

# Build and Share Interactive Content

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Maple 2022 provides additional tools for creating documents and interactive applications programmatically. These tools can be used to develop [Maple Learn](#) content or to create applications to be used in Maple. Maple Learn is a new online environment designed specifically for teaching and learning mathematics.

## Canvas Scripting

Maple 2022 greatly extends the tools for creating Canvas-based documents and interactive applications programmatically.

The [Canvas](#) package provides a framework for Maple users to easily build applications that can be used both in Maple and also shared on the web through Maple Learn. These applications can gather user input and compute using standard Maple commands in either environment.

## Canvas Package

The [DocumentTools\[Canvas\]](#) package builds on [DocumentTools](#) component primitives to provide a simple way to generate a grid layout of text and math. It provides an easy mechanism to programmatically generate a page of math text and other elements. New in Maple 2022 is the ability to add Sliders, 3-D Plots, Images, Hyperlinks, Line-Drawings, and many new options for controlling the display of math and text.

## 3-D Plot Example

```
> with(DocumentTools:-Canvas):  
  
> cv := NewCanvas([  
    Text("Volume of Revolution",fontSize=24),  
    "This solid of revolution is created by rotating",  
    f(x) = cos(x) + 1,  
    Text("about the y=0 axis on the interval %1",(0 <= x) and (x  
<= 4*Pi)),  
    Plot3D( "Student:-Calculus1:-VolumeOfRevolution(cos(x) + 1,  
x = 0 .. 4*Pi, output = plot, caption=``)" )  
    ]):
```

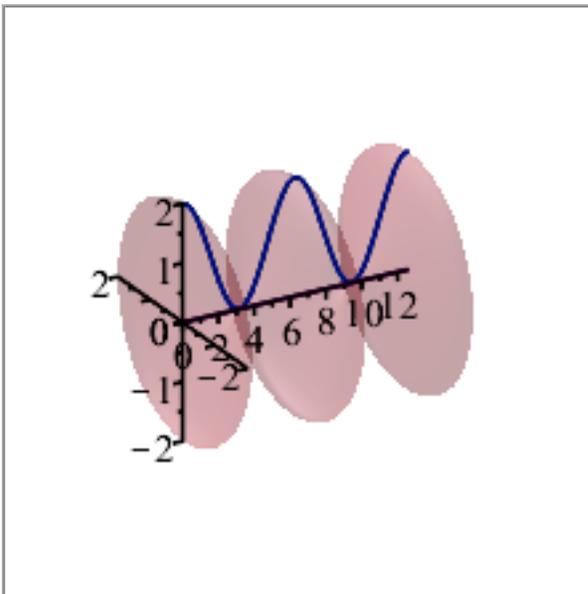
> **ShowCanvas(cv);**

Volume of Revolution

This solid of revolution is created by rotating

$$f(x) = \cos(x) + 1$$

about the  $y=0$  axis on the interval  $0 \leq x \leq 4\pi$



## Image Example

In this example we embed an image in the canvas.

Note: To execute this code you must be logged into the MapleCloud; see the [Image](#) command's help page for details.

- > `with(DocumentTools:-Canvas) :`
- > `file := cat(kernelopts(datadir), "/images/antennas.jpg") :`
- > `cv := NewCanvas(["Sample Image", Image(file)]) :`

> *ShowCanvas(cv)*

Sample Image



The [ShareCanvas](#) command sends the canvas to Maple Learn and gives you a link to your document.

> *ShareCanvas(cv)*

<https://learn.maplesoft.com/#/?d=OTCKBNLTJUKMAKLMCLFIDMBFMJLKJPDQCGJIOMPJCPIOAOFQHNNHERHGFUIRNOBNEKOMG SMTIGCNKHETLJOLPIITMGKFMUMTONNN>

