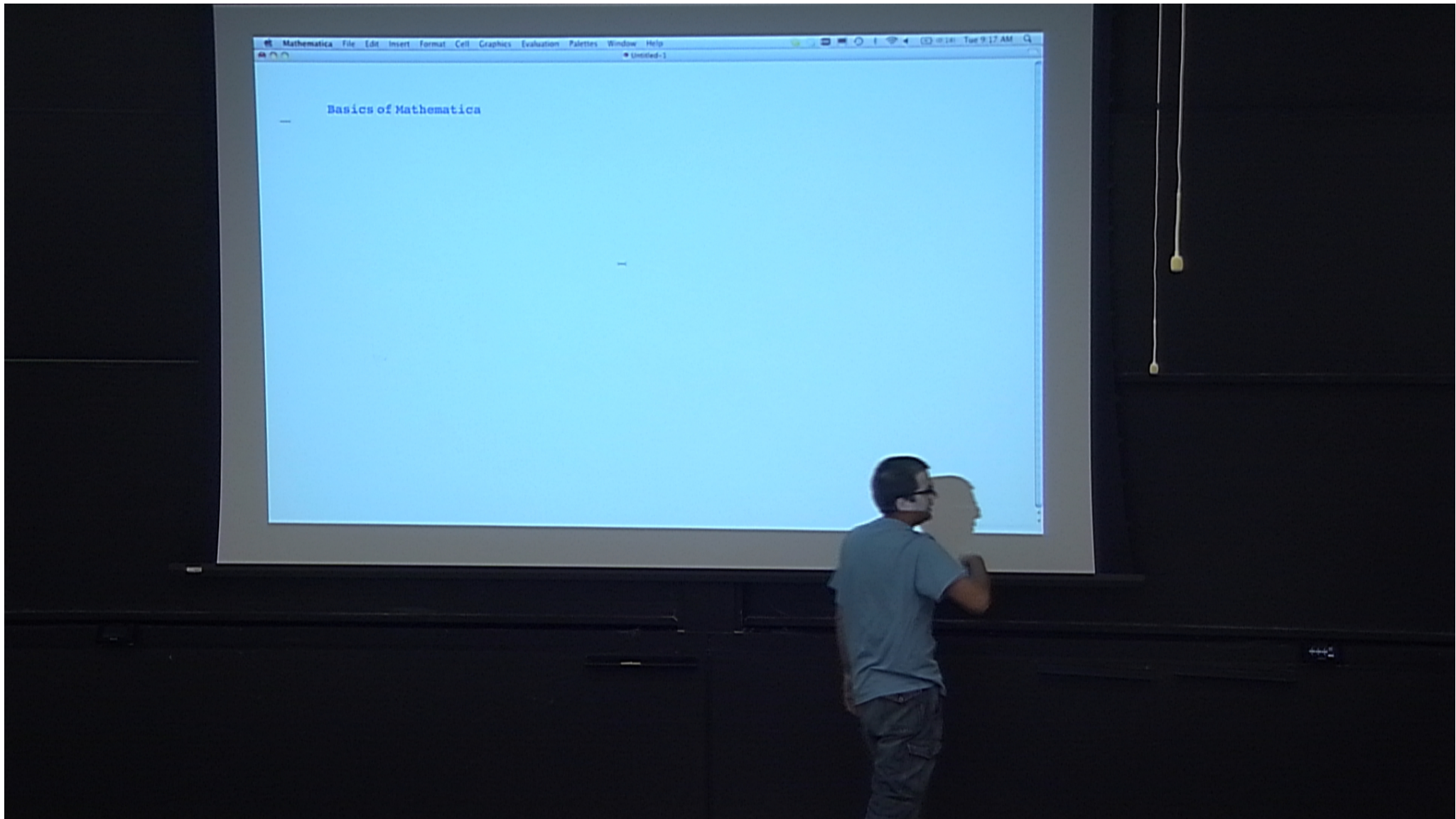


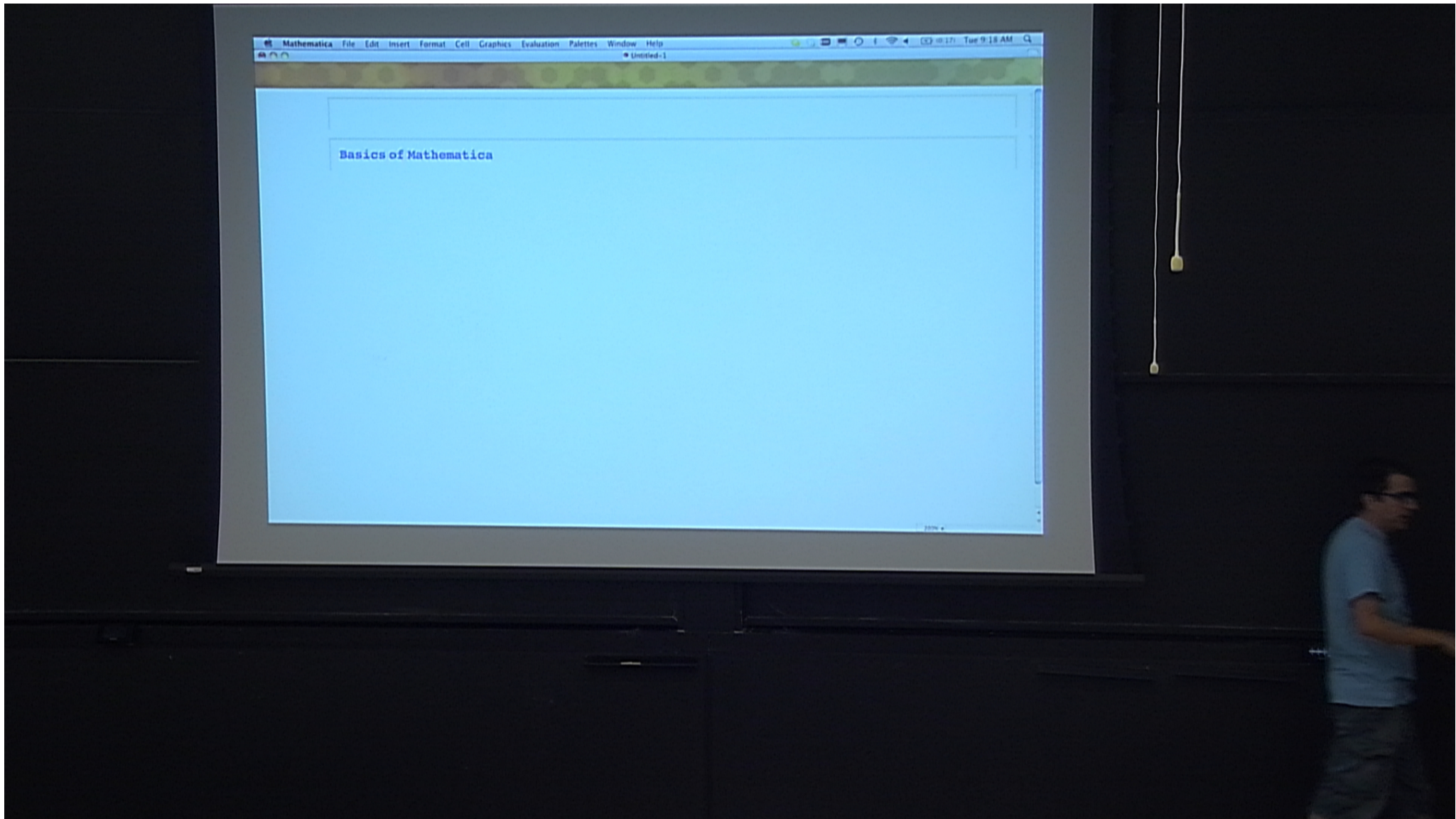
Title: Introduction to Mathematica - Lecture 1a

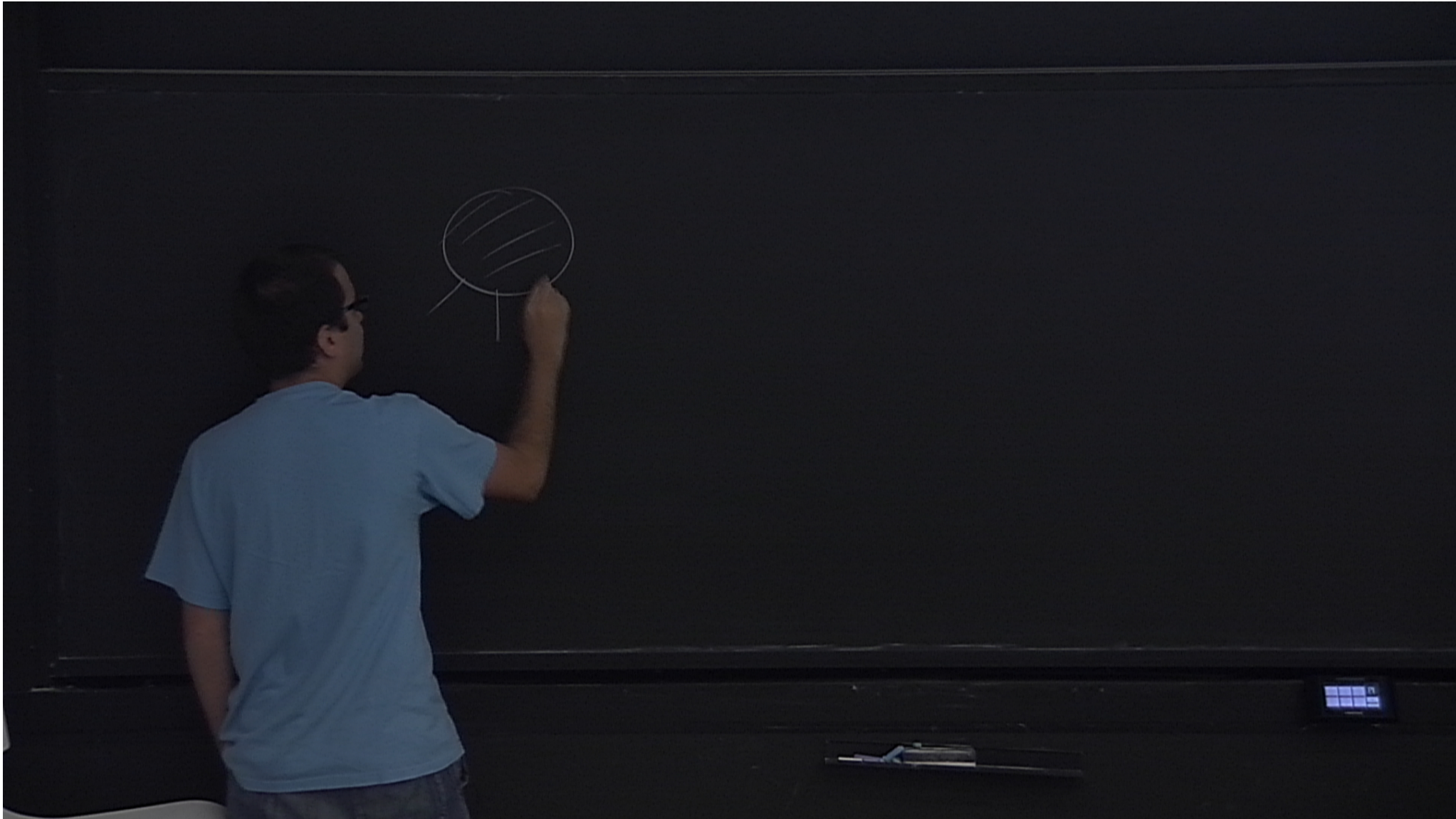
Date: Sep 04, 2012 09:00 AM

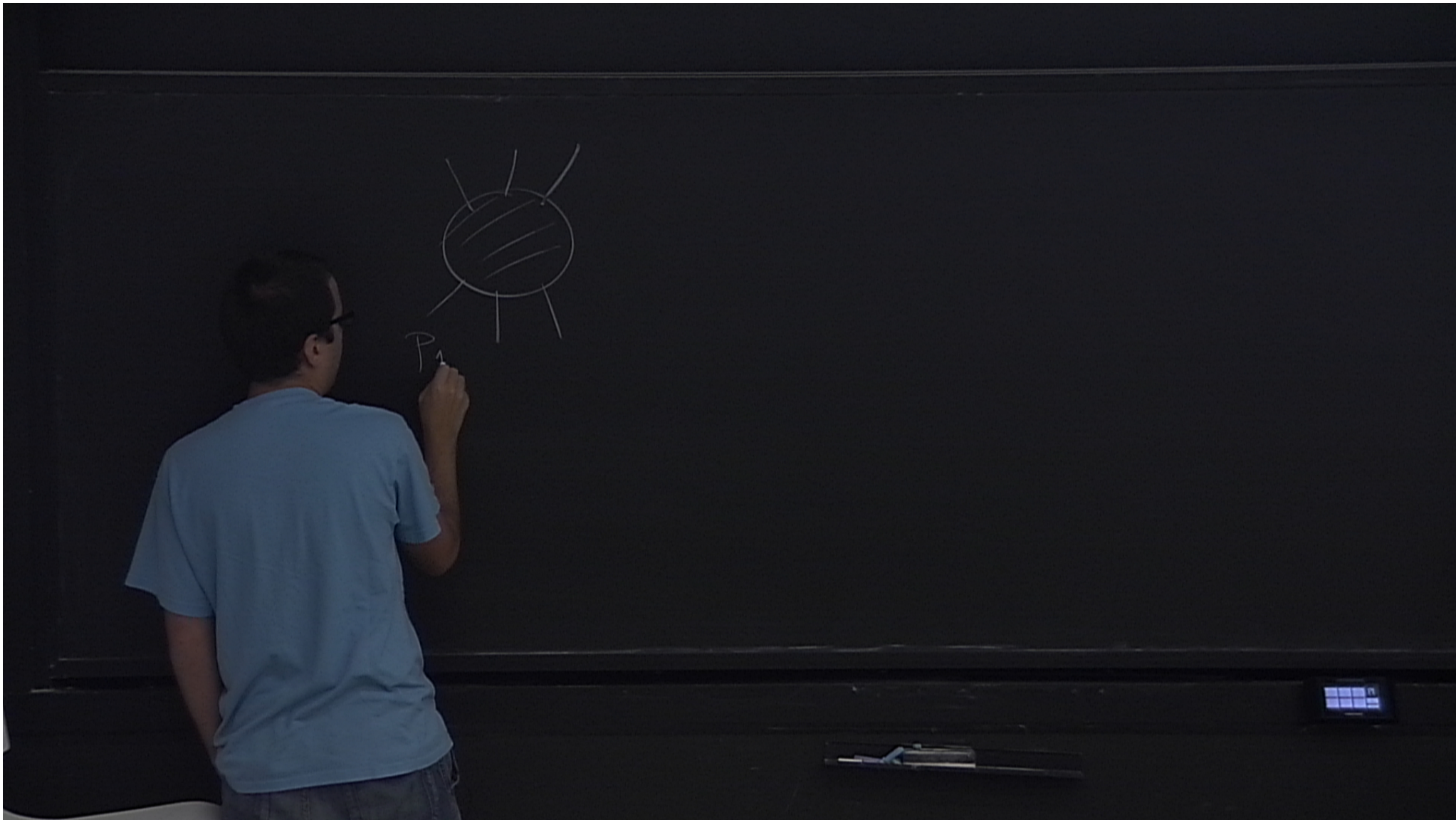
URL: <http://pirsa.org/12090041>

Abstract:







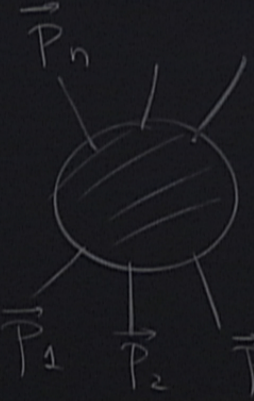


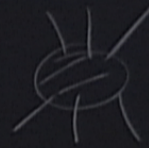
$$(\vec{P}_1, \dots, \vec{P}_n) = \left(\bigotimes \right) \left(\sum \right)$$

