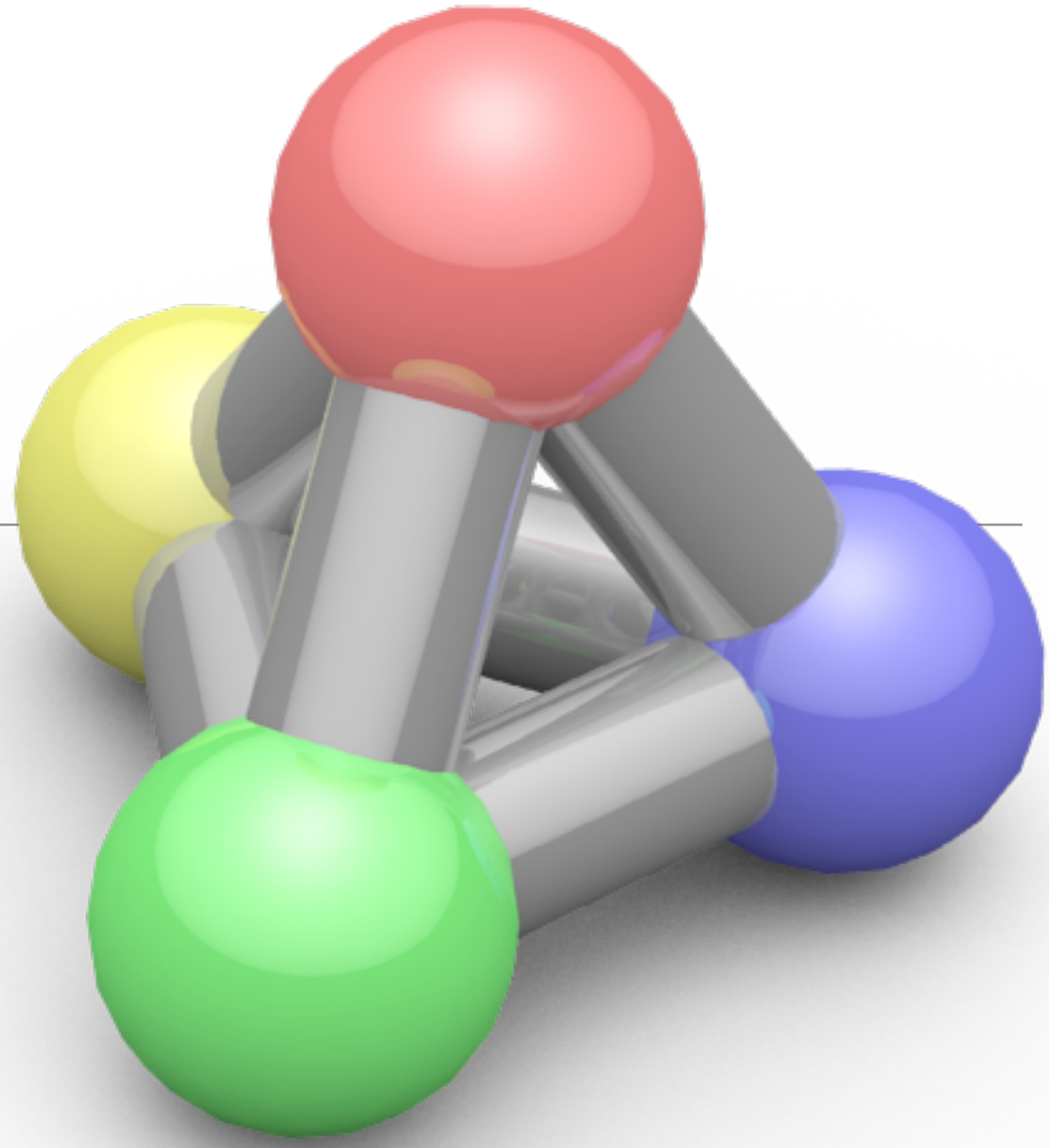
Geometric Representation



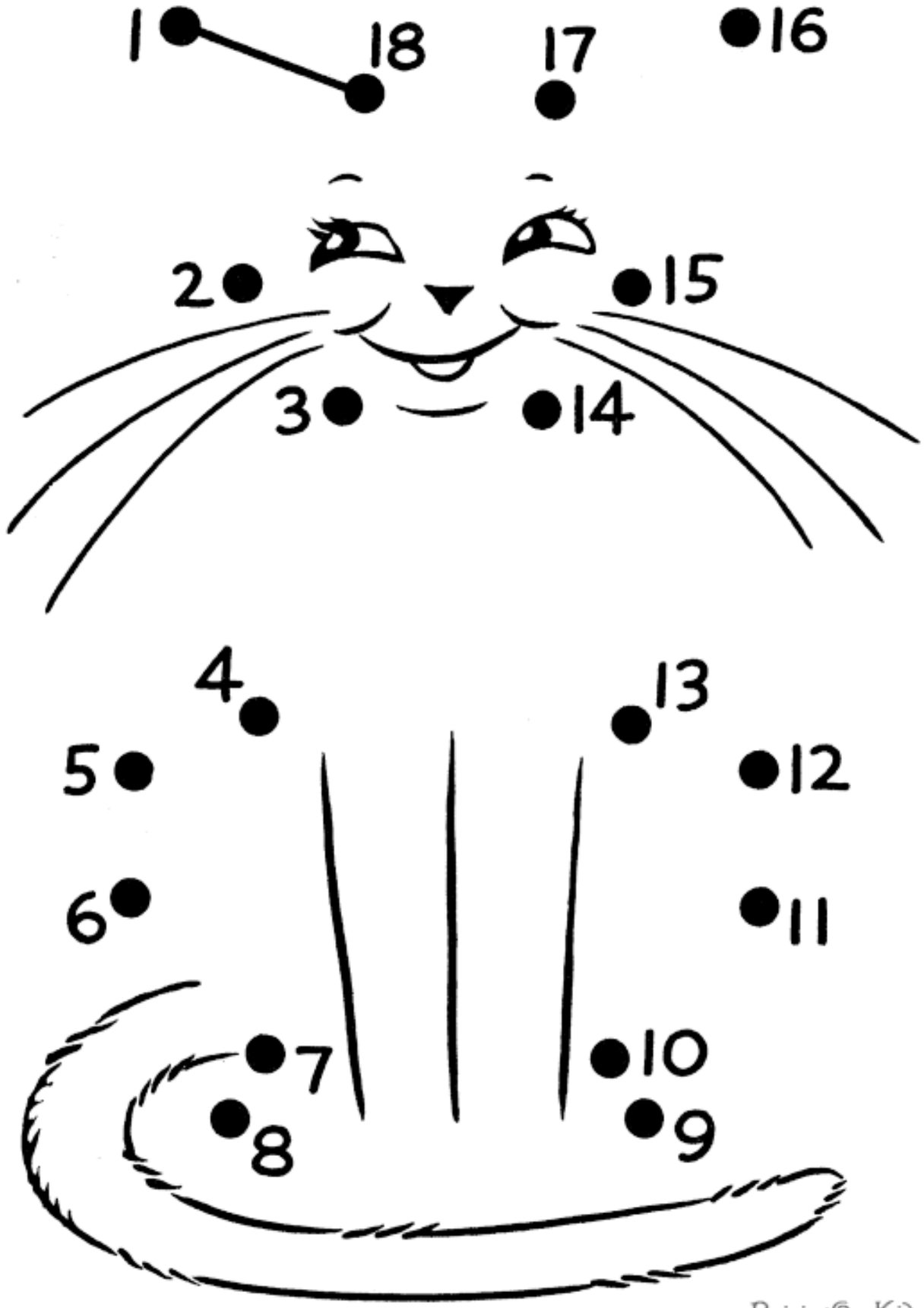
CPSC 453 – Fall 2016
Sonny Chan

Summary

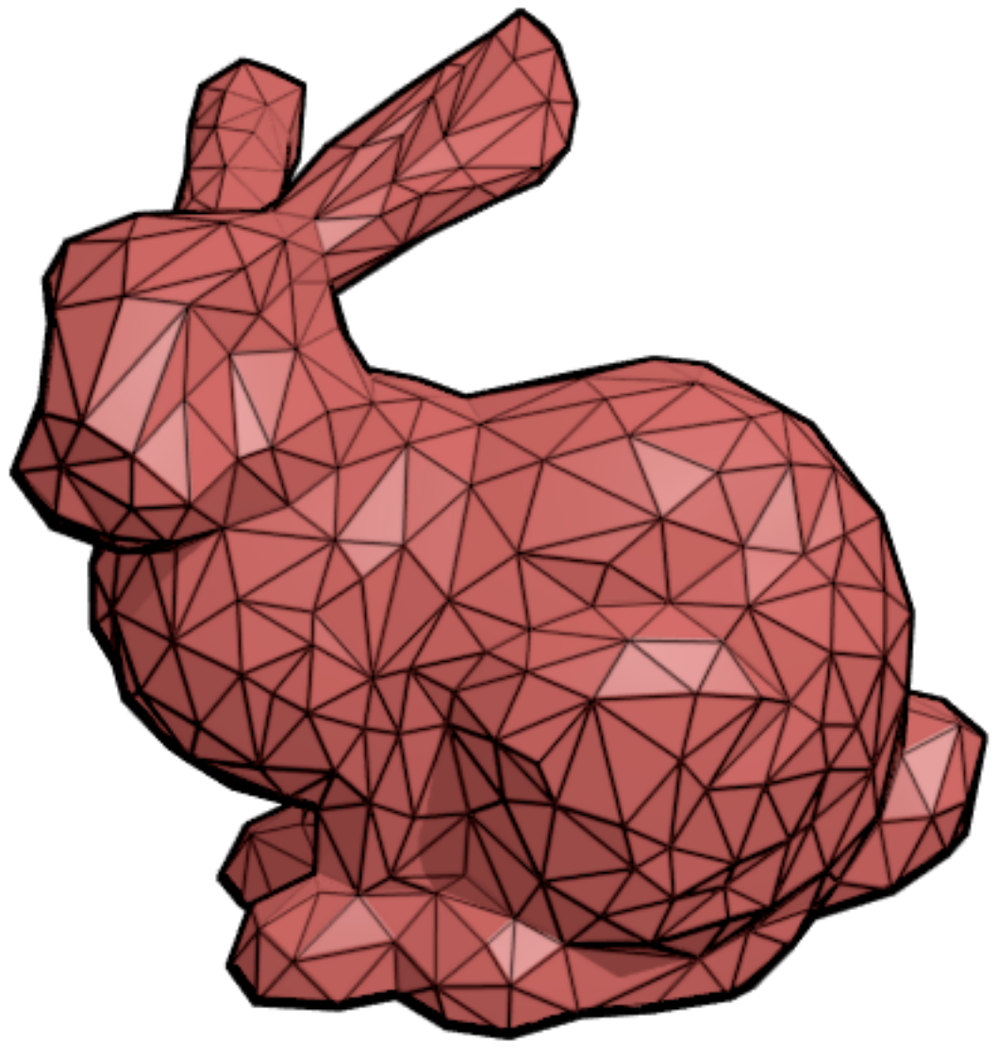
- We examined ways to store geometry on the computer:
  - Discrete values or samples
  - Implicit functions
  - Parametric equations
  - Generative procedures
- We discussed how one might convert between them

Discrete Samples

- Essentially what you learned in kindergarten
- Advantages:
  - simple to use
  - flexible and expressive
- Disadvantages:
  - often just an approximation
  - needs a lot of points!