## Interactive Example

In this example, we will define an application that allows user input and provides feedback. The UpdateStats procedure will run when a button is pressed. It will use the new [GetElements](#) command to extract specific pieces of the canvas, including an array of points as input to analyze, and named elements so they can be replaced with updated values.

```

1 with(Statistics):
2 with(DocumentTools:-Canvas):
3
4 UpdateStats := proc( canvas )
5     local data := GetElements(canvas, 'custom'="Grades")[1]:-math;
6     local data_mean := Statistics:-Mean(data);
7     local data_variance := Statistics:-Variance(data);
8     local X := RandomVariable(Normal(data_mean, sqrt(data_variance)));
9     local P := DensityPlot(X, range = 0..100, thickness = 3, color=red)
10    ~
11    :
12    local Q := Histogram(data, range = 0..100):
13
14    local sc := Script();
15    SetActive(sc, GetElements(canvas, "plot")[1]);
16    SetPlot(sc, plots[display](P, Q) );
17    ~
18    SetActive(sc, GetElements(canvas, 'custom'="mean")[1]);
19    SetMath(sc, 'mu'=data_mean);
20    Annotate(sc, "mean");
21
22    SetActive(sc, GetElements(canvas, 'custom'="std")[1]);
23    SetMath(sc, 'sigma'=sqrt(data_variance));
24    Annotate(sc, "standard deviation");
25    ToString(sc);
26 end proc:
27
28 SampleGrades := [65, 68, 70, 97, 64, 73, 39, 69, 70, 65, 82, 71, 76, 60
29 , 77, 86, 69, 71, 90, 74, 66, 75, 70, 80, 72, 82, 80, 79, 56, 74]:
30
31 cv := NewCanvas( ["Normal Distribution of Grades",
32 "Grades:",
33 Math(SampleGrades, 'custom'="Grades"),
34 StaticPlot(),
35 Math(sigma = sigma, 'custom'="std"),
36 Math(mu = mu, 'custom'="mean"),
37 ScriptButton("Calculate", UpdateStats, position=[500,50
38 ])

```

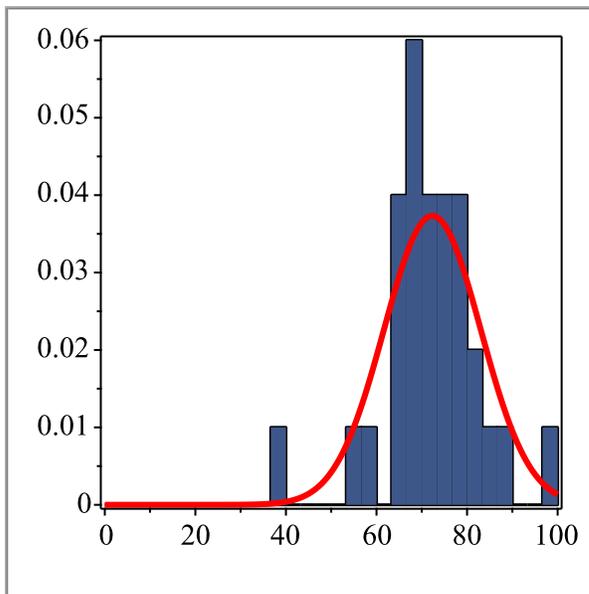
> ShowCanvas(cv)

Normal Distribution of Grades

Calculate

Grades:

[[65, 68, 70, 97, 64, 73, 39, 69, 70, 65, 82, 71,  
76, 60, 77, 86, 69, 71, 90, 74, 66, 75, 70,  
80, 72, 82, 80, 79, 56, 74]]



$\sigma = 10.6878381844726338$  standard deviation

$\mu = 72.333333333333286$  mean

> New Math Entry Box

To try this on the web using [Maple Learn](#), execute:

```
> ShareCanvas(cv);
```