$$\vec{P}_j^2 = 0$$

$$(\vec{P}_j^0)^2 - (\vec{P}_j^1)^2 - (\vec{P}_j^2)^2 - (\vec{P}_j^3)^2 = 0$$

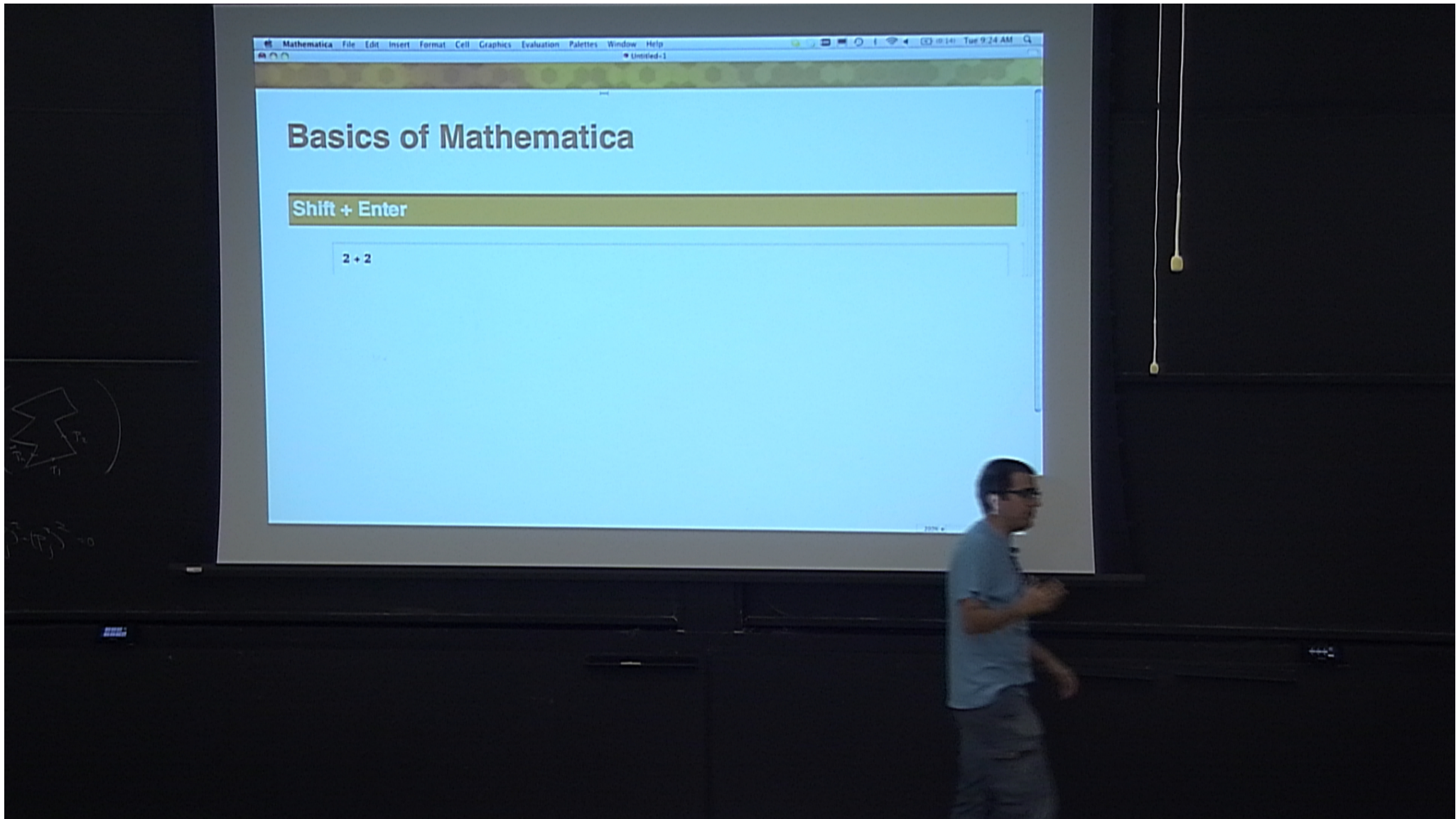
$n=7$

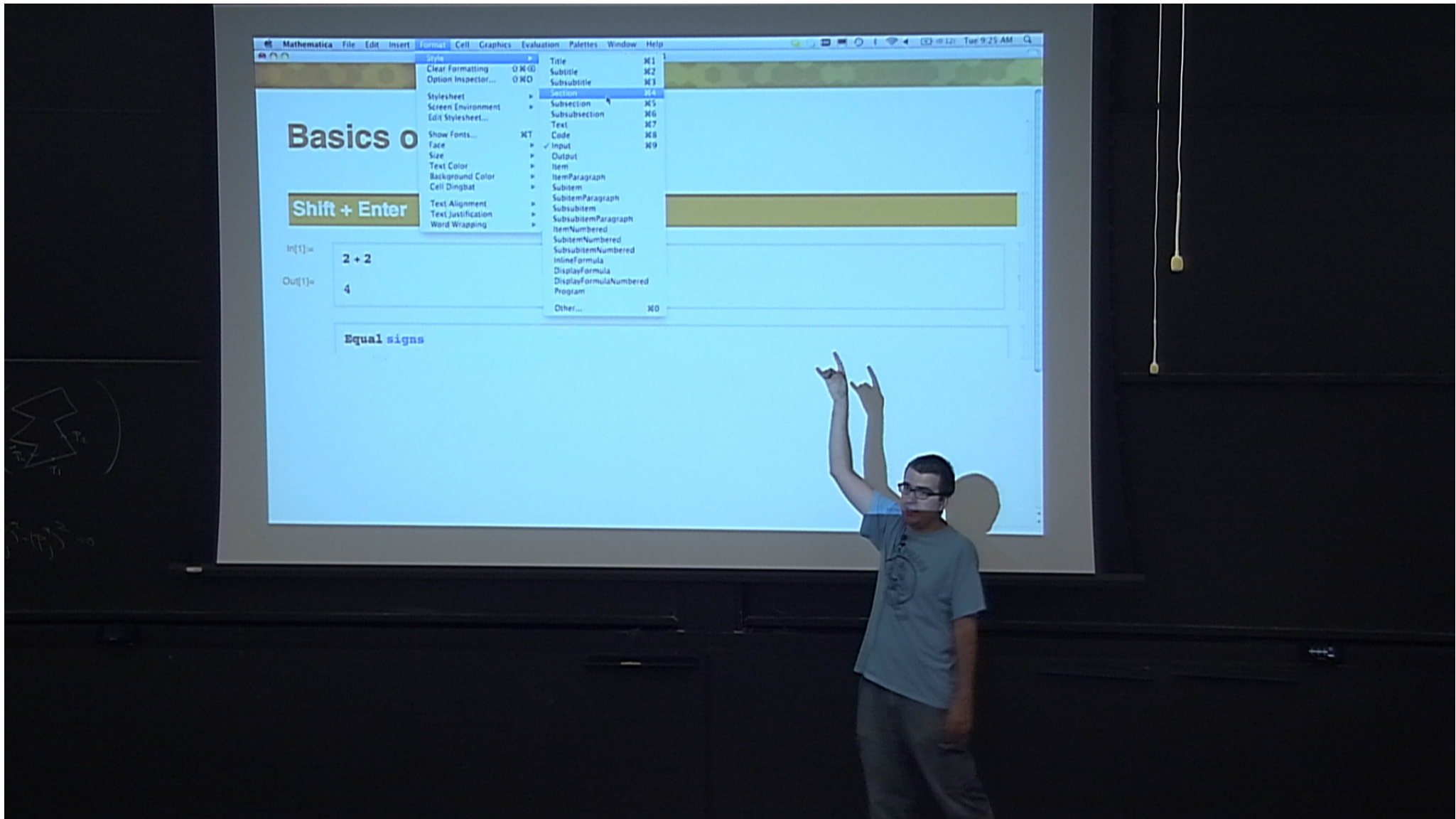


$(\vec{P}_1, \dots, \vec{P}_n) =$

 $\left(\begin{array}{c} \text{Diagram of a polygon with internal lines and labels } P_1, P_2, \vec{P}_n \end{array} \right)$

$\vec{P}_j^2 = 0$

$(P_j^0)^2 - (P_j^1)^2 - (P_j^2)^2 - (P_j^3)^2 = 0$





Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Basics of Mathematica

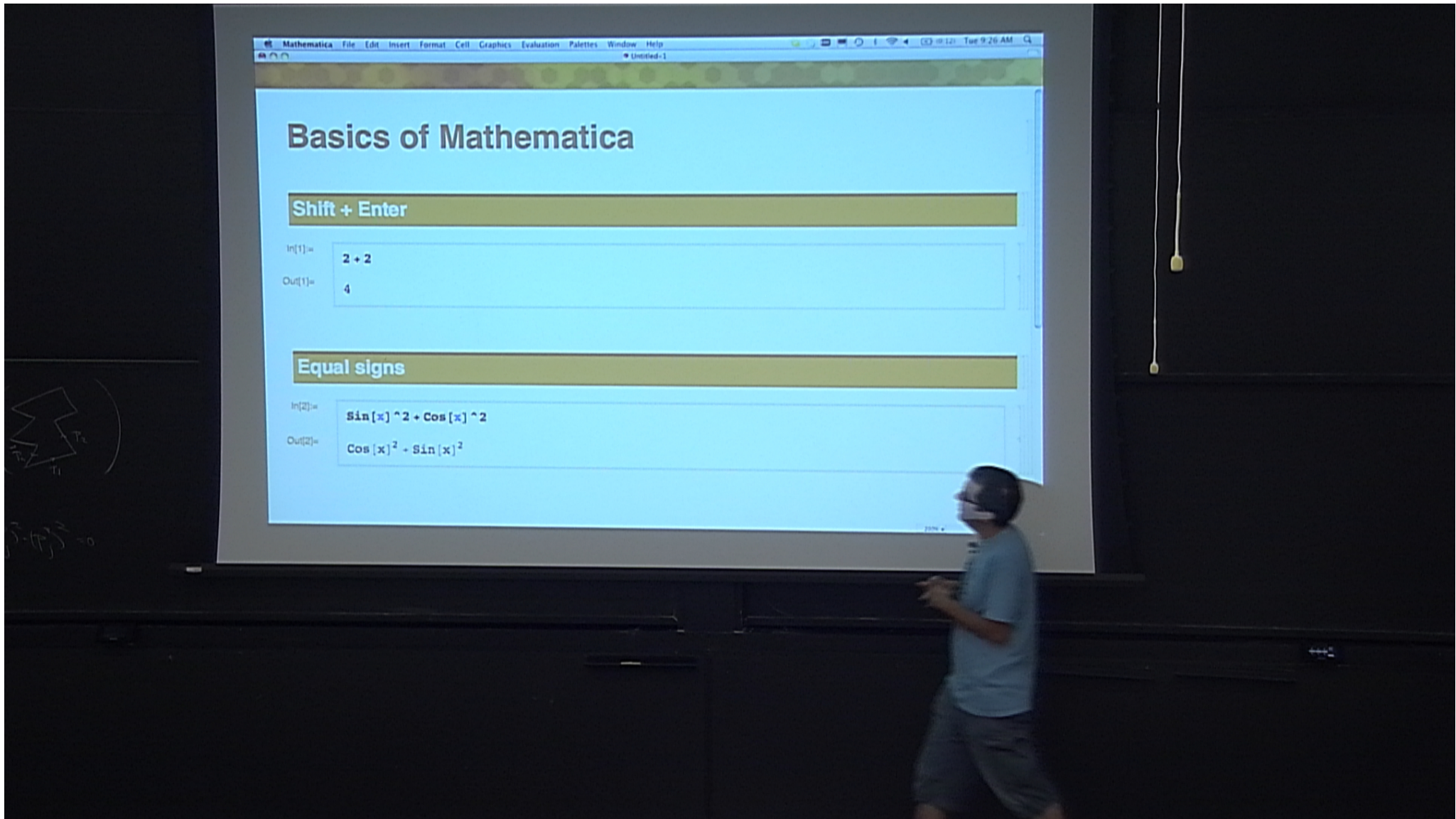
Shift + Enter

In[1]:= $2 + 2$
Out[1]:= 4

Equal signs

In[2]:= $\sin[x]^2 + \cos[x]^2$
Out[2]:= $\cos^2 x - \sin^2 x$

2006



Basics of Mathematica

Shift + Enter

In[1]:= **2 + 2**
Out[1]:= **4**

Equal signs

In[2]:= **Sin[x]^2 + Cos[x]^2**
Out[2]:= **Cos[x]^2 + Sin[x]^2**

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Shift + Enter

In[1]:= $2 + 2$
Out[1]:= 4

Equal signs

In[3]:= `Simplify[Sin[x]^2 + Cos[x]^2]`
Out[3]:= 1

In[4]:= `Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + Shift + Enter *)`
Out[4]:= 1

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[1]:= $2 + 2$
Out[1]:= 4

Equal signs

In[3]:= `Simplify[Sin[x]^2 + Cos[x]^2]`
Out[3]:= 1

In[5]:= `Simplify[Sin[x]^2 + Cos[x]^2]` (= Ctrl + 6 =)
Out[5]:= 1

`s[x_] = Simplify[x + 1]`

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[1]:= $2 + 2$
Out[1]:= 4

Equal signs

In[3]:= `Simplify[Sin[x]^2 + Cos[x]^2]`
Out[3]:= 1

In[5]:= `Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + 6 *)`
Out[5]:= 1

`u[x_] = Simplify[x + 1]`

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Equal signs

In[3]:= `Simplify[Sin[x]^2 + Cos[x]^2]`
Out[3]= 1

In[5]:= `Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + 6 *)`
Out[5]= 1

In[6]:= `s[x_] = Simplify[x + 1]`
`s2[x_] := Simplify[x + 1]`
Out[6]= 1 + x

In[8]:= `s[Cos[x]^2 + Sin[x]^2]`
Out[8]= 1 + Cos[x]^2 + Sin[x]^2

`s[Cos[x]^2 + Sin[x]^2]`

```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[3]:= Simplify[Sin[x]^2 + Cos[x]^2]
Out[3]= 1

In[5]:= Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + 6 *)
Out[5]= 1

In[6]:= s[_] = Simplify[x + 1]
s2[_] := Simplify[x + 1]
Out[6]= 1 + x

In[8]:= s[Cos[x]^2 + Sin[x]^2]
Out[8]= 1 + Cos[x]^2 + Sin[x]^2

In[9]:= s2[Cos[x]^2 + Sin[x]^2]
Out[9]= 2
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[4]:= Simplify[Sin[x]^2 + Cos[x]^2]
Out[4]= 1

In[5]:= Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + 6 *)
Out[5]= 1

In[11]:= s[_] = Simplify[x + 1]
Out[11]= 1 + x

In[10]:= s2[_] := Simplify[x + 1]

In[8]:= s[Cos[x]^2 + Sin[x]^2]
Out[8]= 1 + Cos[x]^2 + Sin[x]^2

In[9]:= s2[Cos[x]^2 + Sin[x]^2]
```




```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[4]:= Simplify[Sin[x]^2 + Cos[x]^2]
Out[3]= 1

In[5]:= Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + 6 *)
Out[5]= 1

In[11]:= s[_] = Simplify[x + 1];
Out[11]= 1 + x

In[10]:= s2[_] := Simplify[x + 1]

In[8]:= s[Cos[x]^2 + Sin[x]^2]
Out[8]= 1 + Cos[x]^2 + Sin[x]^2

In[9]:= s2[Cos[x]^2 + Sin[x]^2]
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[3]:= Simplify[Sin[x]^2 + Cos[x]^2]
Out[3]= 1

In[5]:= Simplify[Sin[x]^2 + Cos[x]^2] (* Ctrl + 6 *)
Out[5]= 1

In[12]:= s[x_] = Simplify[x + 1];
In[10]:= s2[x_] := Simplify[x + 1]

In[8]:= s[Cos[x]^2 + Sin[x]^2]
Out[8]= 1 + Cos[x]^2 + Sin[x]^2

In[9]:= s2[Cos[x]^2 + Sin[x]^2]
Out[9]= 2
```


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

```
s[x_] = Simplify[x + 1];  
  
In[10]:= s2[x_] := Simplify[x + 1]  
  
In[8]:= s[Cos[x]^2 + Sin[x]^2]  
Out[8]= 1 + Cos[x]^2 + Sin[x]^2  
  
In[9]:= s2[Cos[x]^2 + Sin[x]^2]  
Out[9]= 2  
  
2 == 3
```

50%
75%
100%
125%
150%
✓ 200%
300%


```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[12]:= S2[Cos[x]^2 + Sin[x]^2]
Out[12]= 2

In[13]:= 2 == 3
Out[13]= False

In[14]:= a == b
Out[14]= a == b

In[15]:= a === b
Out[15]= False

Solve[x + 1 == x^2]
```

```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[9]:= 2

In[13]:= 2 == 3
Out[13]:= False

In[14]:= a == b
Out[14]:= a == b

In[15]:= a === b
Out[15]:= False

In[16]:= Solve[x + 1 == x^2, x]
Out[16]:= {{x -> 1/2 (1 - Sqrt[5])}, {x -> 1/2 (1 + Sqrt[5])}}
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[14]:= a == b
Out[14]:= a == b

In[15]:= a === b
Out[15]:= False

In[16]:= Solve[x + 1 == x^2, x]
Out[16]:= {{x -> 1/2 (1 - Sqrt[5])}, {x -> 1/2 (1 + Sqrt[5])}}

Simplify

Solve
```


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[14]:= `a == b`

Out[14]:= `a == b`

In[15]:= `a === b`

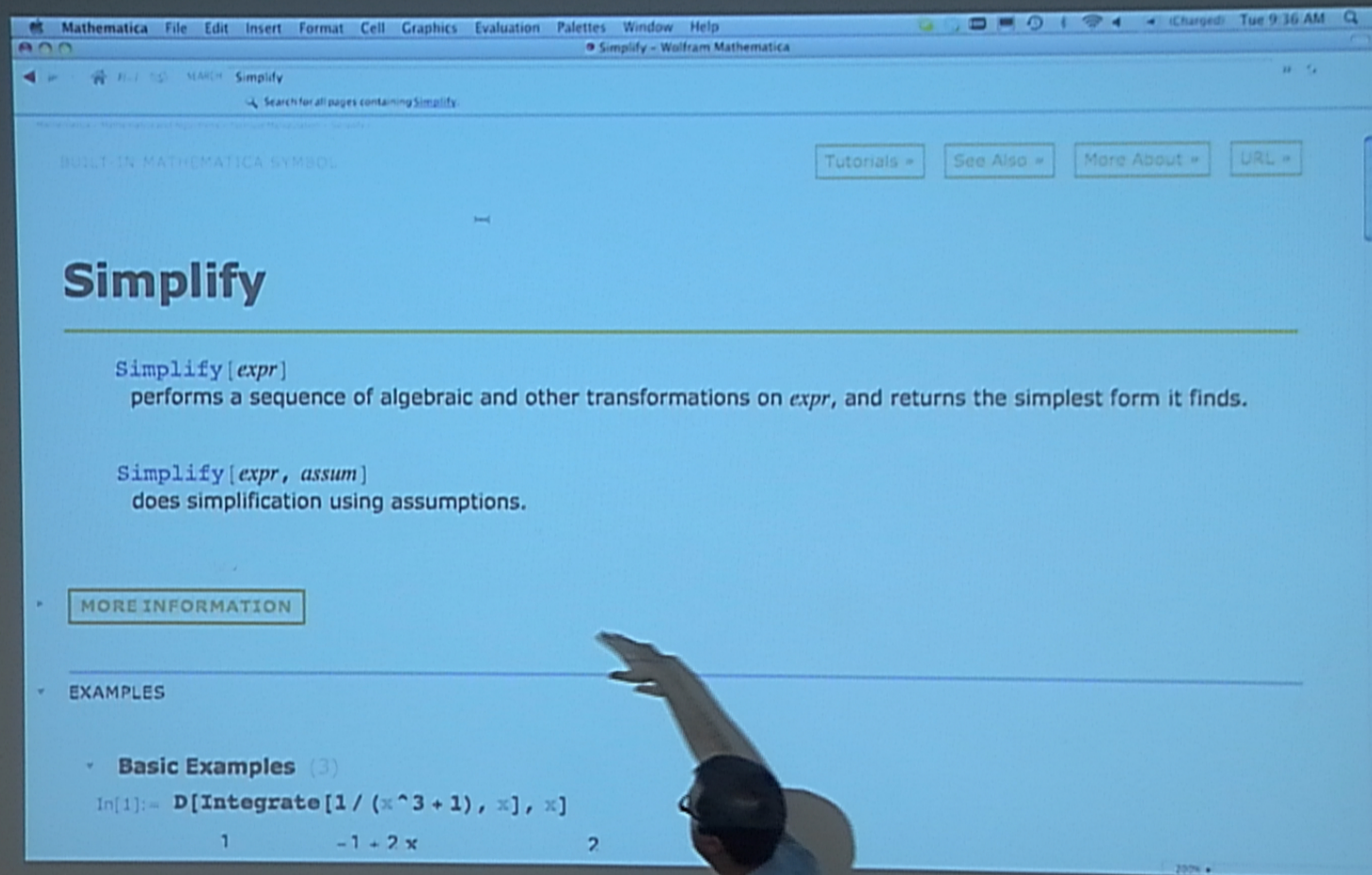
Out[15]:= `False`

In[16]:= `Solve[x + 1 == x^2, x]`

Out[16]:= $\left\{ \left\{ x \rightarrow \frac{1}{2} (1 - \sqrt{5}) \right\}, \left\{ x \rightarrow \frac{1}{2} (1 + \sqrt{5}) \right\} \right\}$

Simplify

Solve



The image shows a person from behind, pointing at a large projection screen. The screen displays the Mathematica documentation for the `Simplify` function. The interface includes a menu bar at the top with options like File, Edit, Insert, Format, Cell, Graphics, Evaluation, Palettes, Window, and Help. Below the menu bar is a search bar with the text "Simplify" and a search icon. The main content area has a light blue background and features the title "Simplify" in a large, bold font. Below the title, there is a description of the function: `Simplify[expr]` performs a sequence of algebraic and other transformations on `expr`, and returns the simplest form it finds. Another description shows `Simplify[expr, assum]` does simplification using assumptions. There are buttons for "Tutorials", "See Also", "More About", and "URL". A section titled "MORE INFORMATION" is visible, followed by a section titled "EXAMPLES". Under "EXAMPLES", there is a subsection titled "Basic Examples (3)". The first example shows the input `In[1]:= D[Integrate[1 / (x^3 + 1), x], x]` and the output $\frac{1}{-1 + 2x^2}$.

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help

Simplify - Wolfram Mathematica

SEARCH Simplify

Search for all pages containing Simplify.

BUILT-IN MATHEMATICA SYMBOL

Tutorials » See Also » More About » URL »

Simplify

`Simplify[expr]`
performs a sequence of algebraic and other transformations on `expr`, and returns the simplest form it finds.

`Simplify[expr, assum]`
does simplification using assumptions.

MORE INFORMATION

EXAMPLES

Basic Examples (3)

In[1]:= `D[Integrate[1 / (x^3 + 1), x], x]`

$\frac{1}{-1 + 2x^2}$

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Simplify - Wolfram Mathematica

SEARCH Simplify
Search for all pages containing Simplify.