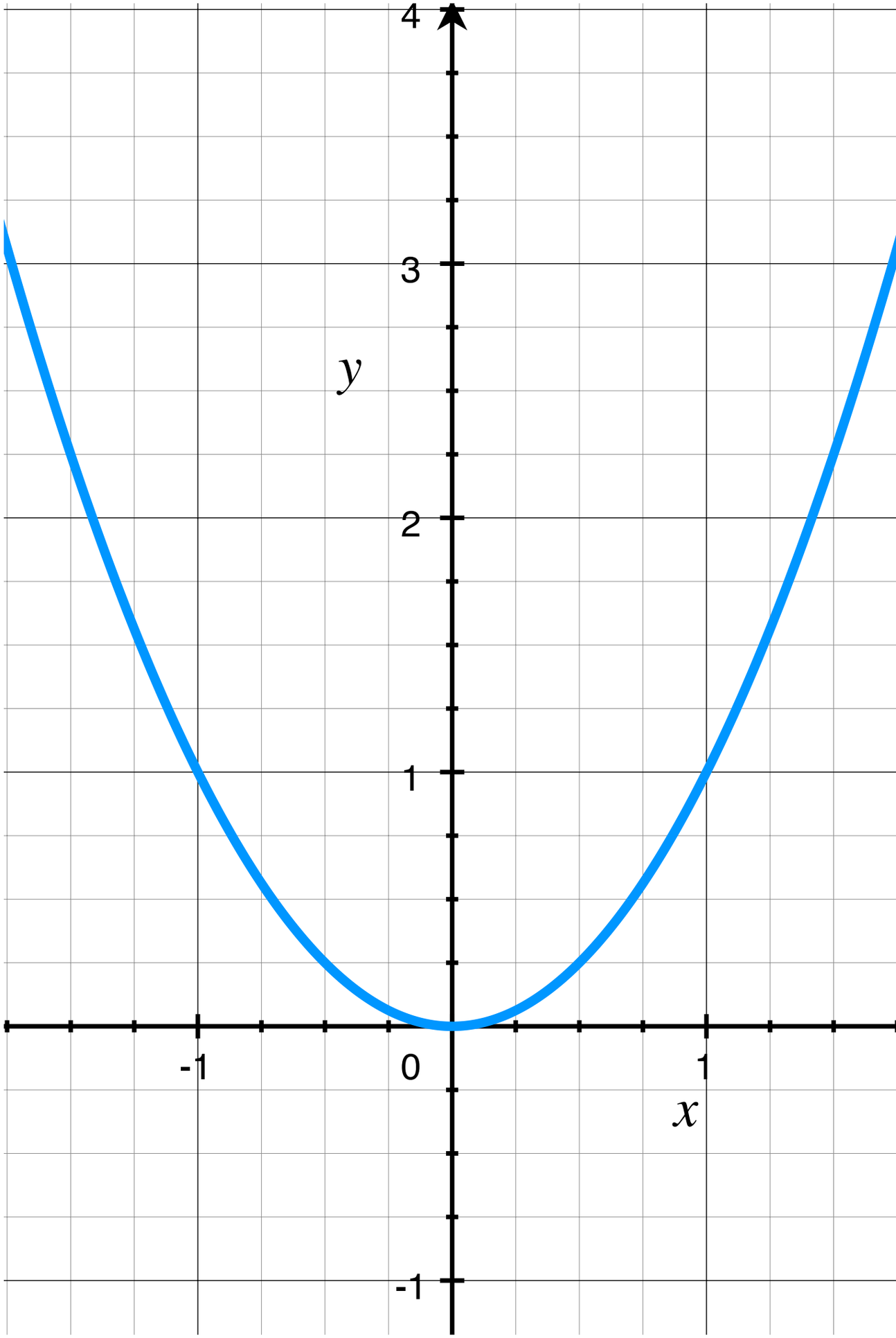
In Three Dimensions



["Stanford Bunny", 1994]