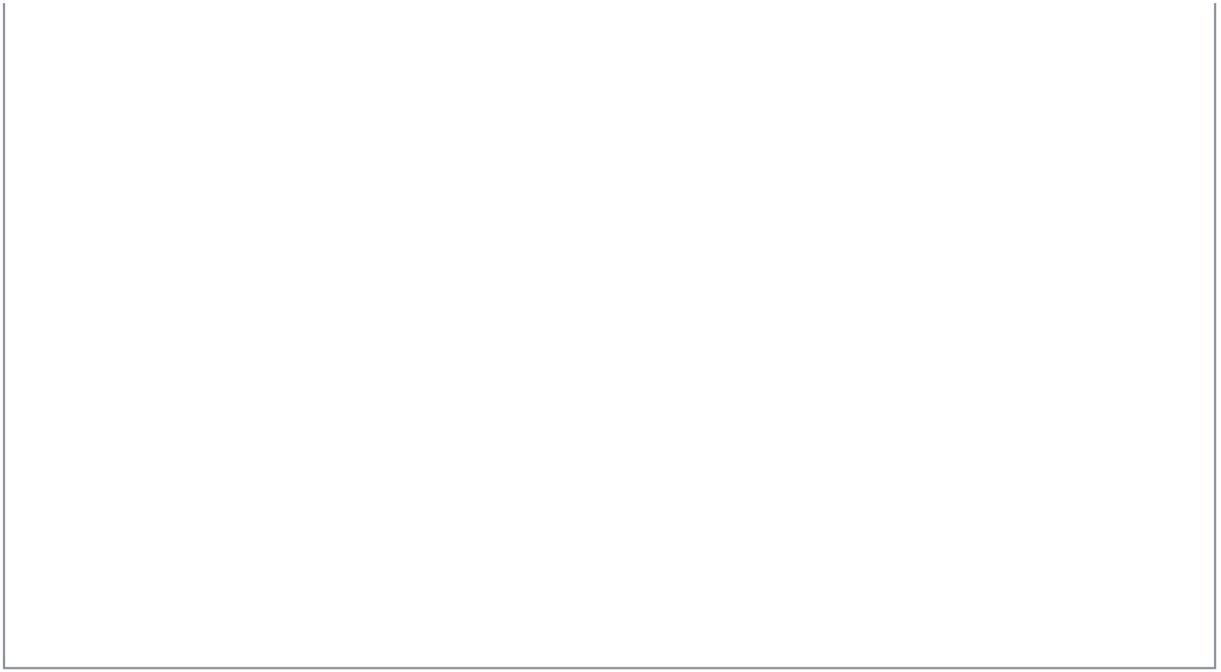
<https://learn.maplesoft.com/#/?d=BNMSGTBOPRITAPETOFHTHSLKMKFQANDSKGRRBUOTCPNKDQJKAMOSNPHUHNKEGHODJCPEPCLFOMOPUIUNKPGCPMRDQHKNHMLCOBU>

## On-Click Events

The [Plot](#) element has a new "onclick" option, and the [Button](#) element has a new "onmoved" option. These can be used to react to events such as clicking on a plot or moving an image on a canvas. There is also a new hidden [State](#) element, which can be used to record behind the scenes values that don't need to be visible in the canvas.

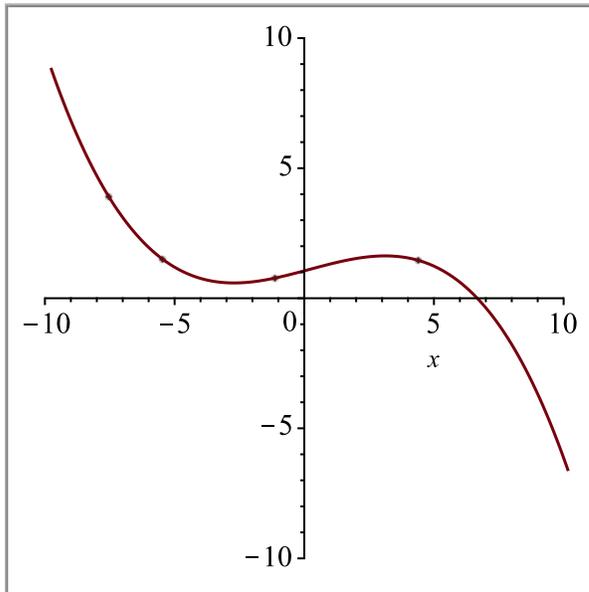
In this example the user is asked to click on a plot to add points. When 2 or more points are set, the application will find a polynomial curve fit approximation and draw that on the plot too.