MORE INFORMATION

EXAMPLES

Basic Examples (3)

In[1]:= `D[Integrate[1/(x^3+1), x], x]`

Out[1]= $\frac{1}{3(1+x)} - \frac{-1+2x}{6(1-x+x^2)} + \frac{2}{3\left(1+\frac{1}{3}(-1+2x)^2\right)}$

In[2]:= `Simplify[%]`

Out[2]= $\frac{1}{1+x^3}$

In[1]:= `Simplify[Sin[x]^2 + Cos[x]^2]`

Out[1]= 1

Simplify can get further if assumptions are made about x:

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Simplify - Wolfram Mathematica

SEARCH Simplify
Search for all pages containing Simplify.

Out[3]= **Abs**[x]

- **Scope** (4)
- **Options** (10)
- **Applications** (4)
- **Properties & Relations** (2)
- **Possible Issues** (1)

SEE ALSO

[FullSimplify](#) · [Refine](#) · [Factor](#) · [Expand](#) · [TrigExpand](#) · [PowerExpand](#) · [ComplexExpand](#) · [PiecewiseExpand](#) · [Element](#) · [FunctionExpand](#) · [Reduce](#) · [Assuming](#) · [TrigReduce](#) · [TrigFactor](#)

TUTORIALS

- [Simplifying Algebraic Expressions](#)
- [Simplifying with Assumptions](#)
- [Simplification](#)
- [Putting Expressions into Different Forms](#)
- [Using Assumptions](#)

MORE ABOUT

- [Algebraic Transformations](#)

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Simplify - Wolfram Mathematica

SEARCH Simplify
Search for all pages containing *Simplify*.

Out[3]= **Abs**[x]

- **Scope** (4)
- **Options** (10)
- **Applications** (4)
- **Properties & Relations** (2)
- **Possible Issues** (1)

SEE ALSO

[FullSimplify](#) · [Refine](#) · [Factor](#) · [Expand](#) · [TrigExpand](#) · [PowerExpand](#) · [ComplexExpand](#) · [PiecewiseExpand](#) · [Element](#) · [FunctionExpand](#) · [Reduce](#) · [Assuming](#) · [TrigReduce](#) · [TrigFactor](#)

TUTORIALS

- [Simplifying Algebraic Expressions](#)
- [Simplifying with Assumptions](#)
- [Simplification](#)
- [Putting Expressions into Different Forms](#)
- [Using Assumptions](#)

MORE ABOUT

- [Algebraic Transformations](#)

200%

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[16]:= **Solve**[$x + 1 == x^2$, x]

Out[16]= $\left\{ \left\{ x \rightarrow \frac{1}{2} (1 - \sqrt{5}) \right\}, \left\{ x \rightarrow \frac{1}{2} (1 + \sqrt{5}) \right\} \right\}$

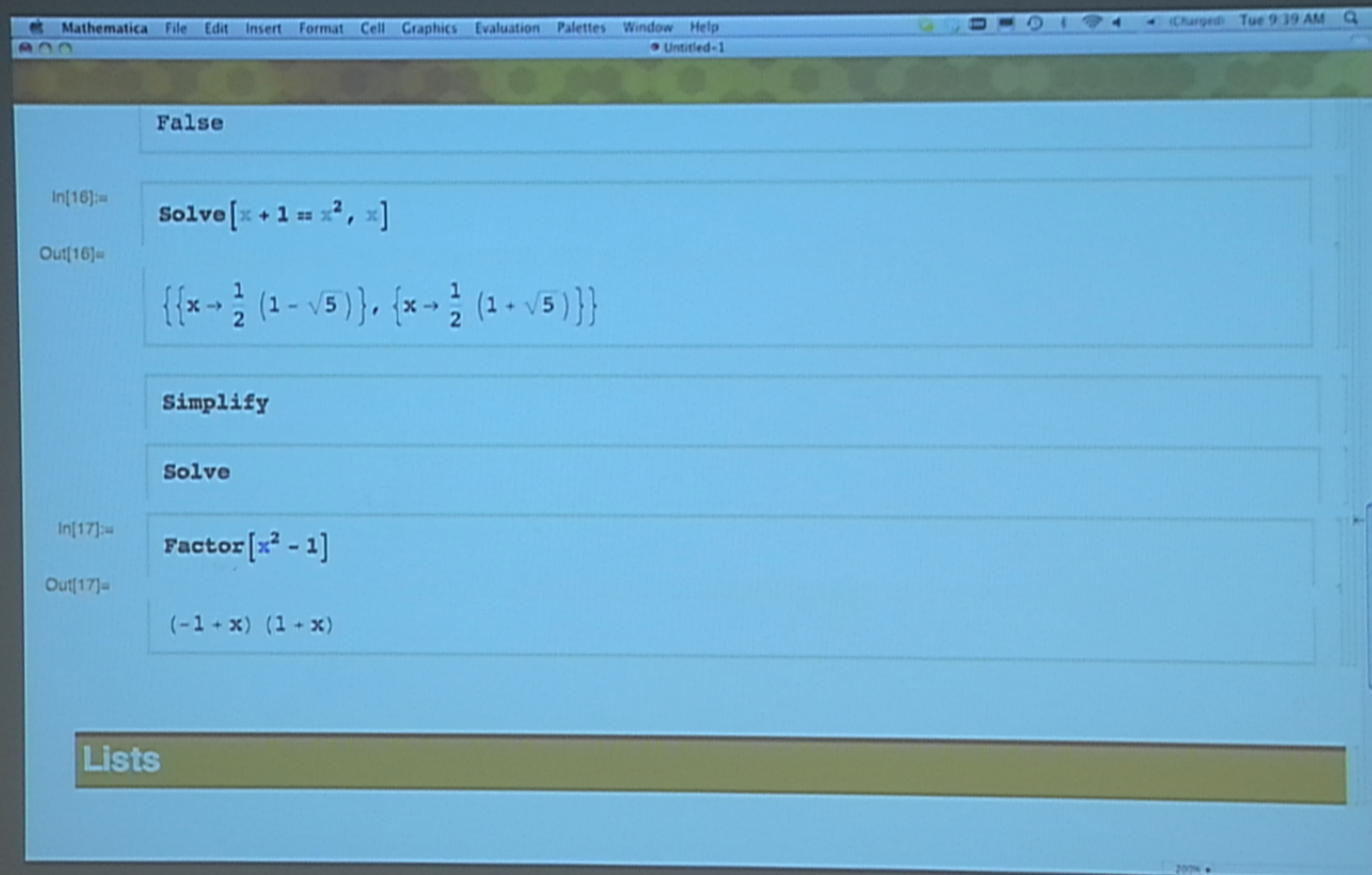
Simplify

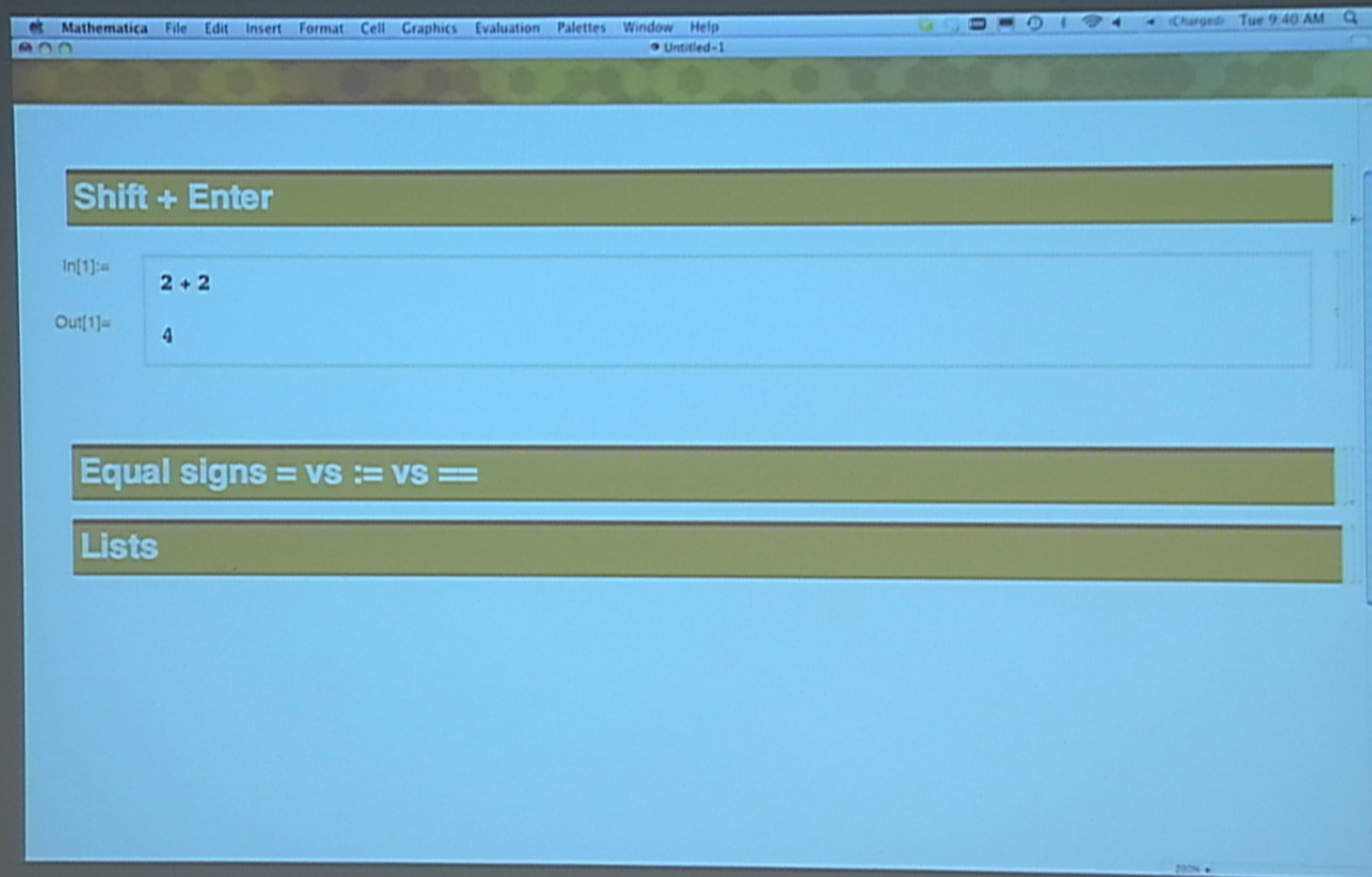
Solve

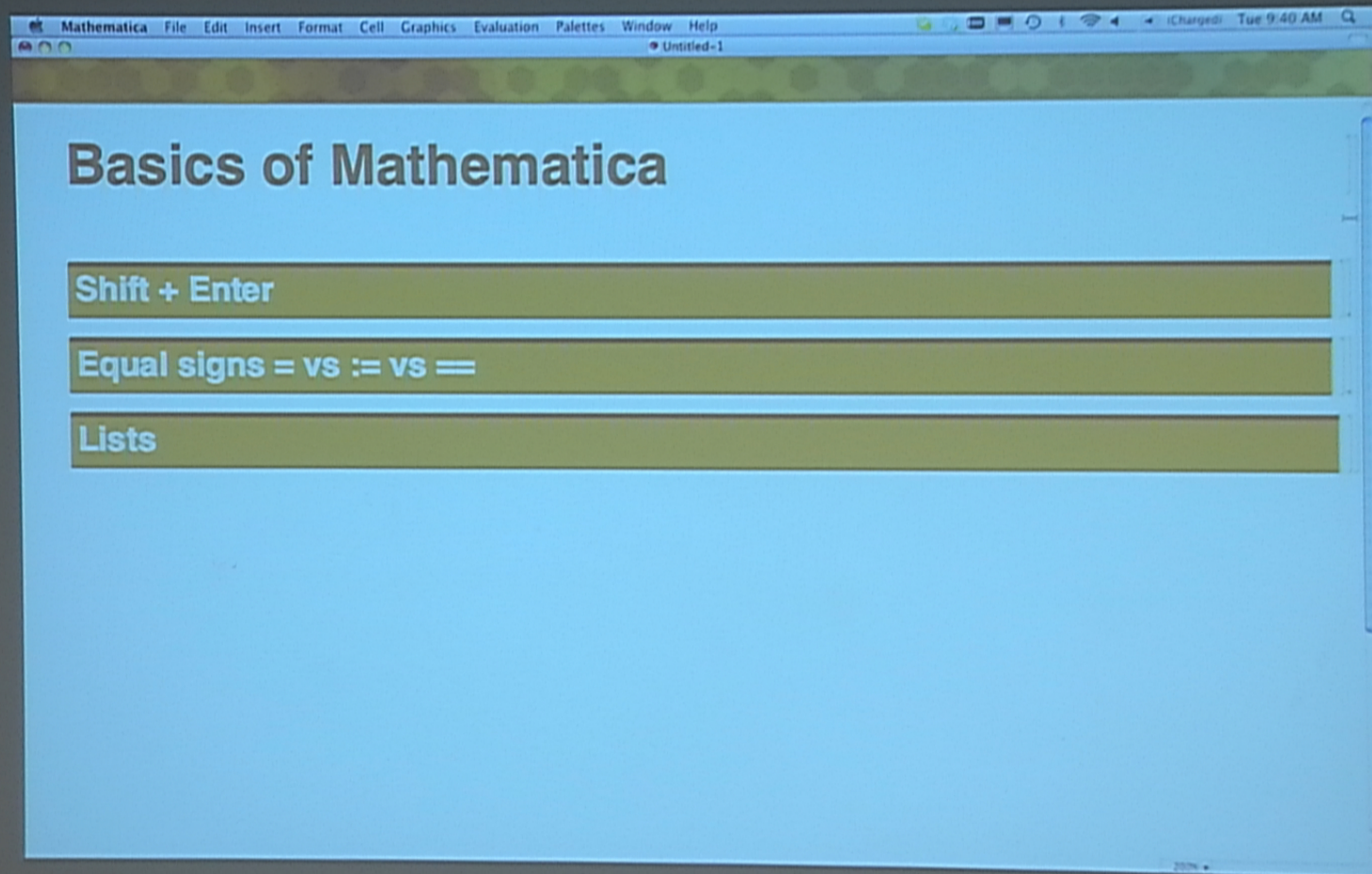
In[17]:= **Factor**[$x^2 - 1$]

Out[17]= $(-1 + x) (1 + x)$

Lists







The screenshot shows the Mathematica application window. The title bar includes the Mathematica logo and menu items: File, Edit, Insert, Format, Cell, Graphics, Evaluation, Palettes, Window, and Help. The status bar at the bottom right indicates 'iCharged' and 'Tue 9:40 AM'. The main content area displays a presentation slide with a light blue background and a green patterned header. The slide title is 'Basics of Mathematica'. Below the title, there are three green rectangular boxes containing the text 'Shift + Enter', 'Equal signs = vs := vs ==', and 'Lists'. In the center of the slide, there is a code input area with 'In[1]:= 2 + 2' and an output area with 'Out[1]:= 4'. The bottom right corner of the slide shows a zoom level of '200%'.

