

Sept. 16 2005: Lecture 5:

## Introduction to Mathematica IV

### Graphics

Graphics are an important part of exploring mathematics and conveying its results. An informative plot or graphic that conveys a complex idea succinctly and naturally to an educated observer is a work of creative art. Indeed, art is sometimes defined as “an elevated means of communication,” or “the means to inspire an observation, heretofore unnoticed, in another.” Graphics are art; they are necessary. And, I think they are fun.

For graphics, we are limited to two- and three-dimensions, but, with the added possibility of animation, sound, and perhaps other sensory input in advanced environments, it is possible to usefully visualize more than three dimensions. Mathematics is not limited to a small number of dimensions; so, a challenge—or perhaps an opportunity—exists to use artfulness to convey higher dimensional ideas graphically.

Basic graphics starts with two-dimensional plots.

MATHEMATICA<sup>®</sup> Example: Lecture-05

#### **Two-dimensional Plots**

*2D plots, plot options, log plots*

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*Plotting Data*

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Sometimes you will want to plot number that come from elsewhere—otherwise known as data. Presumably, data will be imported with file I/O. It is useful to plot data within MATHEMATICA<sup>®</sup> so you can compare it to model equations or to fit to an empirical equation.

Three-dimensional graphics are typically projected onto the screen. This means that you need to specify the direction in space from which you will look at the two-dimensional projection. You get some depth information in a projection by the perspective (i.e, the trick that artists use of making parallel lines converge at a non-infinite point. (e.g. 15th century Italian School, Donetello)). You also get information by changing your viewpoint. In MATHEMATICA<sup>®</sup> you need to specify a ViewPoint that orients the viewer from a certain direction and sets the perspective. At a close viewpoint (i.e., magnitude of the ViewPoint vector

is small), parallel lines converge quickly and perspective—as well as distortion—is enhanced. For more distant ViewPoints, an object projects more "flatly" (as in Art Naif) and with less distortion.

MATHEMATICA<sup>®</sup> Example: Lecture-05

### Three Dimensional Graphics

*Plotting three dimensional graphics*

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MATHEMATICA<sup>®</sup> has a "graphical engine" that allows you to add additional graphics to your plot. Although, it is not efficient, one could use MATHEMATICA<sup>®</sup> as a drawing program like Pourri-pinte or similar. MATHEMATICA<sup>®</sup> has a number of graphics primitives that can be drawn—it is only a question of asking MATHEMATICA<sup>®</sup> to draw a primitive where you want it.

MATHEMATICA<sup>®</sup> Example: Lecture-05

### Graphics Primitives

*Examples: Circles, Text, Random Walk, Wulff Construction*

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Because PostScript is one of the graphics primitives, you can draw anything that can be imaged in another application. You can also import your own drawing and images into MATHEMATICA<sup>®</sup>.