`ShowCanvas(cv, entrybox = false);`

Curve Fitting - click on the plot to add points



Your curve looks like:

$$\begin{aligned} &1.05350118755305178 \\ &+ 0.266264093627340770x \\ &+ 0.00642071434340281411x^2 \\ &- 0.0104951972740076789x^3 \end{aligned}$$

**> ShareCanvas(cv);**

<https://learn.maplesoft.com/#/?d=JOESANAGLRBIJUFMNOQRKGBMGKPIEODNBGGSCSEGOINMOIMFOOMODLILPIASNREKAKERCTHSEPIOIRGUAQCTIKLSCMCTOIAUFOJP>

# Help with Math Problems

The new [IntPractice](#) and [DiffPractice](#) commands extend the algorithm behind [SolveFeedback](#) to handle integrals and derivatives.

> *with(Grading)* :

> *IntPractice*( $\int x \cdot \sin(x) \, dx$ )

Find this integral

Check Page

Please fill in your steps line by line.

$$\int x \sin(x) \, dx$$

$$u = x$$

Substitution Step

$$v = \int \sin(x) \, dx = -\cos(x) \quad \text{Substitution Step}$$

$$du = 1$$

Ok

$$dv = \sin(x)$$

Ok

$$\int u \, dv = u \cdot v - \int v \, du \quad \text{Ok}$$

$$x \cdot (-\cos(x)) - \int (-\cos(x) \cdot 1) \, dx \quad \text{Ok}$$

$$-x \cdot \cos(x) + \sin(x) \quad \text{Ok}$$

Almost there! Add constant of integration

> New Math Entry Box

This interactive example can also be shared via Maple Learn:

*IntPractice*( $\int x \cdot \sin(x) \, dx$ , 'output'='link') :

<https://learn.maplesoft.com/#/?d=>

[ITFOMGBOPTOMCGMGLPBNLLKPHFEJERLHLOAJBOGMGKNGHLBQPLDLNIKOPSELBIJNKPLHLOKGFSLFKTC](https://learn.maplesoft.com/#/?d=ITFOMGBOPTOMCGMGLPBNLLKPHFEJERLHLOAJBOGMGKNGHLBQPLDLNIKOPSELBIJNKPLHLOKGFSLFKTC)

## Canvas-based Quizzes

The [Quiz](#) command now has an option to supply a solution. The quiz question, verifier, new-problem generator and solution can return a canvas, which can be deployed to Maple Learn.

```
1 with(Grading):
2 cv := Quiz(
3   "How many ways are there to choose $B balls from a sack containing $A di-
4   erent colored balls?",
5   proc() evalb(Quiz:-Get(
6     ` $RESPONSE `) = binomial(Quiz:-Get(` $A `),Quiz:-Get(` $B `)) )
7   end proc,
8   proc() Quiz:-Set(` $A `=rand(5..10)());
9     Quiz:-Set(` $B `=rand(1..4)());
10    1;
11  end proc,
12  'solution' = proc()
13    local a := Quiz:-Get(` $A `);
14    local b := Quiz:-Get(` $B `);
15    [ ["Compute the Binomial Coefficient", %binomial(a,b) =
16      `%/` (%factorial(a),`%*`(%factorial(b),`%+(a,-b)!))],
17      ["Result:", binomial(a,b)]]
18  end,
```

- > `with(DocumentTools:-Canvas) :`
- > `ShowCanvas(cv, entrybox = false);`

How many ways are there to choose 2 balls from a sack containing 6 different colored balls?

-- Enter Answer Here

Check Answer

Try Another

Show Solution

Compute the Binomial Coefficient

$$\binom{6}{2} = \frac{6!}{2! \cdot (6-2)!}$$

Result:

15

- > `ShareCanvas(cv);`

<https://learn.maplesoft.com/#/?d=LOJKCGMHBMFJHPGPFANCRFGLRDGLHGODFDMIHGNAPBHLNLRGJGUFUMMPRJQJNAFNJGRBPMKEGKUAUOKAOKRINEPNNPNCIFULMIE>