Basics of Mathematica

Shift + Enter

In[1]:= `2 + 2`

Out[1]:= `4`

Equal signs = vs := vs ==

Lists

200%

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Basics of Mathematica

Shift + Enter

Equal signs = vs := vs ==

Lists

In[18]:= `list = {a, b, c}`

Out[18]:= `{a, b, c}`

In[19]:= `MatrixForm[list]`

Out[19]//MatrixForm=

$$\begin{pmatrix} a \\ b \\ c \end{pmatrix}$$


```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[18]:= list = {a, b, c}
Out[18]:= {a, b, c}

In[19]:= MatrixForm[list]
Out[19]/MatrixForm=

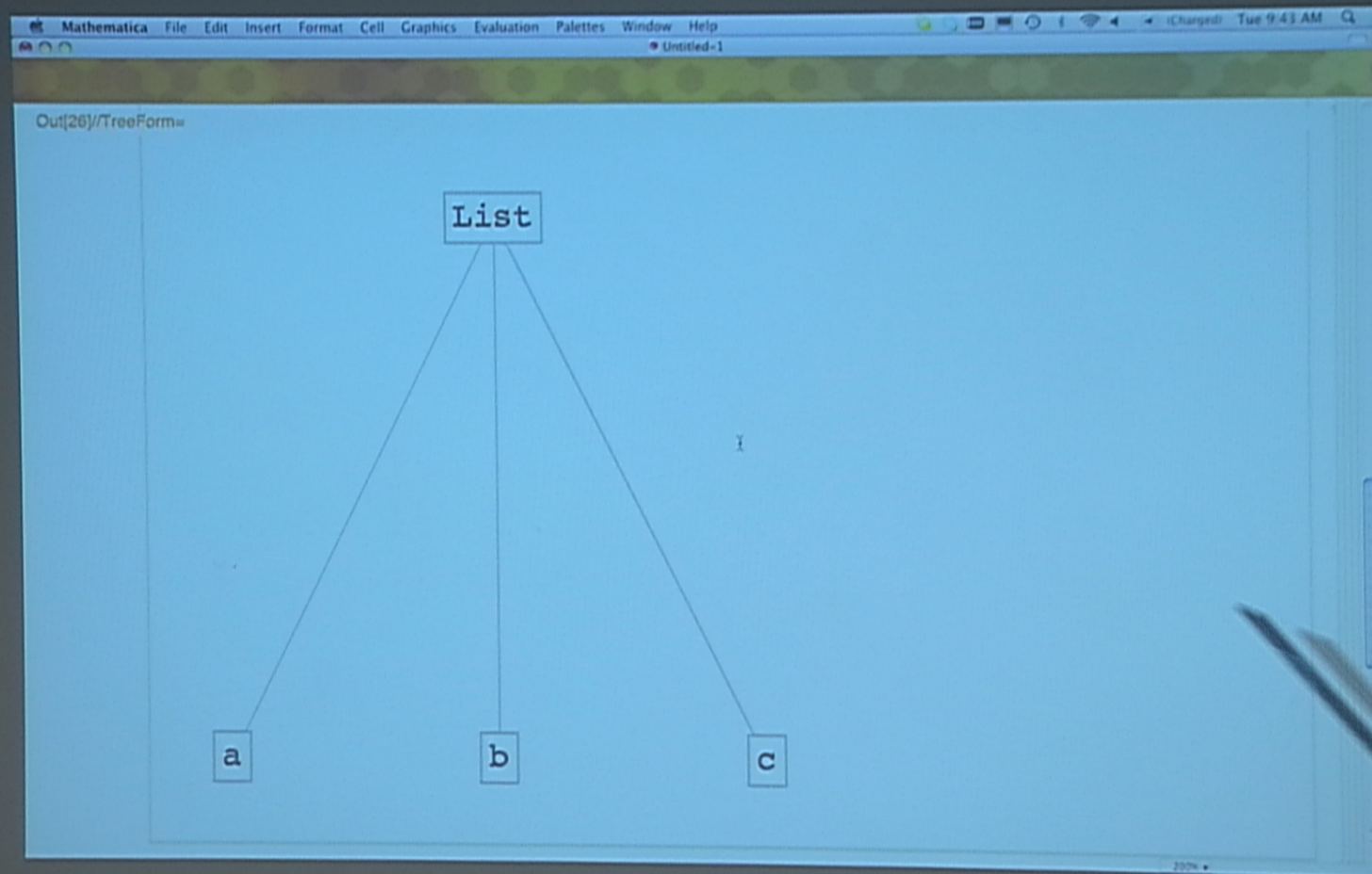
$$\begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

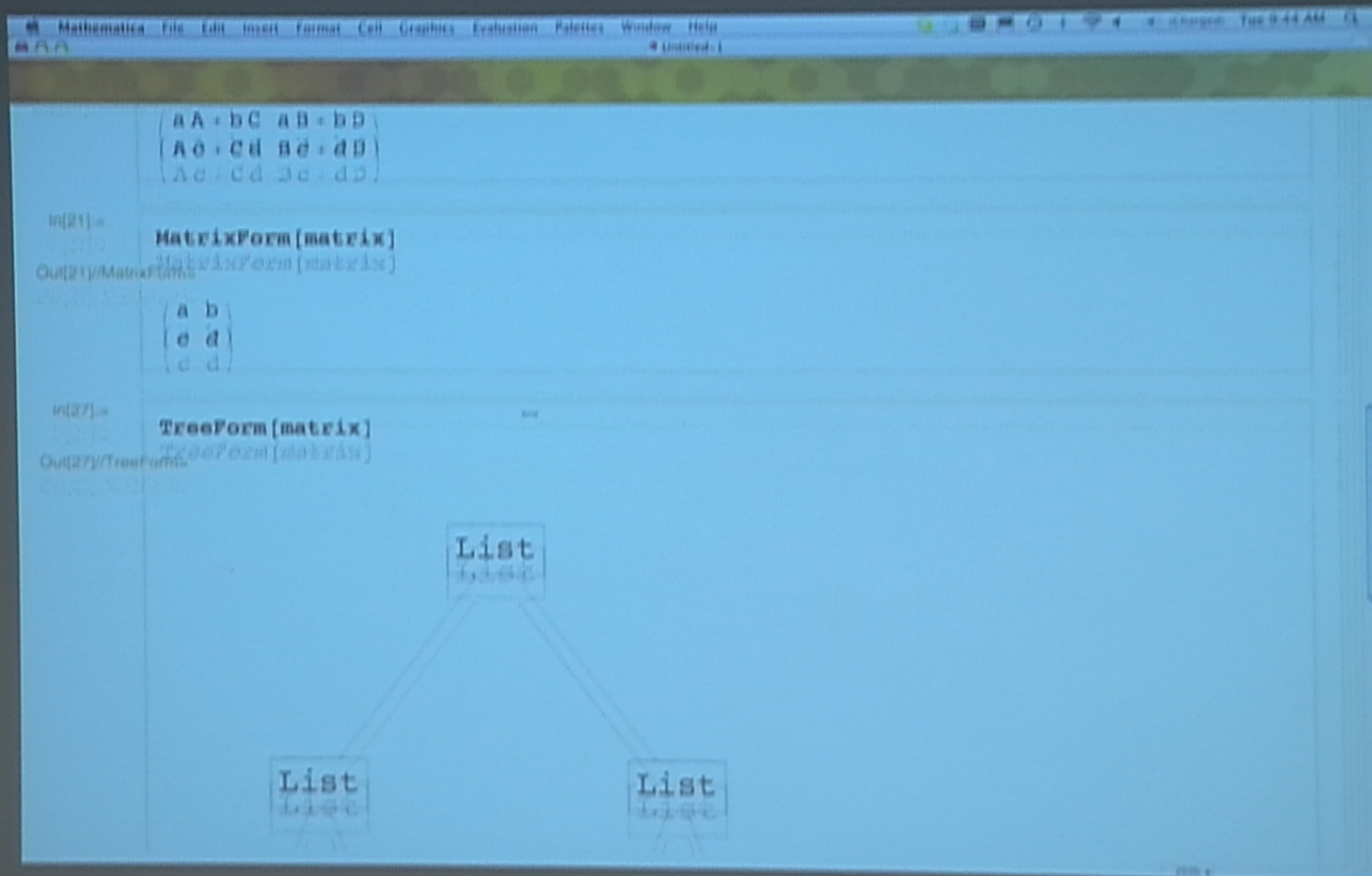

In[20]:= matrix = {{a, b}, {c, d}}
Out[20]:= {{a, b}, {c, d}}

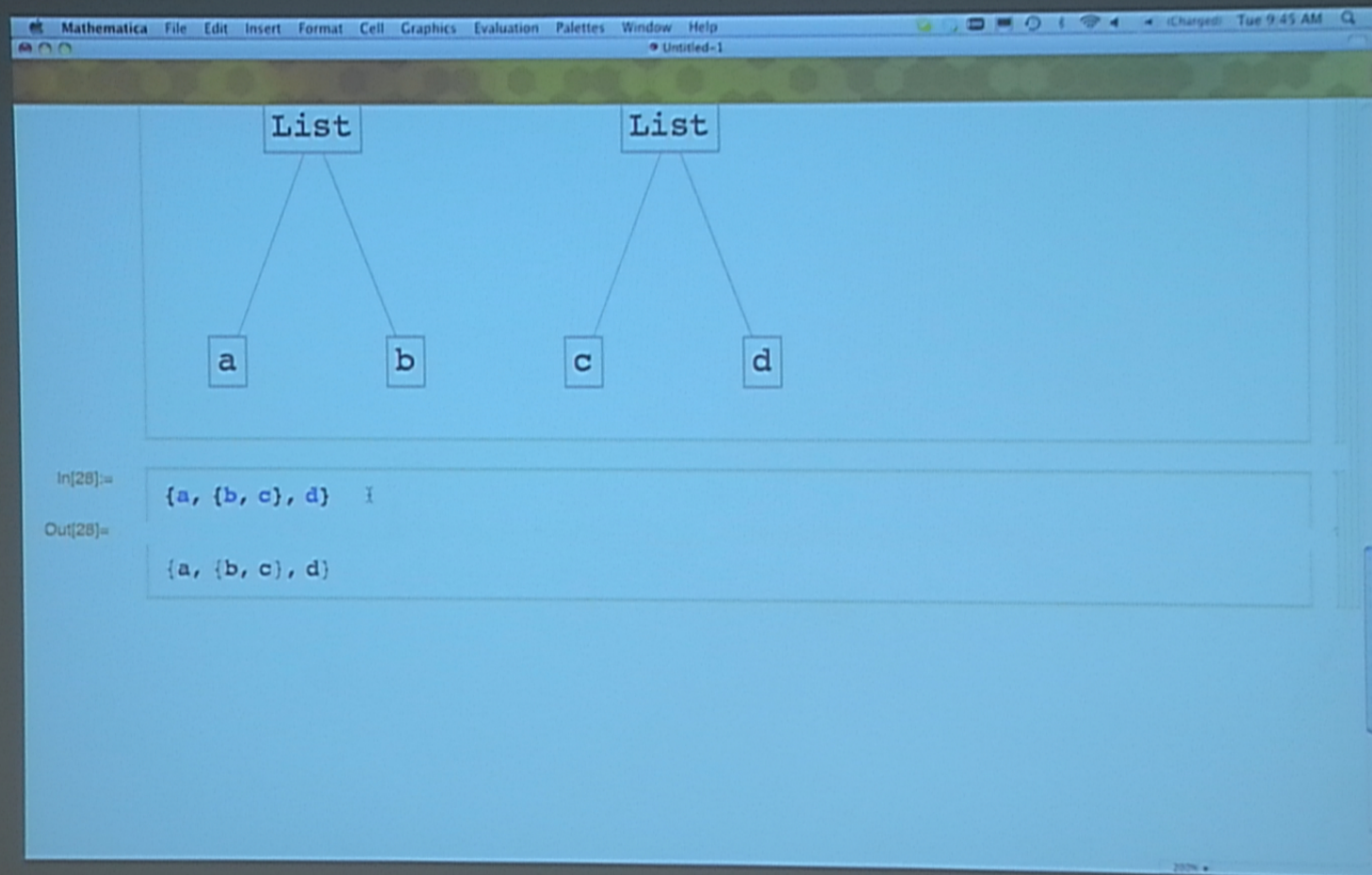
In[21]:= MatrixForm[matrix]
Out[21]/MatrixForm=

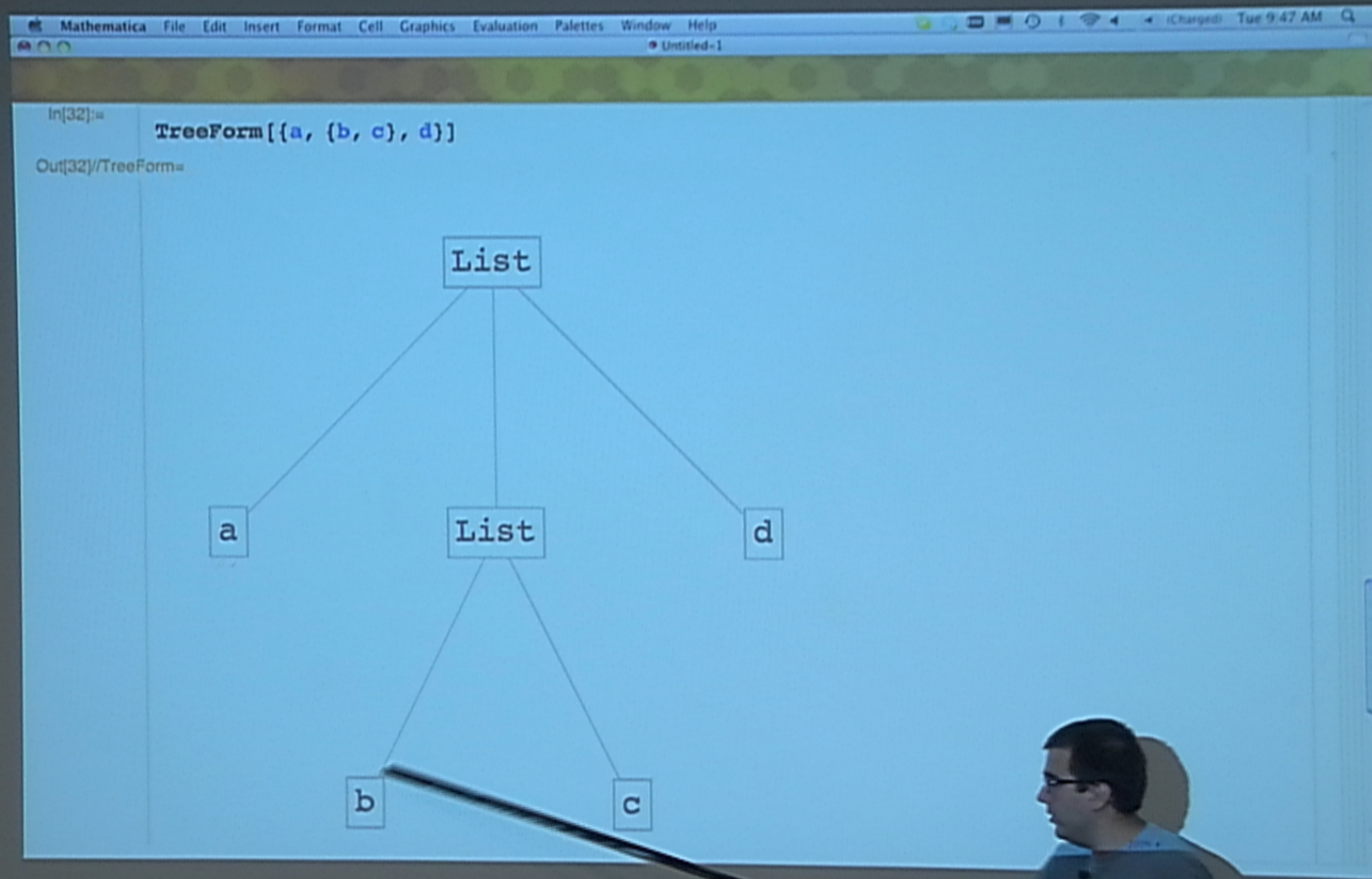
$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

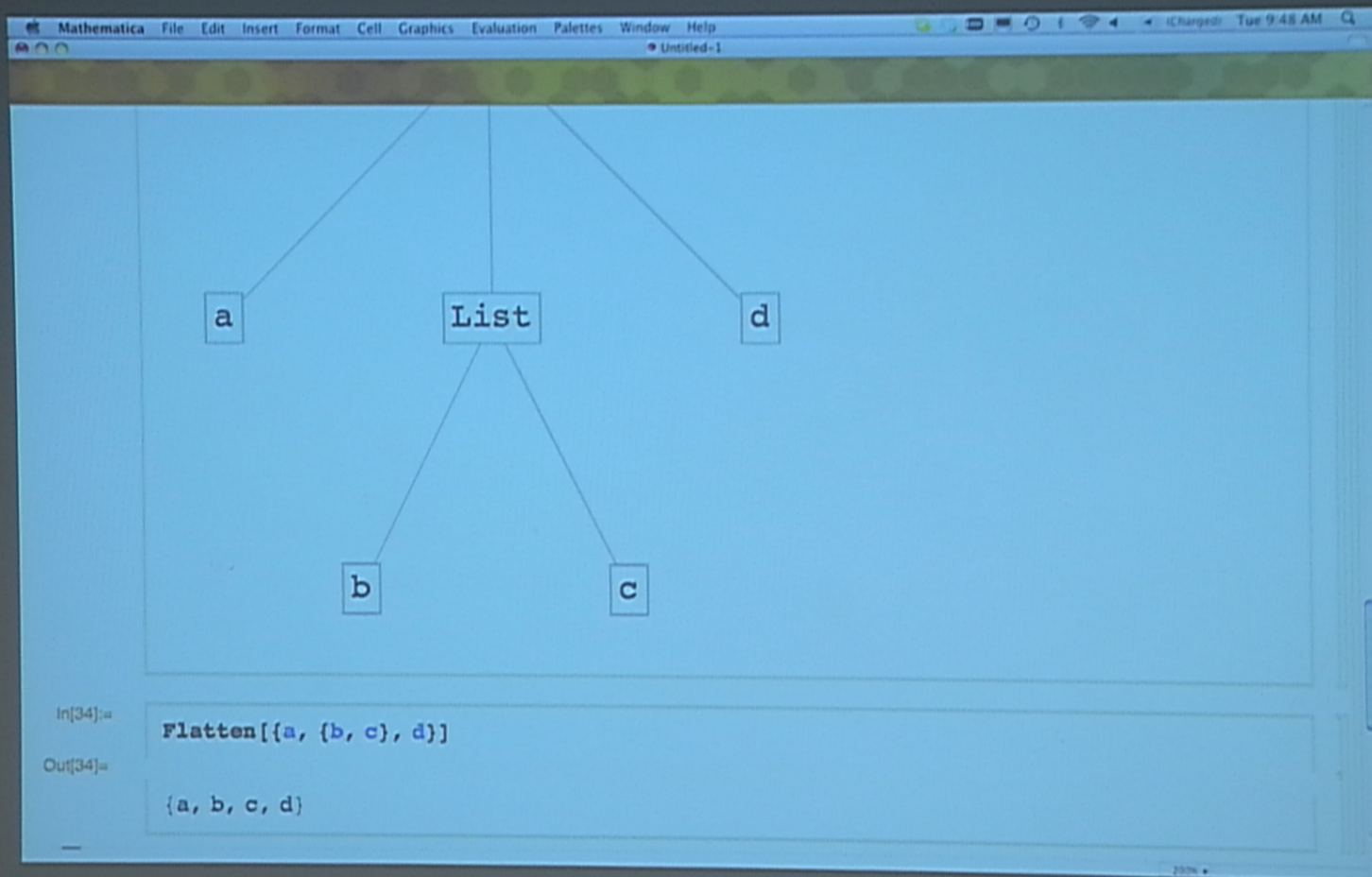
```











Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Tue 9:48 AM

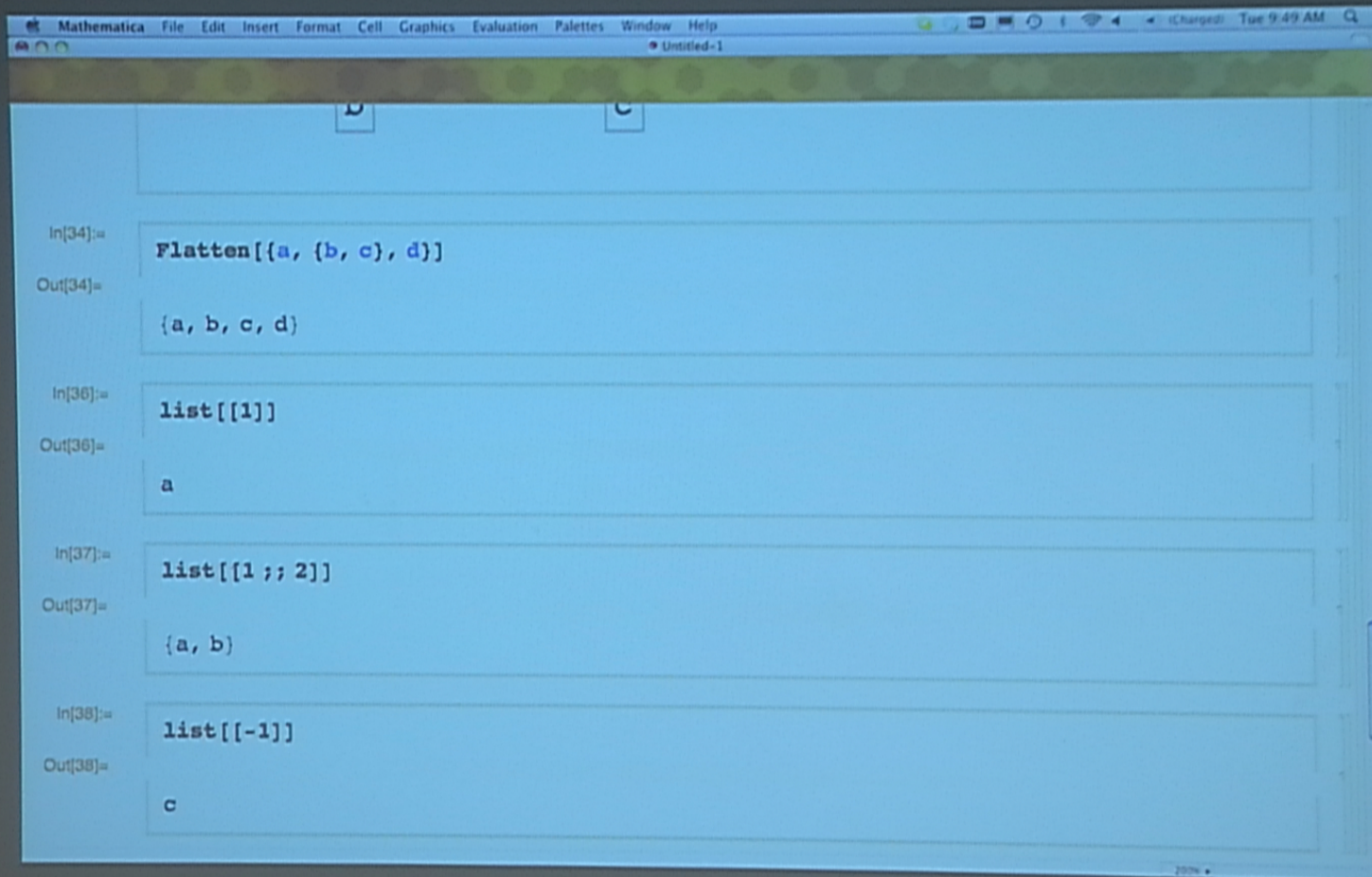
```
graph TD; List --> a; List --> b; List --> c; List --> d;
```

In[34]:= `Flatten[{a, {b, c}, d}]`

Out[34]:= `{a, b, c, d}`

In[35]:= `list`

Out[35]:= `{a, b, c}`



```
In[34]:= Flatten[{a, {b, c}, d}]
Out[34]= {a, b, c, d}

In[36]:= list[[1]]
Out[36]= a

In[37]:= list[[1 ;; 2]]
Out[37]= {a, b}

In[38]:= list[[-1]]
Out[38]= c
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[34]=
{a, b, c, d}

In[36]:=
list[[1]]
Out[36]=
a

In[37]:=
list[[1 ;; 2]]
Out[37]=
{a, b}

In[38]:=
list[[-1]]
Out[38]=
c

{a, {b, c}, d}[[2]]
```

```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[38]:= list[[-1]]
Out[38]= c

In[42]:= {a, {b, c}, d}[[2]]
Out[42]= {b, c}

In[40]:= {a, {b, c}, d}[[2, 1]]
Out[40]= b

In[41]:= TreeForm[{a, {b, c}, d}]
Out[41]/TreeForm=
```



Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Equal signs = vs := vs ==

Lists

Substitutions

In[43]:= $x / (x^2 + 1) /. x \rightarrow \text{Zeta}[3]$

Out[43]=
$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help

Untitled-1

Equal signs = vs

Lists

Substitutions

Out[43]=

$$\frac{x}{(x^2 + 1) \cdot x}$$

$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

$$\frac{x}{(x^2 + 1) \cdot x}$$

Zeta

Zeta
gives the Riemann zeta function $\zeta(x)$.