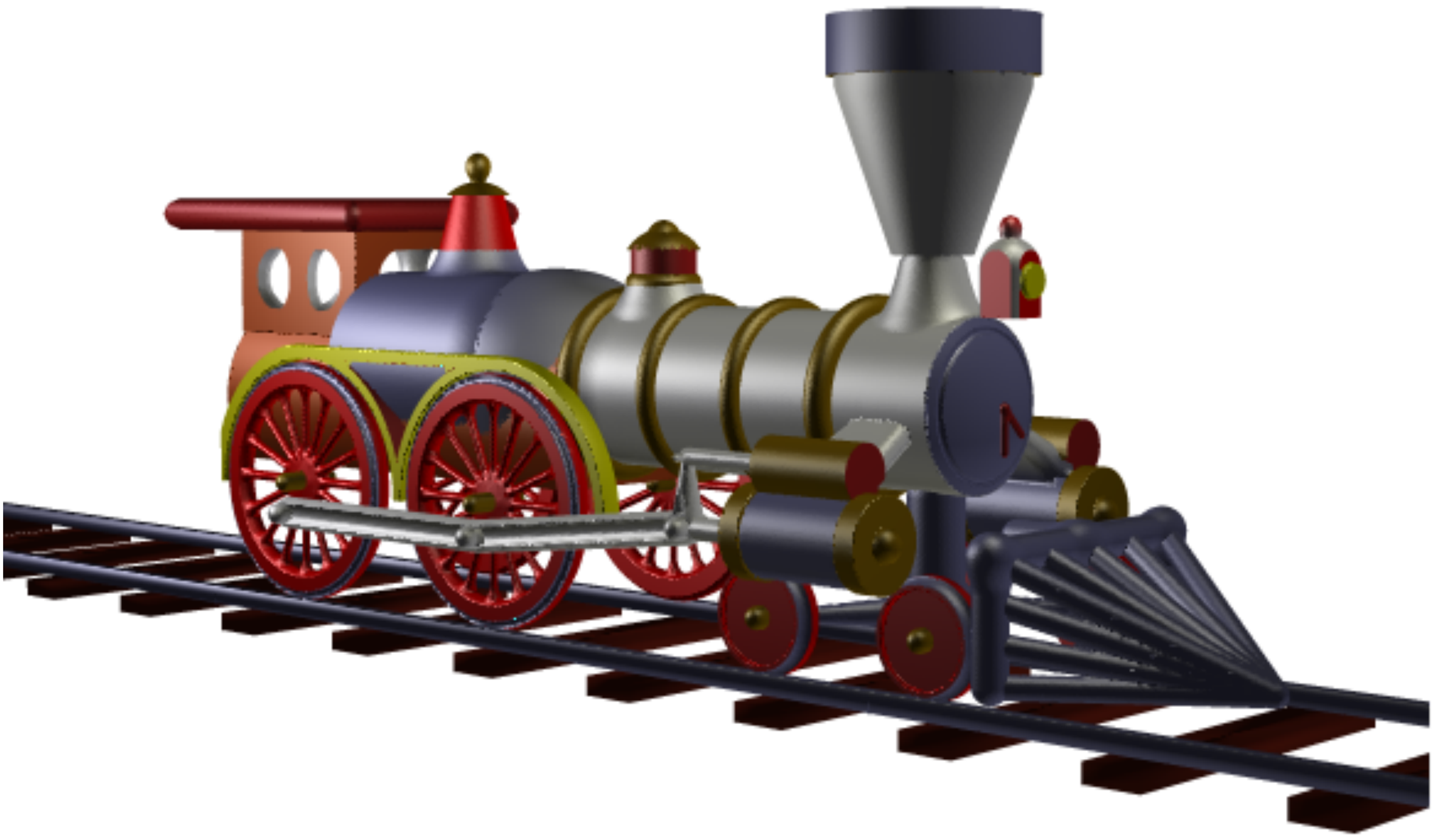
Implicit Functions

- Essentially what you learned in high school
- Explicit form: $y = x^2$
- Implicit form: $x^2 - y = 0$
- Write as functions in code, or store coefficients
  - compact, intuitive
- Really difficult to render!