Zeta
gives the generalized Riemann zeta function $\zeta(x, u)$.

MORE INFORMATION

- Mathematical function, suitable for both symbolic and numerical manipulation.
- For $\text{Re}(x) > 1$, $\zeta(x) = \sum_{n=1}^{\infty} n^{-x}$.
- $\zeta(x, u) = \sum_{n=0}^{\infty} (u + n)^{-x}$, where any term with $u + n = 0$ is excluded.
- For $\text{Re}(x) < 0$, the definition used is $\zeta(x, u) = \sum_{n=0}^{\infty} (u + n)^{-x}$.
- $\zeta(x)$ has no branch cut discontinuities.
- For certain special arguments, Zeta automatically evaluates to exact values.
- Zeta can be evaluated to arbitrary numerical precision.
- Zeta automatically threads over lists.

EXAMPLES

Basic Examples

`Zeta[2]`

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Equal signs = vs := vs ==

Lists

Substitutions

Out[43]=

$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

In[44]:=

$$\text{Zeta}[2]$$

Out[44]=

$$\frac{\pi^2}{6}$$

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Tue 9:54 AM

Equal signs = vs := vs ==

Lists

Substitutions

Out[43]:=

$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

In[46]:=

$$\text{N}[\text{Zeta}[3]]$$

Out[46]:=

1.20206

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Substitutions

Out[43]:=
$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

In[46]:=
$$\frac{x}{x^2 + 1} /. x \rightarrow \text{Zeta}[3]$$

Out[46]:=
$$\text{N}[\text{Zeta}[3]]$$

1.20206

$$\frac{x}{x^2 + 1}$$

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help

Untitled-1

Out[43]=

$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

In[46]:=

$$x / (x^2 + 1) /. x \rightarrow \text{Zeta}[3]$$

Out[46]=

$$N[\text{Zeta}[3]]$$

1.20206

$$x / (x^2 + 1)$$

$$\frac{x}{x^2 + 1}$$

Basic Math Assistant

Writing an Calculator

Create New

Basic Commands

Typesetting

Cell Mod

Text Pro

Cell Prog

Paragraph

Notebook

Content

Help and Settings

Typesetting

Help and Settings

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[43]:=

$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

In[46]:=

$$x / (x^2 + 1) /. x \rightarrow \text{Zeta}[3]$$

Out[46]:=

$$\text{N}[\text{Zeta}[3]]$$

1.20206

$x / (x^2 + 1)$

$$\frac{x}{x^2 + 1}$$

$$\frac{x}{x^2 + 1}$$

Basic Math Assistant

Writing an Calculator

Create a

Basic Commands

Typesetting

Cell Mod

Text Pro

Cell Prog

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Noteboo

Content

Help and Settings

Typesetting

Help and Settings

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

$$\frac{\text{Zeta}[3]}{1 + \text{Zeta}[3]^2}$$

$$x / (x^2 + 1) /. x \rightarrow \text{Zeta}[3]$$

In[46]:= `N[Zeta[3]]`

Out[46]= 1.20206

$$x / (x^2 + 1)$$

$$\frac{x}{x^2 + 1}$$

$$\frac{x}{x^2 + 1}$$

`Plot[Zeta[z], {z}]`

Basic Math Assistant

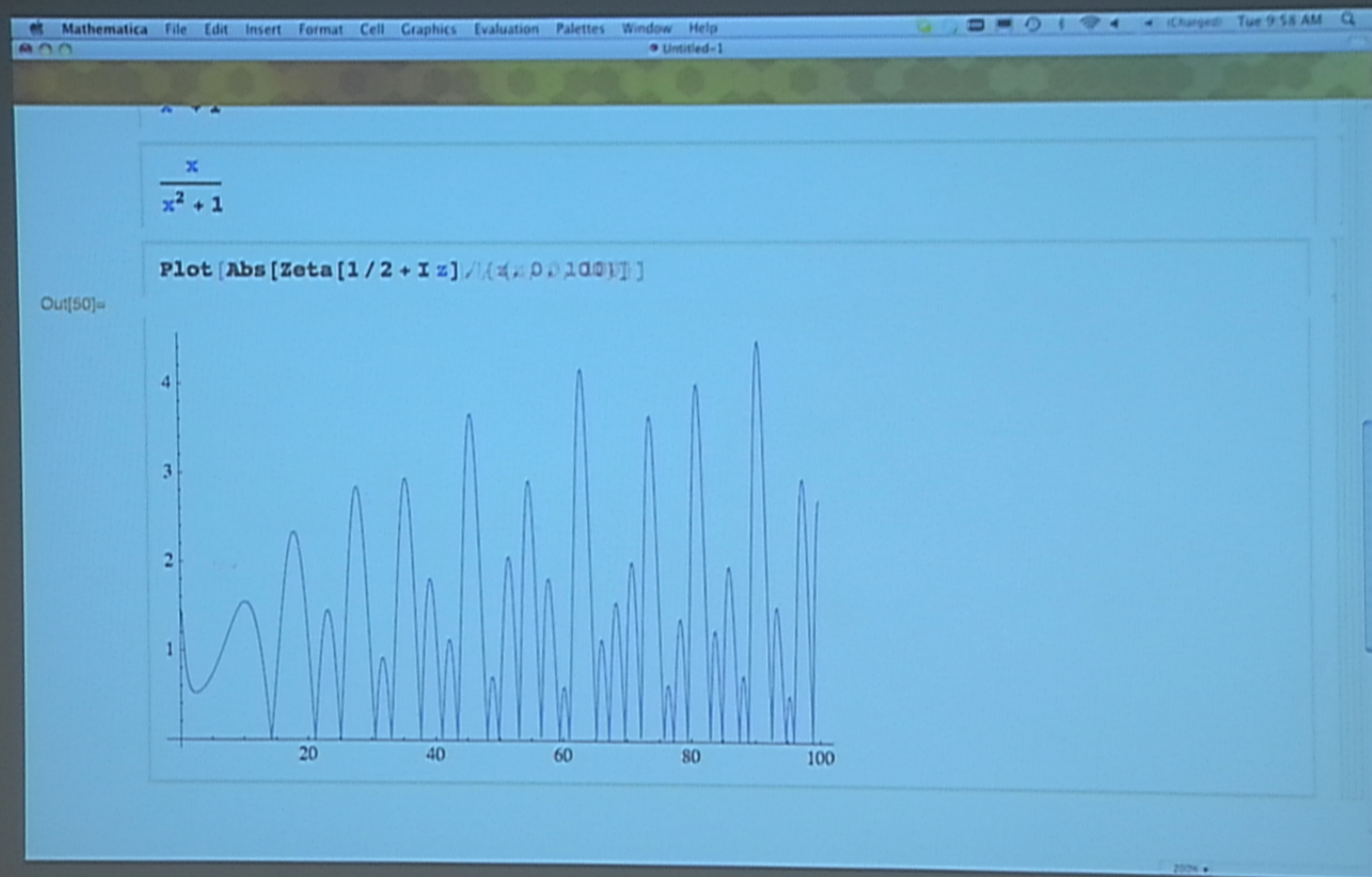
Writing an Calculator

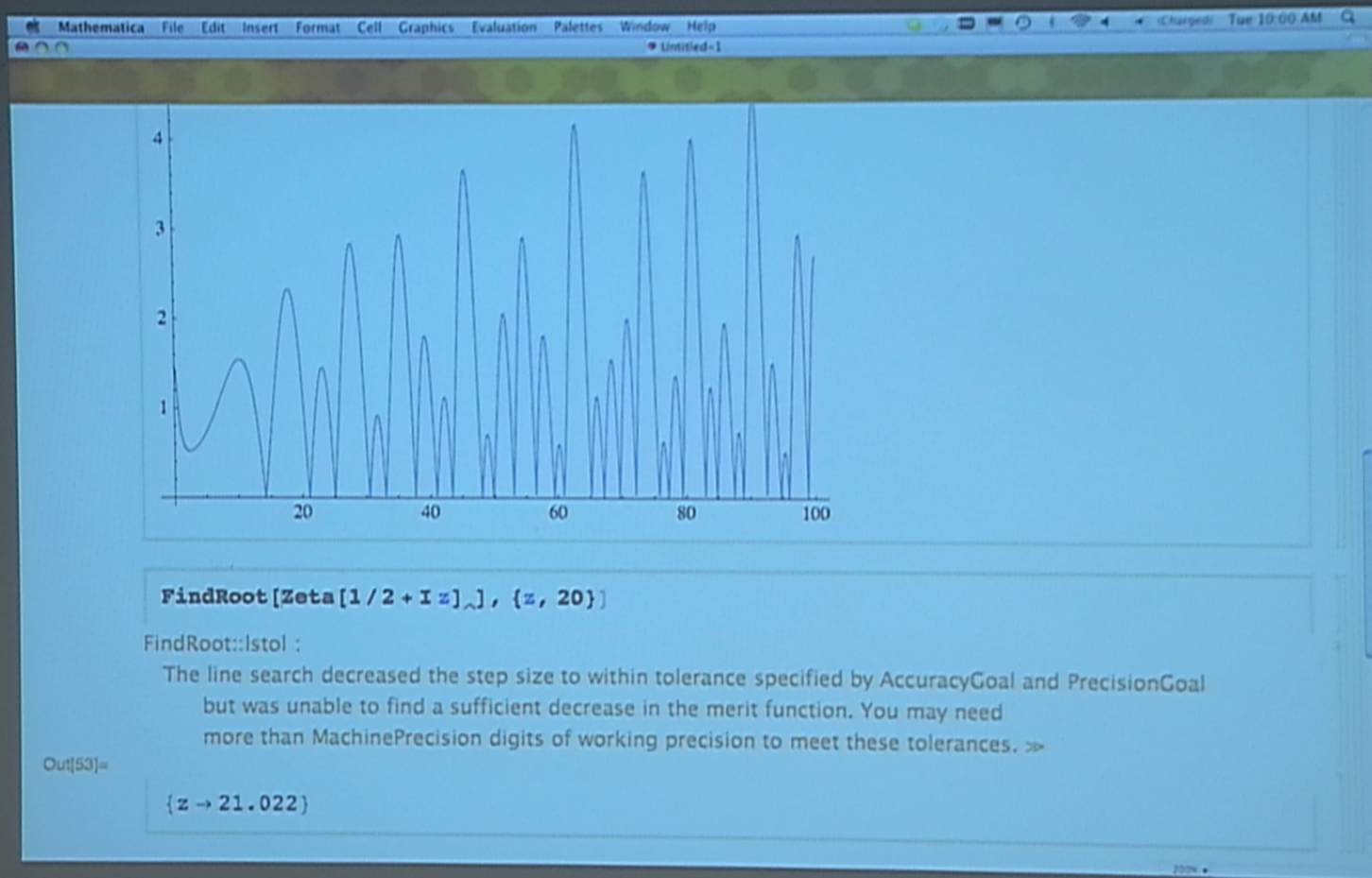
Create a

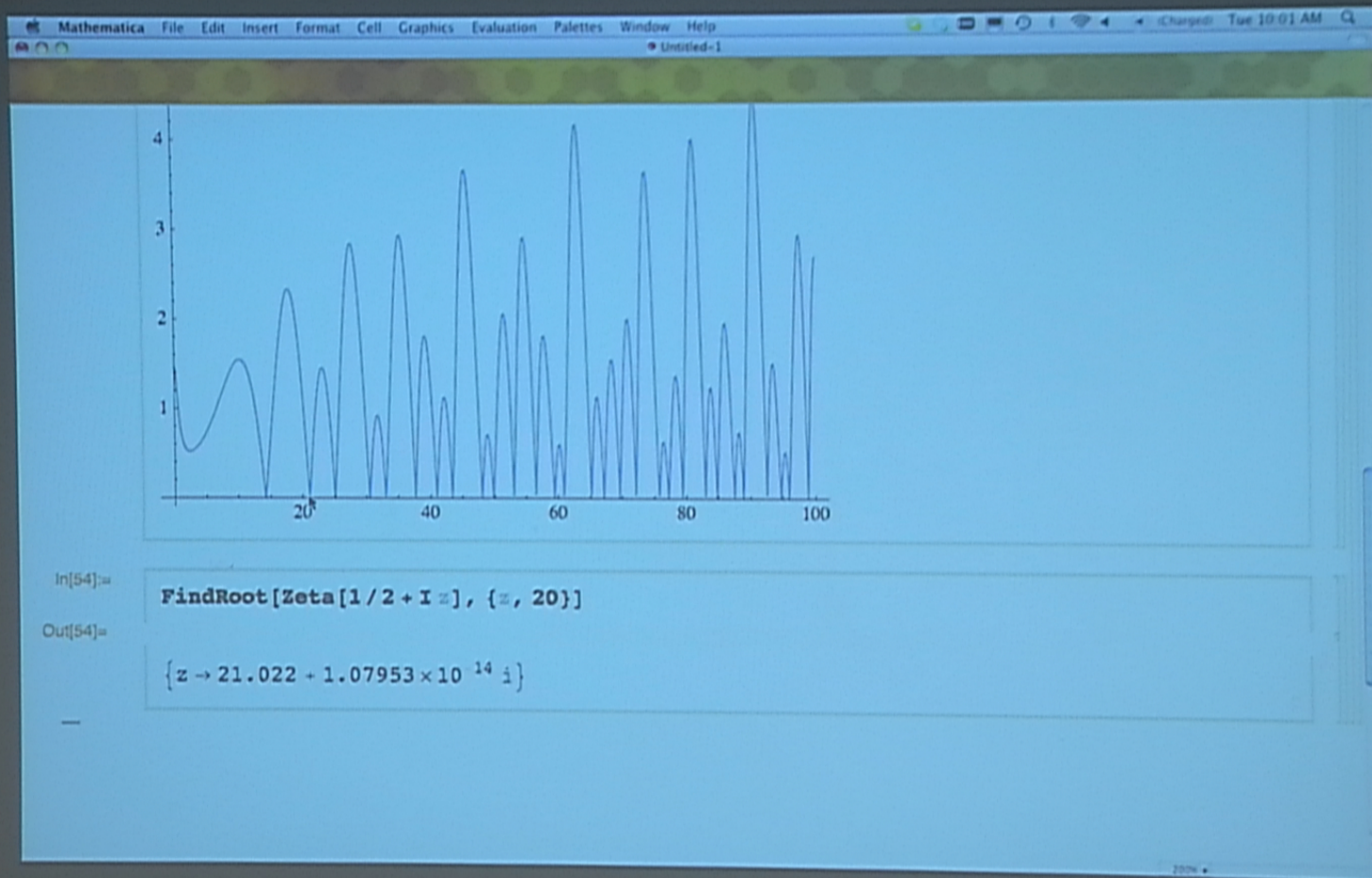
Basic Commands

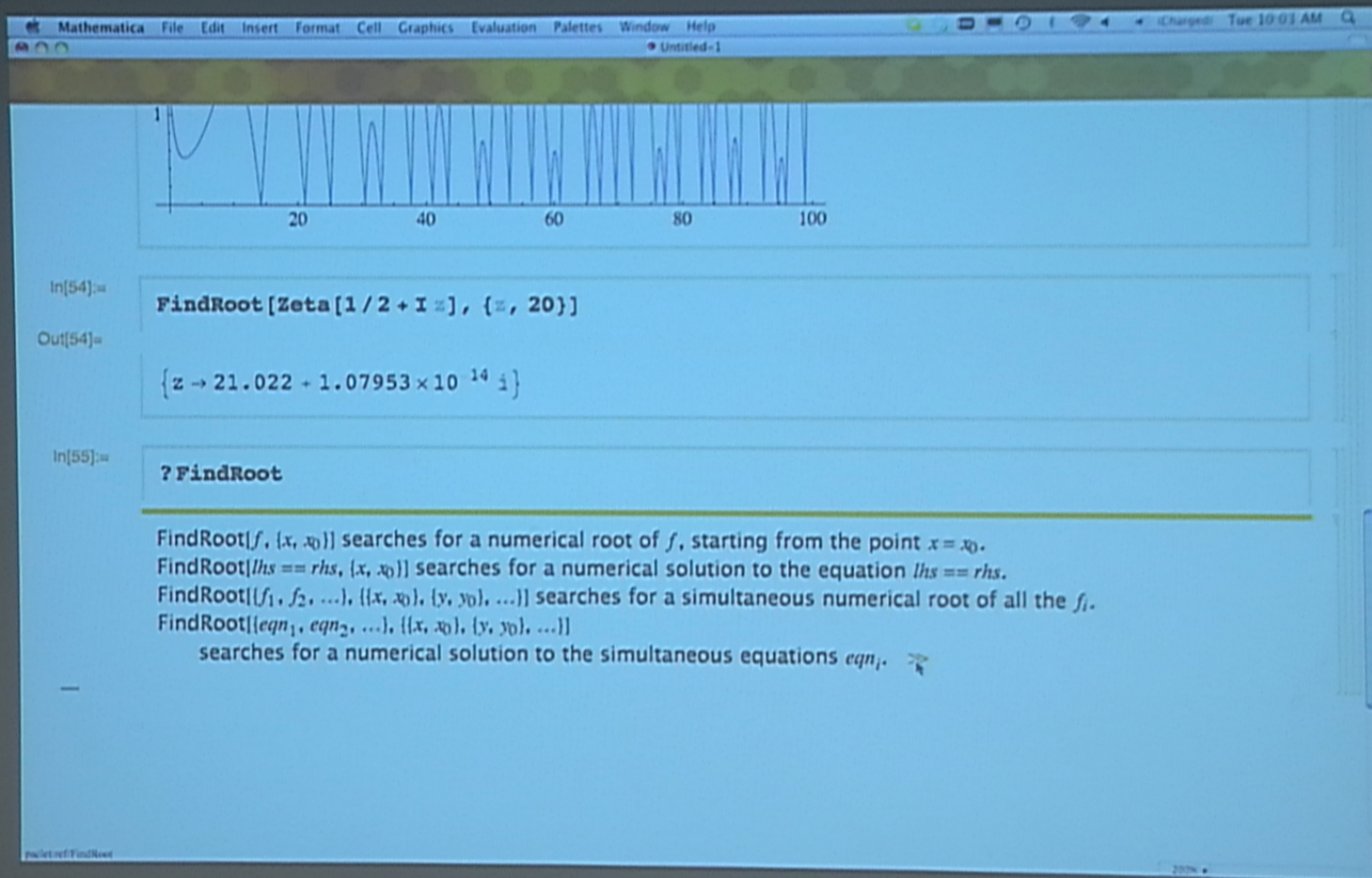
Typesetting

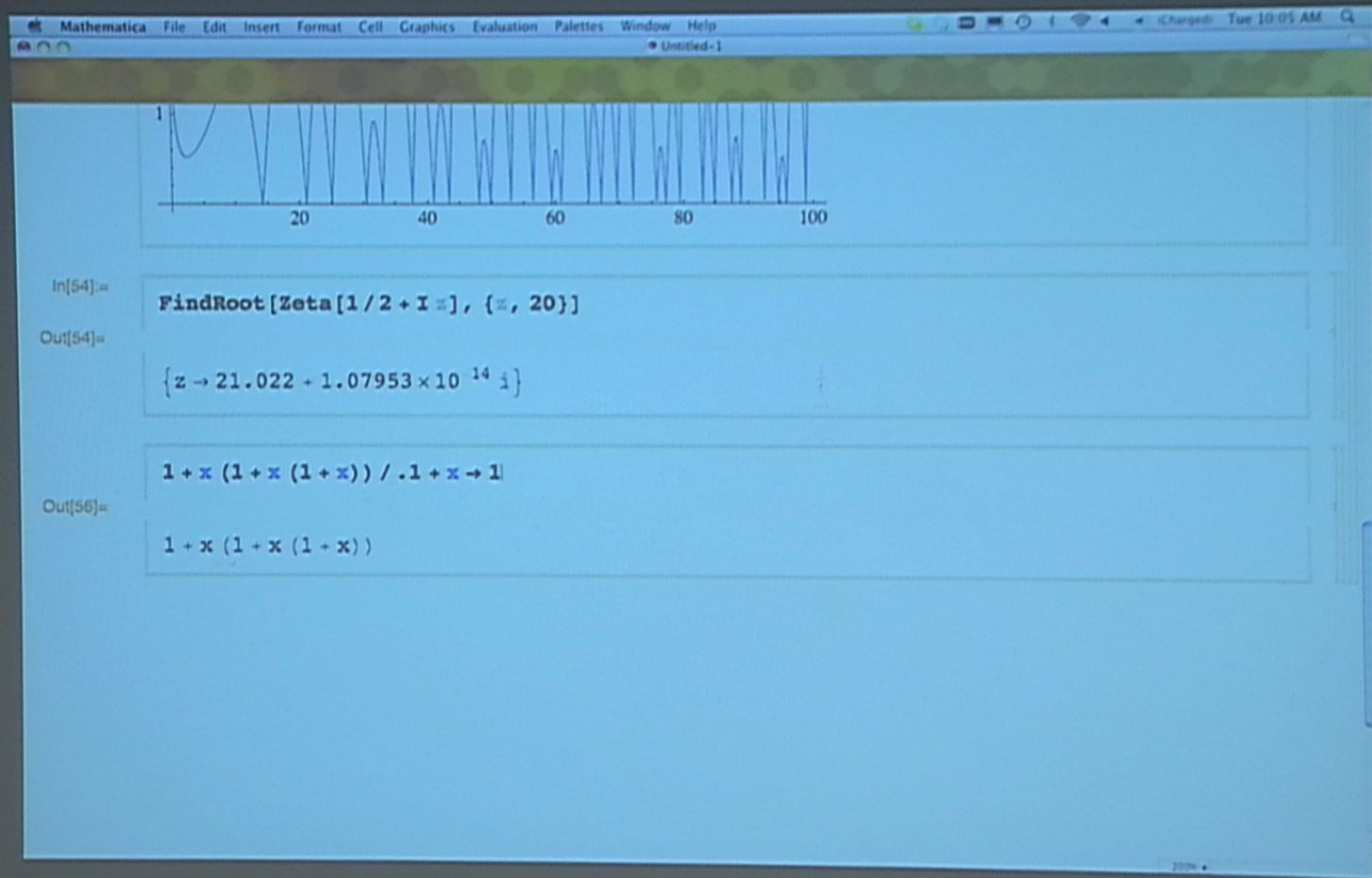
Help and Settings

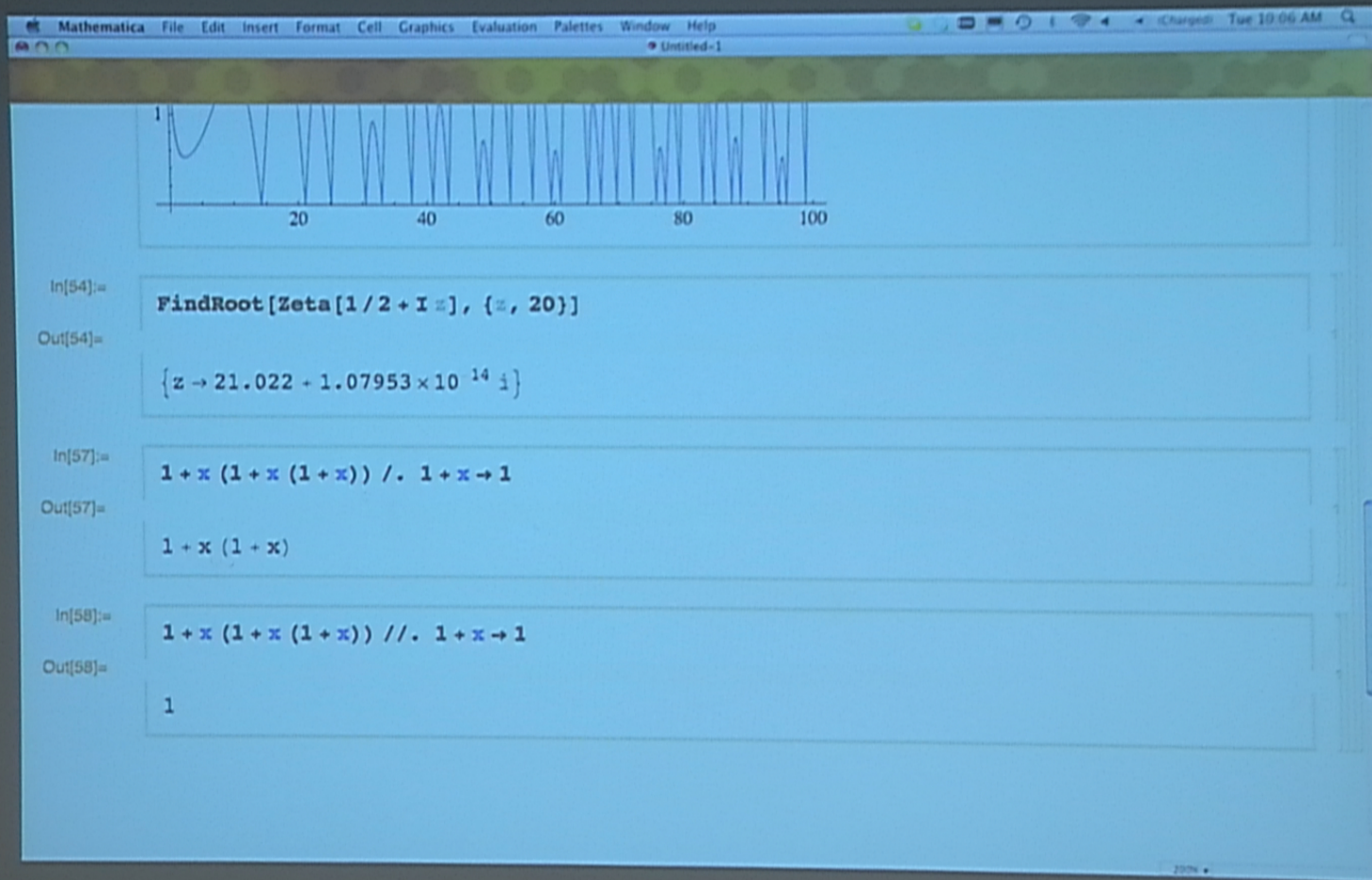


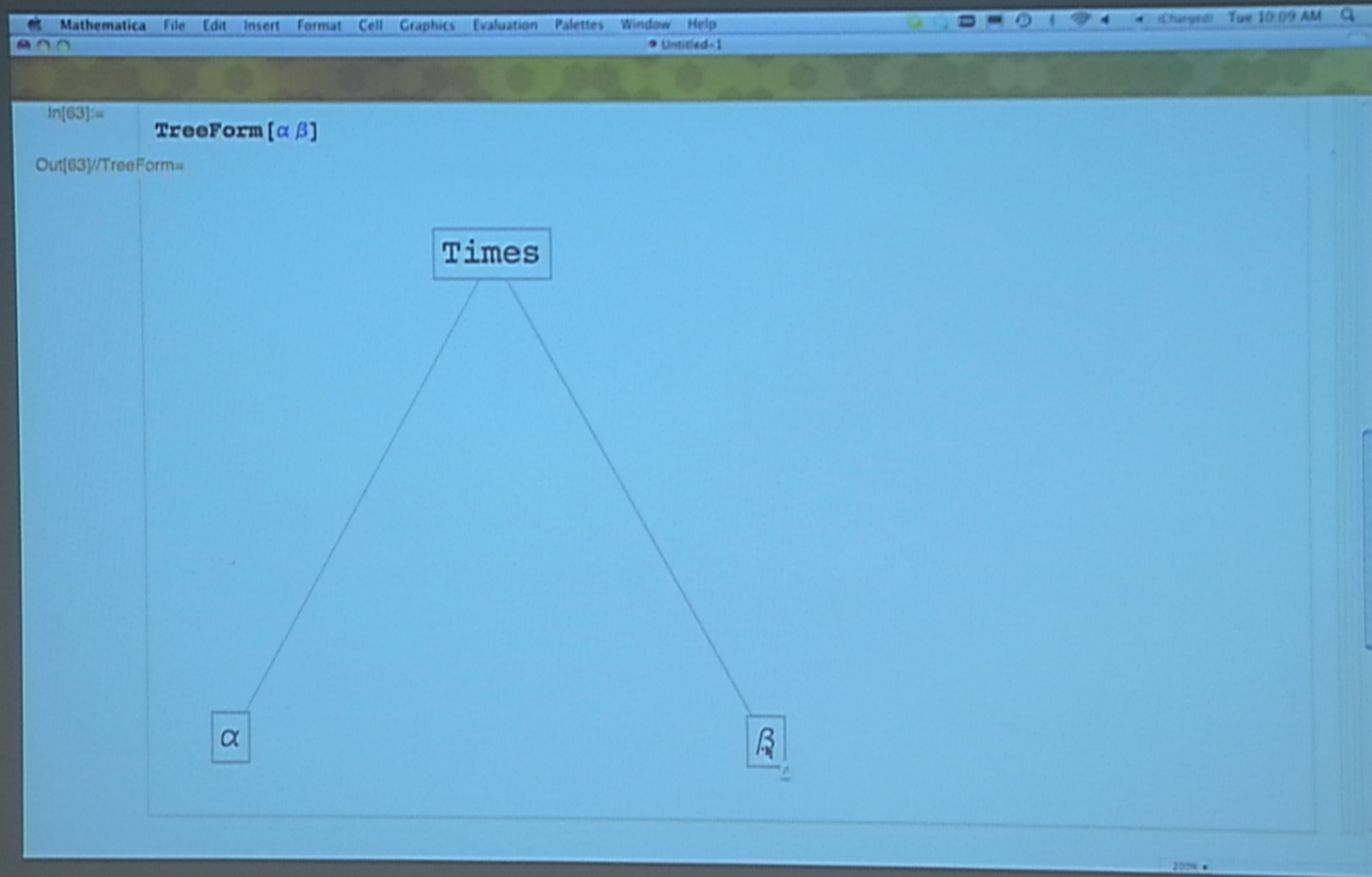












Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

α β

In[66]:= `N[ $\pi$ ]`
Out[66]= 3.14159

In[67]:= `N[ $\alpha$ ]`
Out[67]= α

In[68]:= `Exp[ $1 - \frac{(1 + \pi) 2 - 2 - \pi}{\pi}$ ] /. Exp[x_] -> Exp[Simplify[x]]]`
Out[68]= $e^{1 - \frac{2 - \pi + 2(1 + \pi)}{\pi}}$

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

α β

In[66]:= `N[ $\pi$ ]`
Out[66]= 3.14159

In[67]:= `N[ $\alpha$ ]`
Out[67]= α

In[68]:= `Exp[ $1 - \frac{(1 + \pi) 2 - 2 - \pi}{\pi}$ ] /. Exp[_] -> Exp[Simplify[_]]`
Out[68]= $e^{1 - \frac{2 - \pi + 2(1 + \pi)}{\pi}}$


```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[67]=

$$\alpha$$


In[68]:= Exp[1 - (1 +  $\pi$ ) 2 - 2 -  $\pi$ ] /. Exp[_] -> Exp[Simplify[_]]
Out[68]=

$$e^{1 - \frac{2 - \pi + 2(1 + \pi)}{\pi}}$$


In[69]:= Exp[Simplify[_]]
Out[69]=

$$e^x$$


(* instead of -> we use := *) :>

In[70]:= Exp[1 - (1 +  $\pi$ ) 2 - 2 -  $\pi$ ] /. Exp[_] :=> Exp[Simplify[_]]
Out[70]=
1
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

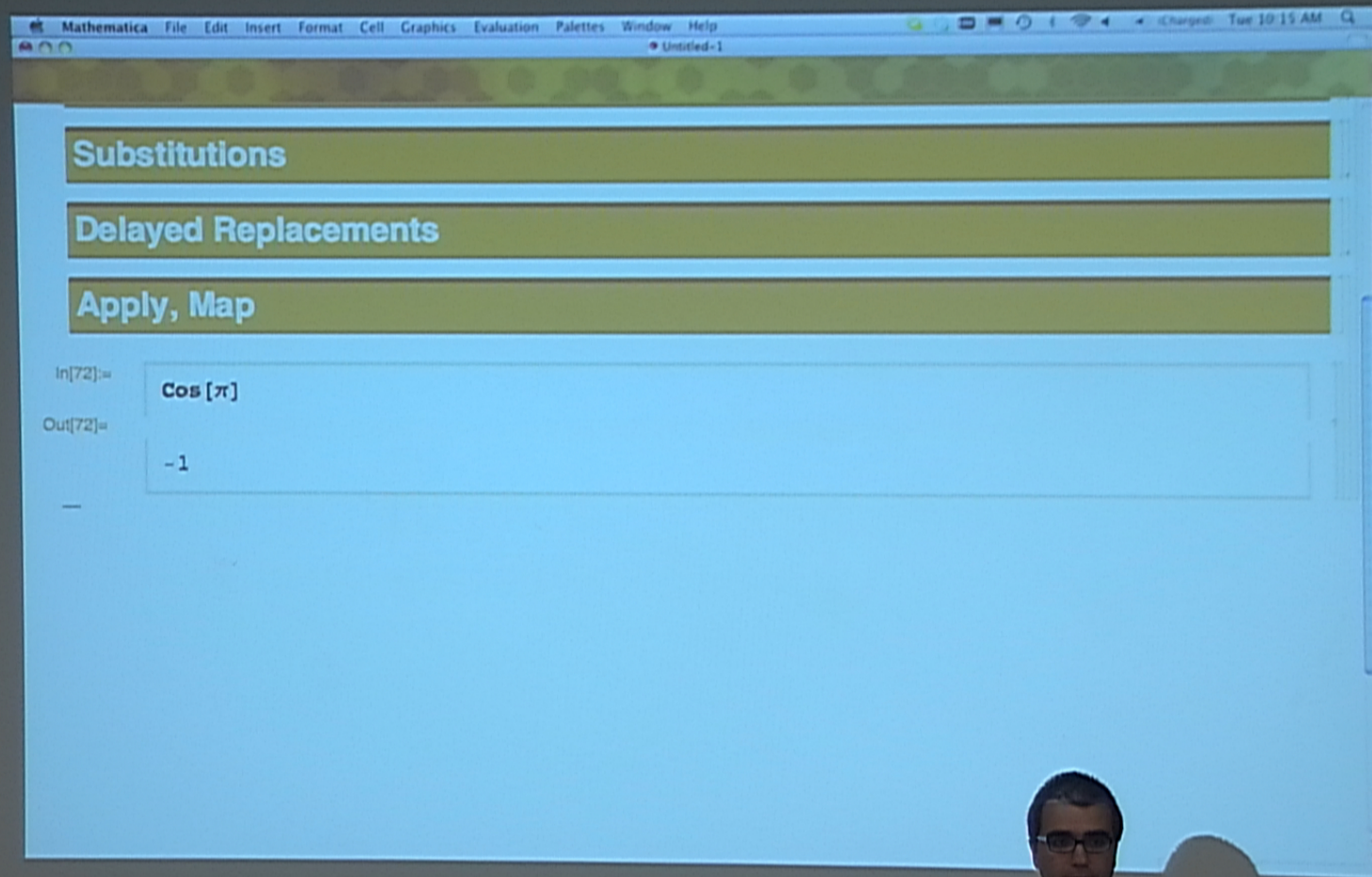
In[69]:= Exp[Simplify[x]]
Out[69]:= ex

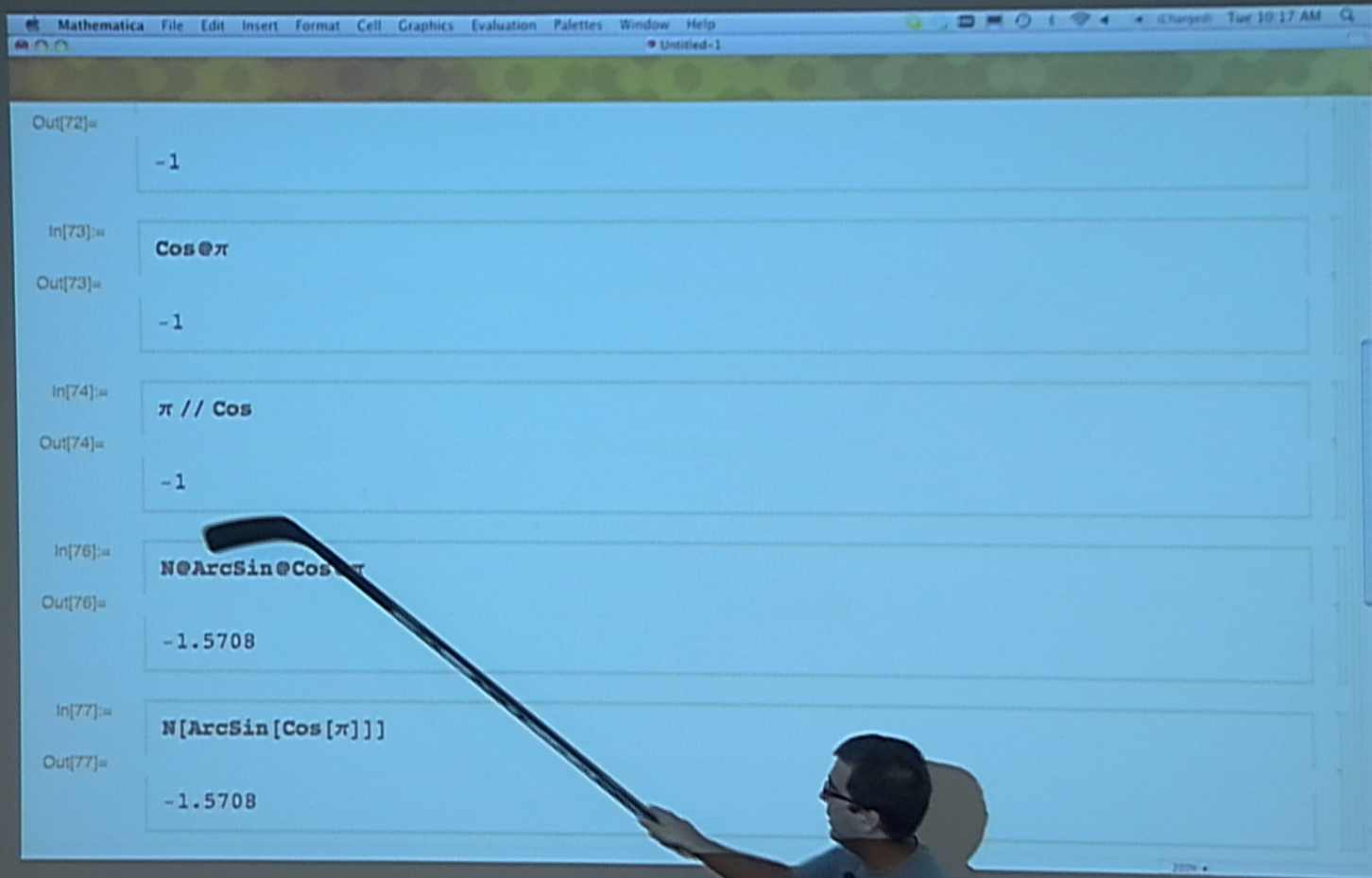
(* instead of → we use := *) :=

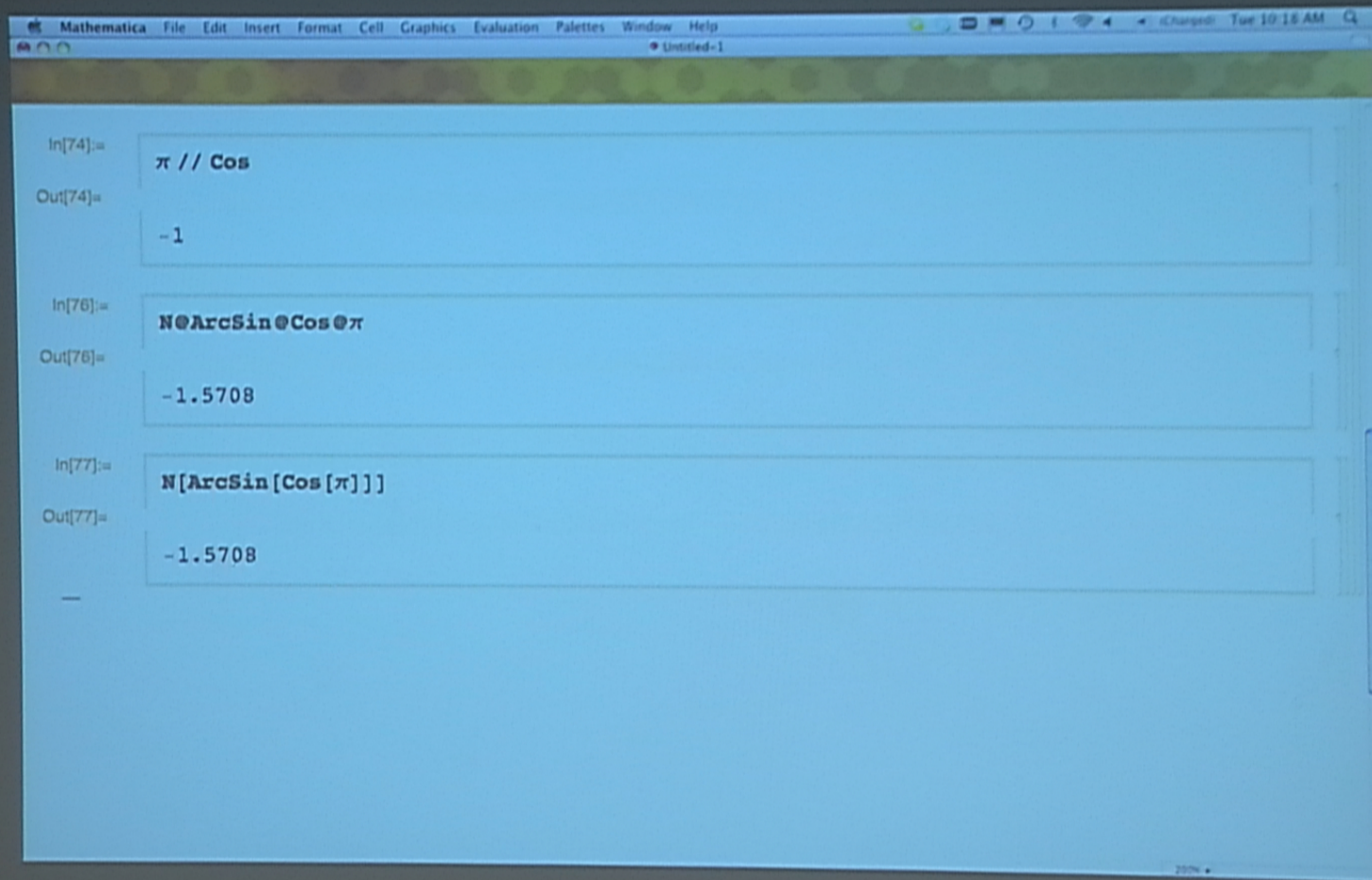
In[70]:= Exp[1 -  $\frac{(1 + \pi)^2 - 2 - \pi}{\pi}$ ] /. Exp[x_] := Exp[Simplify[x]]
Out[70]:= 1

In[71]:= s3[Cos[x]2 + Sin[x]2]
Out[71]:= s3[Cos[x]2 + Sin[x]2]

s2[Cos[x]2 + Sin[x]2]
```





```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[74]:=  $\pi // \text{Cos}$ 
Out[74]:= -1

In[76]:= N[ArcSin[Cos[ $\pi$ ]]
Out[76]:= -1.5708

In[77]:= N[ArcSin[Cos[ $\pi$ ]]
Out[77]:= -1.5708

In[78]:= f1[x_] = Cos[x] + Exp[x];
f4 = Cos[x] + Exp[x] &;

In[80]:= f1[y]
Out[80]:=  $e^y + \text{Cos}[y]$ 
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[76]:= N@ArcSin@Cos@π
Out[76]:= -1.5708

In[77]:= N[ArcSin[Cos[π]]]
Out[77]:= -1.5708

In[78]:= f1[x_] = Cos[x] + Exp[x];
          f4 = Cos[#] + Exp[#] &;

In[80]:= f1[y]
Out[80]:= ey + Cos[y]

In[81]:= f4[y]
Out[81]:= ey + Cos[y]
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[86]:= 5 // (Cos[#] + Exp[#] &)
Out[86]= e5 + Cos[5]

In[87]:= Cos[x]2 + Sin[x]2 // Simplify[# + 1] &
Out[87]= 2

In[90]:= f2 = #1##2 &;
          f3[x_, y_] = xy;

In[94]:= f2[2, 3]
          f3[2, 3]
Out[94]= 8

Out[95]= 8
```


The screenshot shows a Mathematica notebook window with the following content:

```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[87]:=
2

In[90]:=
f2 = #x^#2 &;
f3[x_, y_] = x^y;

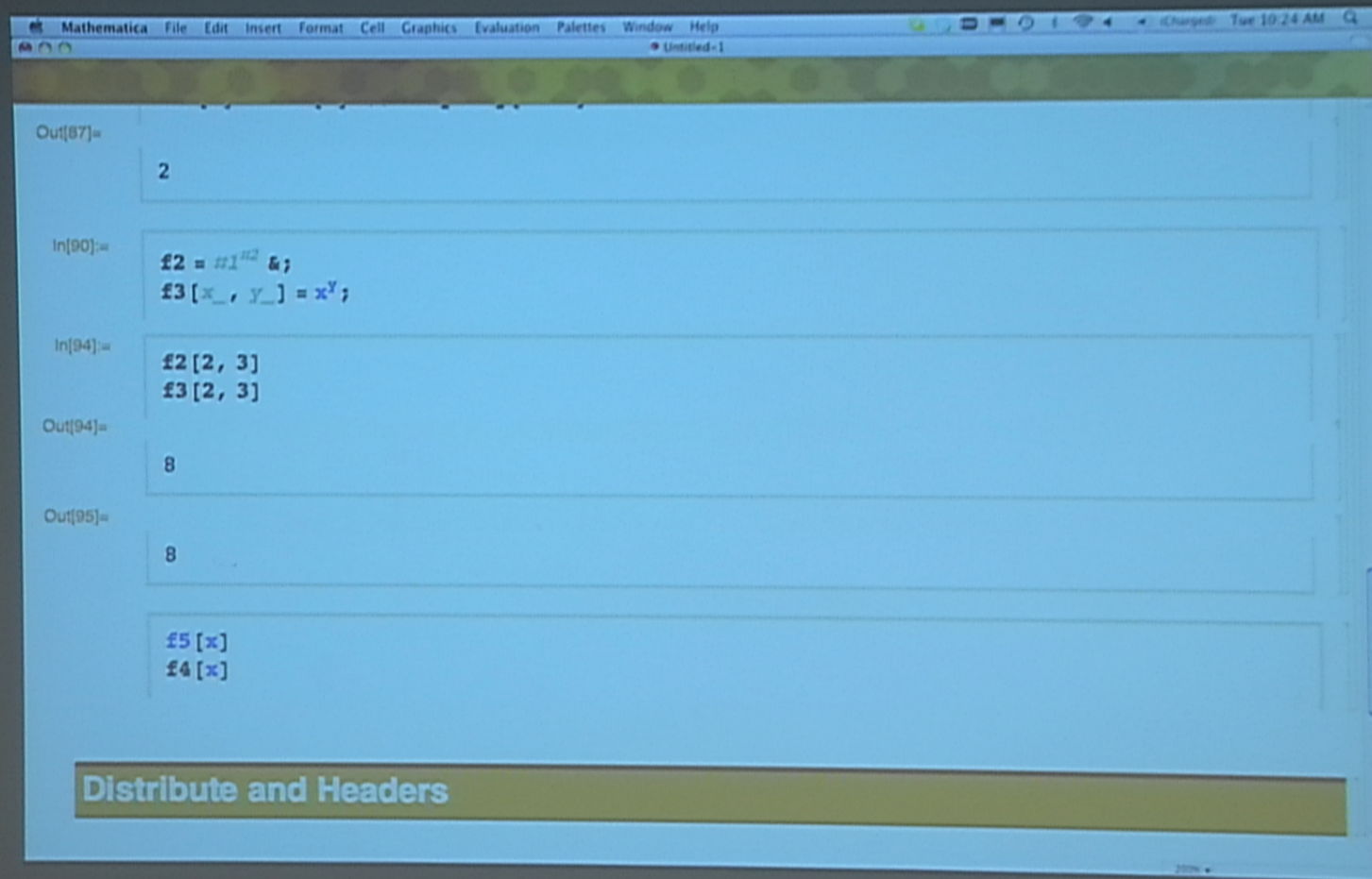
In[94]:=
f2[2, 3]
f3[2, 3]

Out[94]:=
8

Out[95]:=
8
```

Below the code, there is a yellow rectangular box containing the text:

Distribute and Headers




```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[87]:= Cos[x]^2 + Sin[x]^2 // Simplify[# + 1] &
Out[87]= 2

In[90]:= f2 = #1^#2 &;
         f3[x_, y_] := y;
In[94]:= f2[2, 3]
         f3[2, 3]
Out[94]= 8
Out[95]= 8

In[96]:= f5[x]
         f4[x]
Out[96]= f5[x]
Out[97]=
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[87]:= Cos[x]^2 + Sin[x]^2 // Simplify[# + 1] &
Out[87]= 2

In[90]:= f2 = #1^#2 &;
          f3[x_, y_] = x^y;

In[94]:= f2[2, 3]
          f3[2, 3]
Out[94]= 8

Out[95]= 8

In[96]:= f5[x]
          f4[x]
Out[96]= f5[x]

Out[97]=
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[87]:= Cos[x]^2 + Sin[x]^2 // Simplify[#, 1] &
Out[87]= 2

In[90]:= f2 = #1^#2 &;
          f3[x_, y_] = x^y;

In[94]:= f2[2, 3]
          f3[2, 3]
Out[94]= 8

Out[95]= 8

In[96]:= f5[x]
          f4[x]
Out[96]= f5[x]

Out[97]=
```


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

```
f4 = Sin[#1] Exp[#1] &
```

Distribute and Headers

```
In[102]:= {a, b, c, d} // FullForm
Out[102]//FullForm= List[a, b, c, d]
```

```
In[104]:= h@{a, b, c, d} // FullForm
Out[104]//FullForm= h[List[a, b, c, d]]
```

```
In[105]:= h/@{a, b, c, d}
Out[105]= {h[a], h[b], h[c], h[d]}
```


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

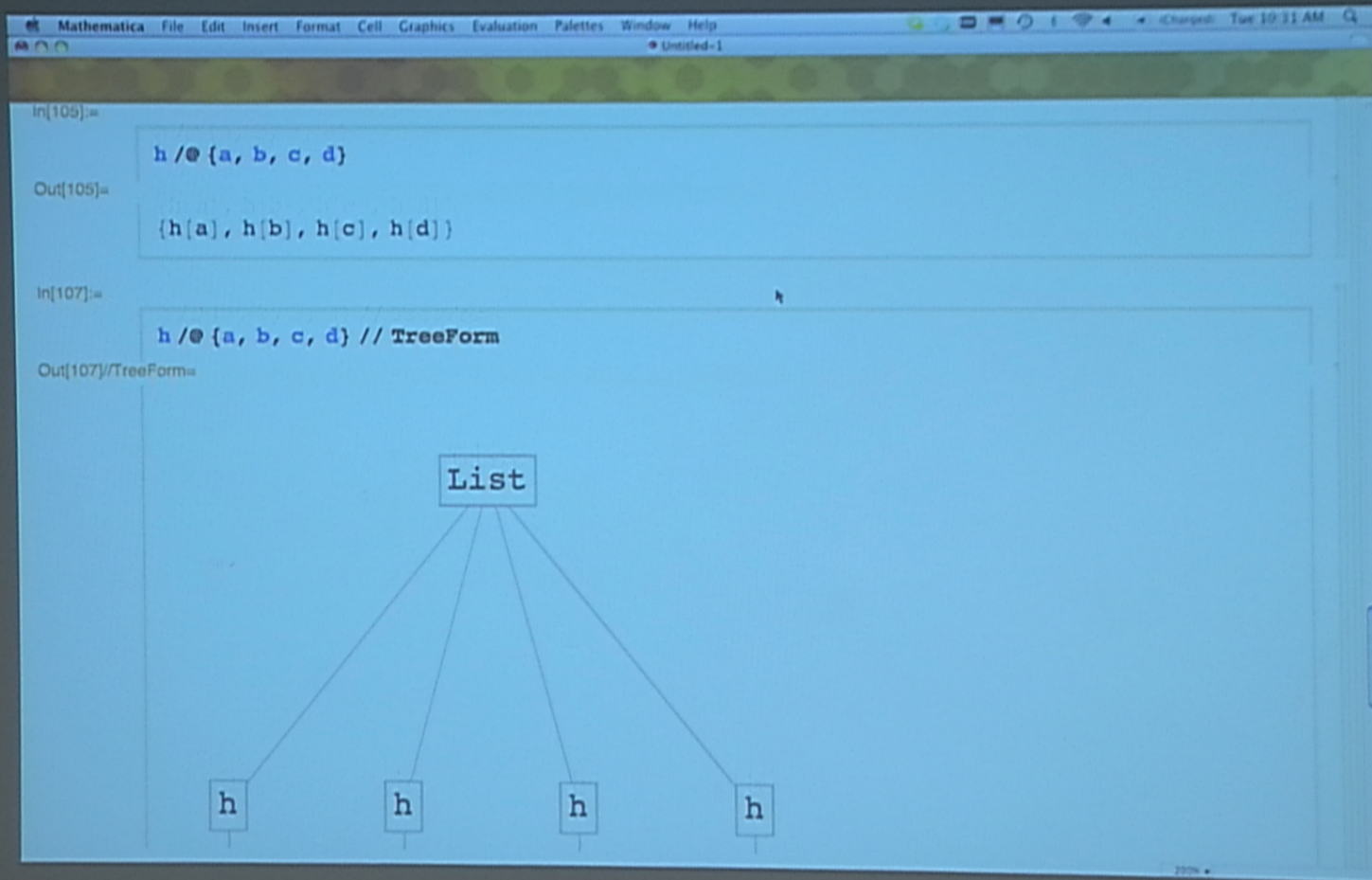
```
f4 = Sin[#1] Exp[#1] &
```

Distribute and Headers

```
In[102]:= {a, b, c, d} // FullForm
Out[102]//FullForm= List[a, b, c, d]
```

```
In[104]:= h@{a, b, c, d} // FullForm
Out[104]//FullForm= h[List[a, b, c, d]]
```

```
In[105]:= h/@{a, b, c, d}
Out[105]= {h[a], h[b], h[c], h[d]}
```



Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

h h h h

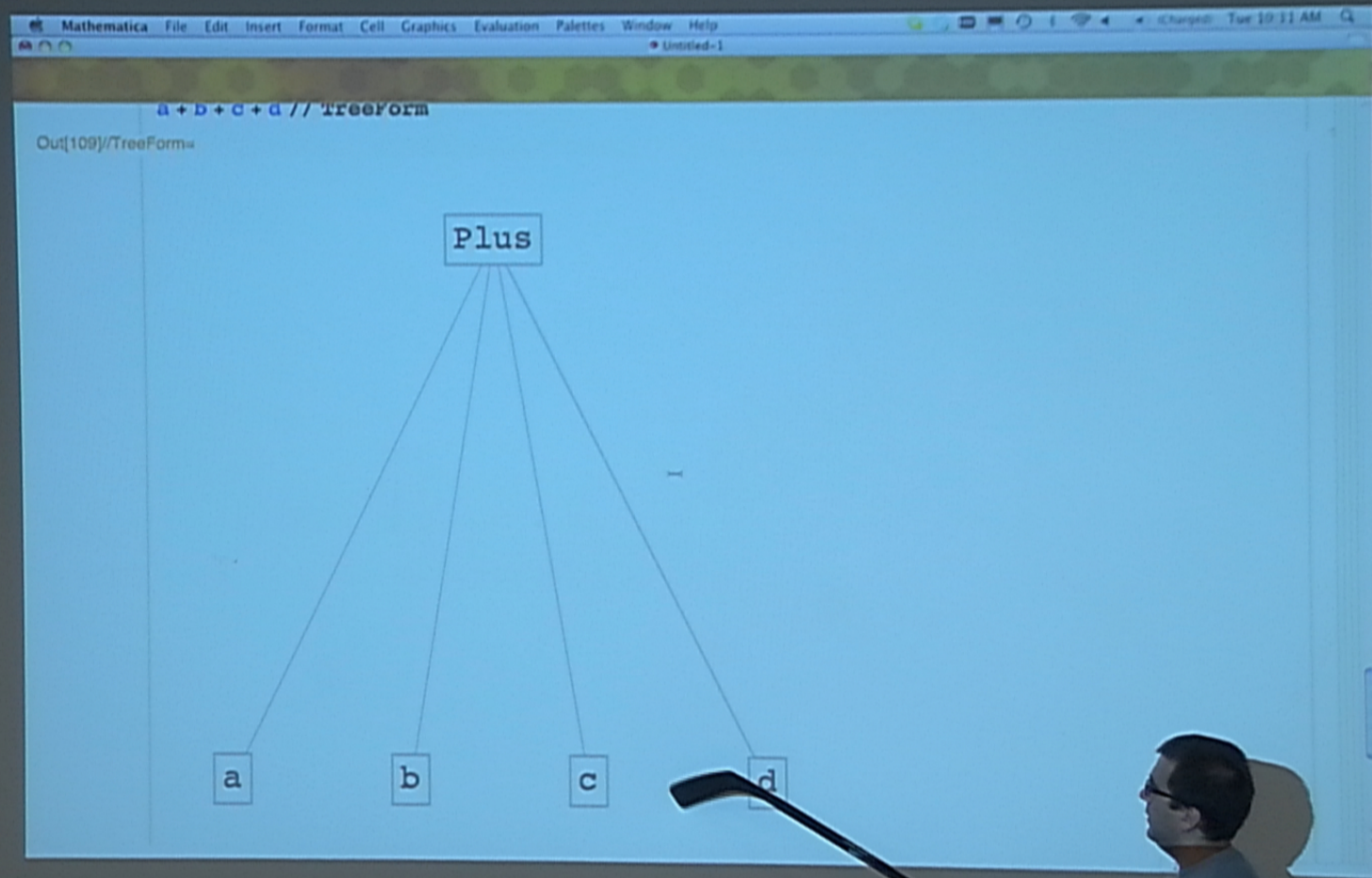
a b c d

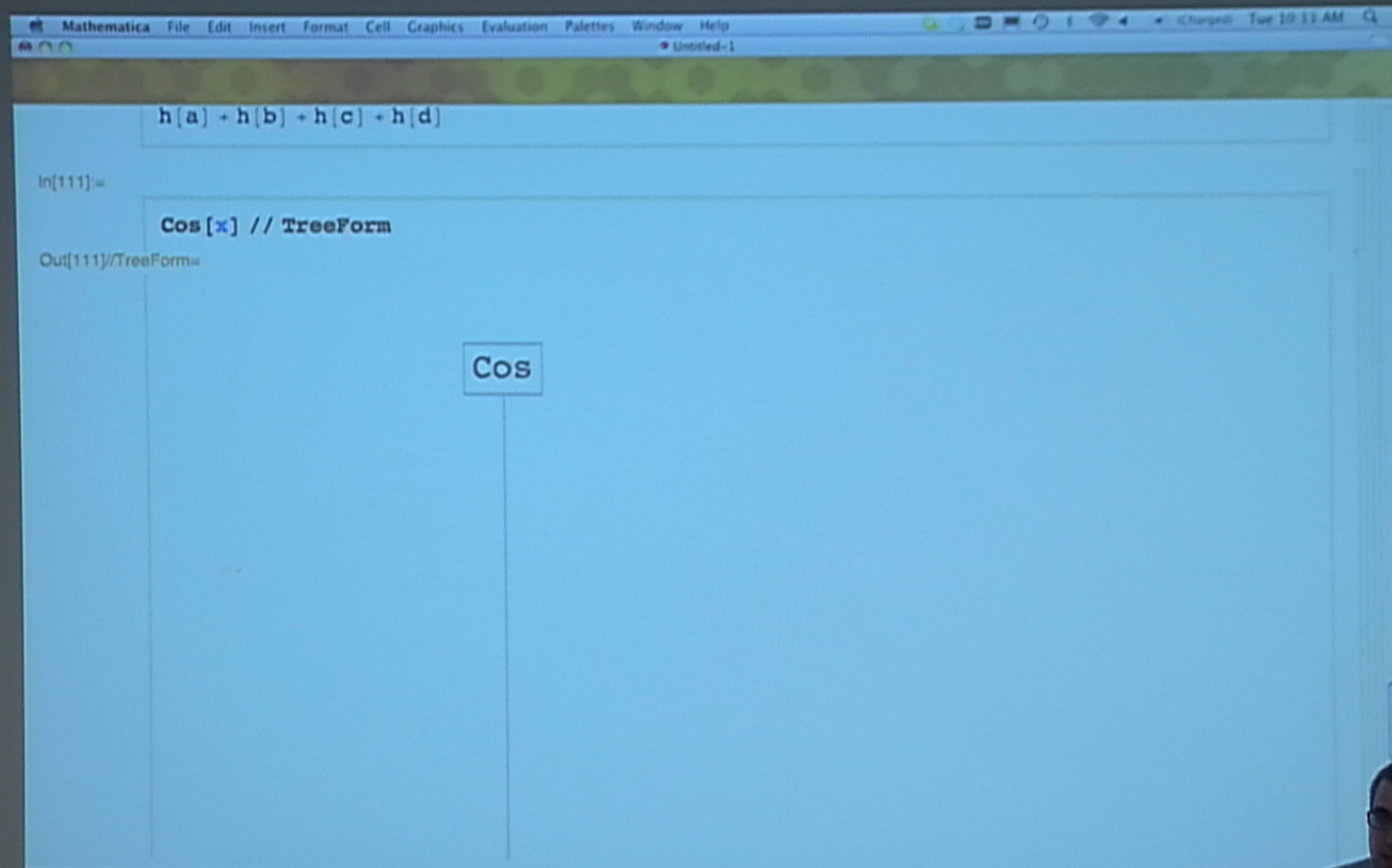
In[108]:=

$a + b + c + d$

Out[108]=

$a + b + c + d$





The screenshot shows a Mathematica notebook window titled "Untitled-1". The menu bar includes File, Edit, Insert, Format, Cell, Graphics, Evaluation, Palettes, Window, and Help. The status bar at the bottom right indicates "257%". The notebook contains the following input and output cells:

```
Out[110]:=
h[a] + h[b] + h[c] + h[d]

In[112]:=
Sin @@ Cos[x]

Out[112]:=
Sin[x]

In[114]:=
Plus @@ {a, b, c, d}

Out[114]:=
a + b + c + d
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

h[a] + h[b] + h[c] + h[d]

In[112]:=
Sin Cos[x]

Out[112]:=
Sin[x]

In[114]:=
Plus[a, b, c, d]

Out[114]:=
a + b + c + d

In[115]:=
Times[a, b, c, d]

Out[115]:=
abcd

Times[-1, -1,]
```

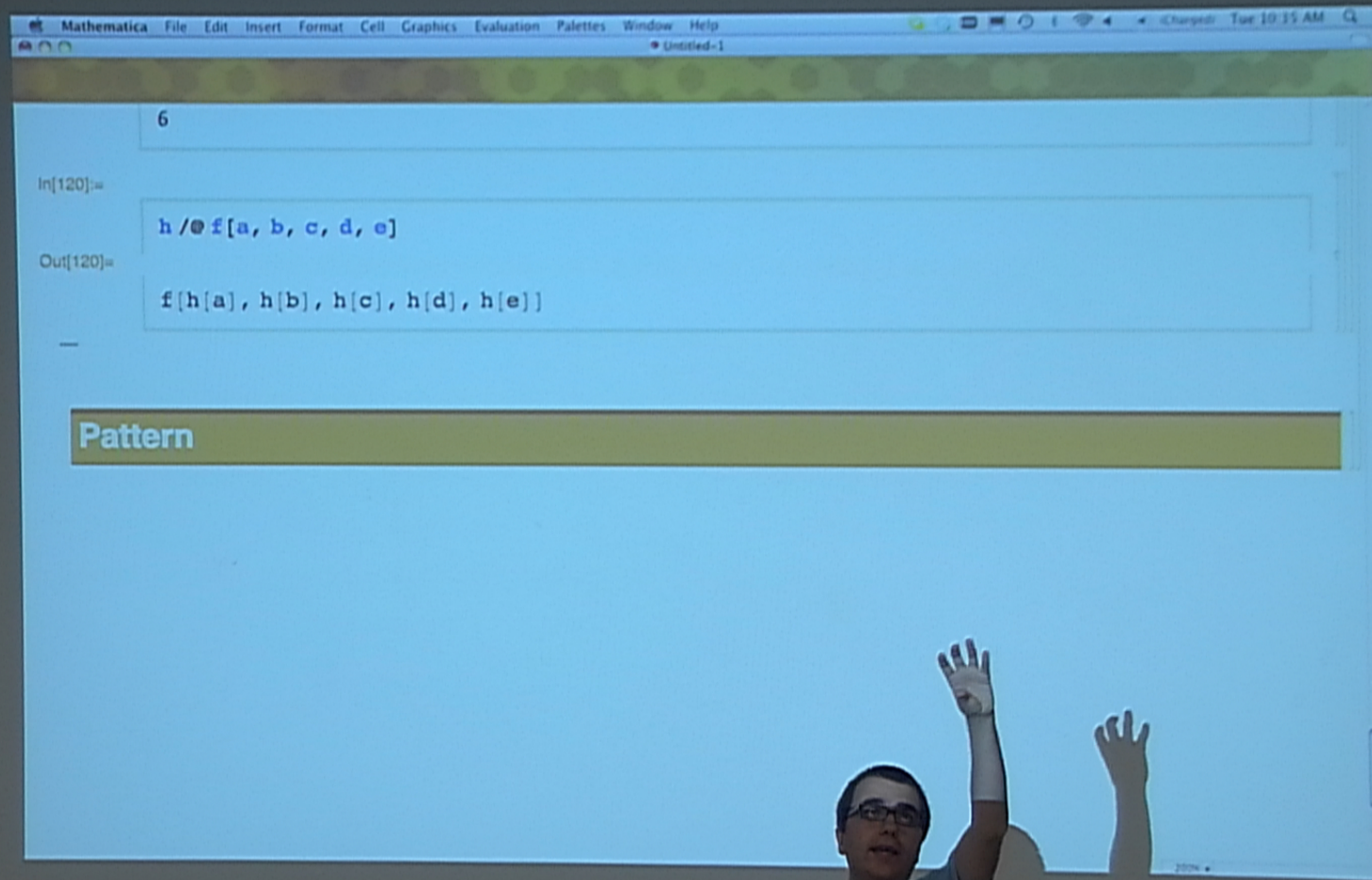
```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Plus @@ {a, b, c, d}
Out[114]=
a + b + c + d

Times @@ {a, b, c, d}
Out[115]=
a b c d

Times @@ {-1, -1, 2, 3}
Out[116]=
6

Pattern
```

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

6

In[120]:=

```
h /@ f[a, b, c, d, e]
```

Out[120]=

```
f[h[a], h[b], h[c], h[d], h[e]]
```

—

Pattern

The screenshot shows a Mathematica notebook window with a menu bar (Mathematica, File, Edit, Insert, Format, Cell, Graphics, Evaluation, Palettes, Window, Help) and a status bar (iCharged, Tue 10:36 AM, Q). The notebook content includes:

- A text input field containing the number `6`.
- An input cell labeled `In[120]:=` containing the expression `h /@ f[a, b, c, d, e]`.
- An output cell labeled `Out[120]=` containing the expression `f[h[a], h[b], h[c], h[d], h[e]]`.
- A section header **Patterns** on a yellow background.
- An input cell labeled `In[121]:=` containing the expression `f[2, 3] + f[3] /. f[_] -> 0`.
- An output cell labeled `Out[121]=` containing the expression `f[2, 3]`.
- A second output cell containing the expression `f[2, 3] + f[3] /.`.


```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[121]:= f[Cos[a]]

Out[121]:= f[2, 3] + f[3] /. f[a_] -> 0

In[122]:= f[2, 3]

Out[122]:= f[3]
```

```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[124]:=
Out[124]=
3 + f[Cos[a]] /. f[a_] -> 0
3

In[121]:=
Out[121]=
f[2, 3] + f[3] /. f[a_] -> 0
f[2, 3]

In[122]:=
Out[122]=
f[2, 3] + f[3] /. f[a_, b_] -> 0
f[3]

In[125]:=
Out[125]=
f[2, 3] + f[3] /. f[a_] -> 0
0
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

3

In[121]:=
Out[121]=
f[2, 3]

In[122]:=
Out[122]=
f[3]

In[125]:=
Out[125]=
0

f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] f[3, 5] + f[5] + f[4] /. f[_ , 4] -> 0
```



```

Out[121]:=
f[2, 3]

In[122]:=
f[2, 3] + f[3] /. f[a_, b_] -> 0

Out[122]:=
f[3]

In[125]:=
f[2, 3] + f[3] /. f[a_] -> 0

Out[125]:=
0

In[126]:=
f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, 4] -> 0

Out[126]:=
f[4] + f[5] + f[3, 5] + f[2, 3, 4] + f[1, 2, 3, 4]

```



```

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

0

In[126]:=
Out[126]=

$$f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[_, 4] \rightarrow 0$$


$$f[4] + f[5] + f[3, 5] + f[2, 3, 4] + f[1, 2, 3, 4]$$


In[127]:=
Out[127]=

$$f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[_, 4] \rightarrow 0$$


$$f[4] + f[5] + f[3, 5]$$


In[128]:=
Out[128]=

$$f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[_, 4] \rightarrow 0$$


$$f[5] + f[3, 5]$$


$$f[1, 2, 3, 4] + f[2, 2, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[_, 4] \rightarrow 0$$


```



```

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

In[126]:=
Out[126]=

$$f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, 4] \rightarrow 0$$


$$f[4] + f[5] + f[3, 5] + f[2, 3, 4] + f[1, 2, 3, 4]$$


In[127]:=
Out[127]=

$$f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, 4] \rightarrow 0$$


$$f[4] + f[5] + f[3, 5]$$


In[128]:=
Out[128]=

$$f[1, 2, 3, 4] + f[2, 3, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, 4] \rightarrow 0$$

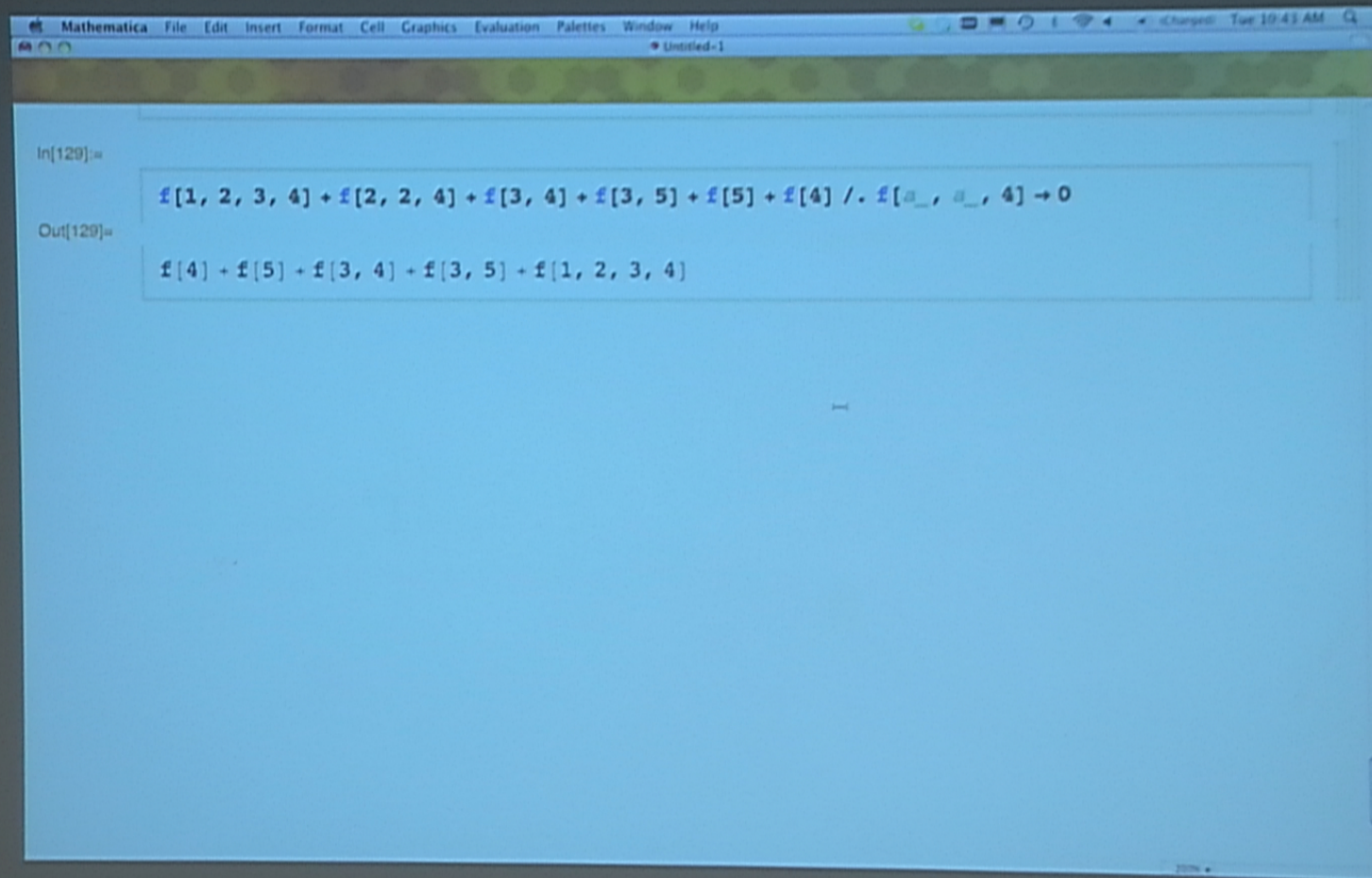

$$f[5] + f[3, 5]$$


In[129]:=
Out[129]=

$$f[1, 2, 3, 4] + f[2, 2, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] \rightarrow 0$$


$$f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]$$


```

The screenshot shows a Mathematica notebook window titled "Untitled-1". The menu bar includes "Mathematica", "File", "Edit", "Insert", "Format", "Cell", "Graphics", "Evaluation", "Palettes", "Window", and "Help". The status bar at the bottom right indicates "Charged" and "Tue 10:43 AM".

The input cell (In[129]) contains the following Mathematica code:

```
f[1, 2, 3, 4] + f[2, 2, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0
```

The output cell (Out[129]) displays the result of the evaluation:

```
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]
```

```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[128]:=
f[5] + f[3, 5]

In[129]:=
f[1, 2, 3, 4] + f[2, 2, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0

Out[129]:=
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]

In[134]:=
f[1, 2, 3, 4] + f[Cos[y], Cos[y], 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0

Out[134]:=
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]
```



```
Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[128]:=
f[5] + f[3, 5]

In[129]:=
f[1, 2, 3, 4] + f[2, 2, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0

Out[129]:=
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]

niupniou

In[134]:=
f[1, 2, 3, 4] + f[Cos[y], Cos[y], 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0

Out[134]:=
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]
```



```

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

Out[128]:=
f[5] + f[3, 5]

In[129]:=
f[1, 2, 3, 4] + f[2, 2, 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0

Out[129]:=
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]

niupniou

In[134]:=
f[1, 2, 3, 4] + f[Cos[y], Cos[y], 4] + f[3, 4] + f[3, 5] + f[5] + f[4] /. f[a_, a_, 4] -> 0

Out[134]:=
f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]

Cos[x + 1] (x + 1) + Sin[x] /. 1 + x -> y

```



```

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Untitled-1

f[4] + f[5] + f[3, 4] + f[3, 5] + f[1, 2, 3, 4]

In[135]:=
Cos[x + 1] (x + 1) + Sin[z] /. 1 + x -> y
Out[135]=
x + (1 + x) Cos[1 + x] + 10. Sin[z] -> y

In[136]:=
Cos[x + 1] (x + 1) + Sin[z] /. 1 + x -> y
Out[136]=
y Cos[y] + Sin[z]

In[139]:=
f[1, 2, 3, 4] + f[Cos[y], Cos[y], 4] + f[3, 5, 4] + f[3, 5] + f[5] + f[4] /.
f[a_, b_, 4] -> If[! a == b, 0, f[a, b, 4]]
Out[139]=
f[4] + f[5] + f[3, 5] + f[Cos[y], Cos[y], 4] + f[1, 2, 3, 4]

```