In Three Dimensions

$$\left(2x^2 + y^2 + z^2 - 1\right)^3 - (0.1x^2 + y^2)z^3 = 0$$



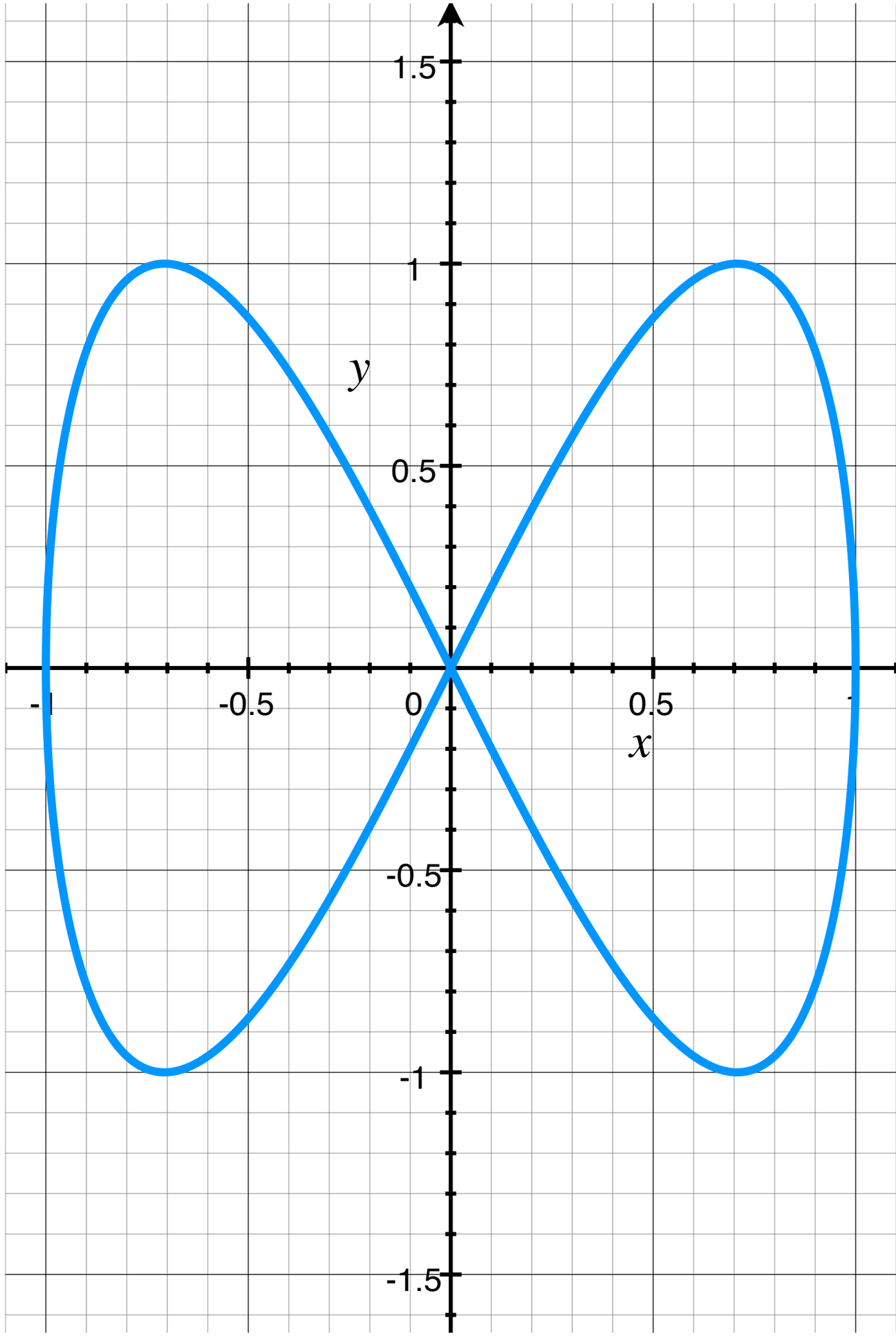
[from B. Wyvill & K. van Overveld, *Intl. J. Shape Modeling* 2(4), 1996]

Parametric Equations

- Expresses points on a curve/surface as function of a free parameter
- 2D parametric equations:

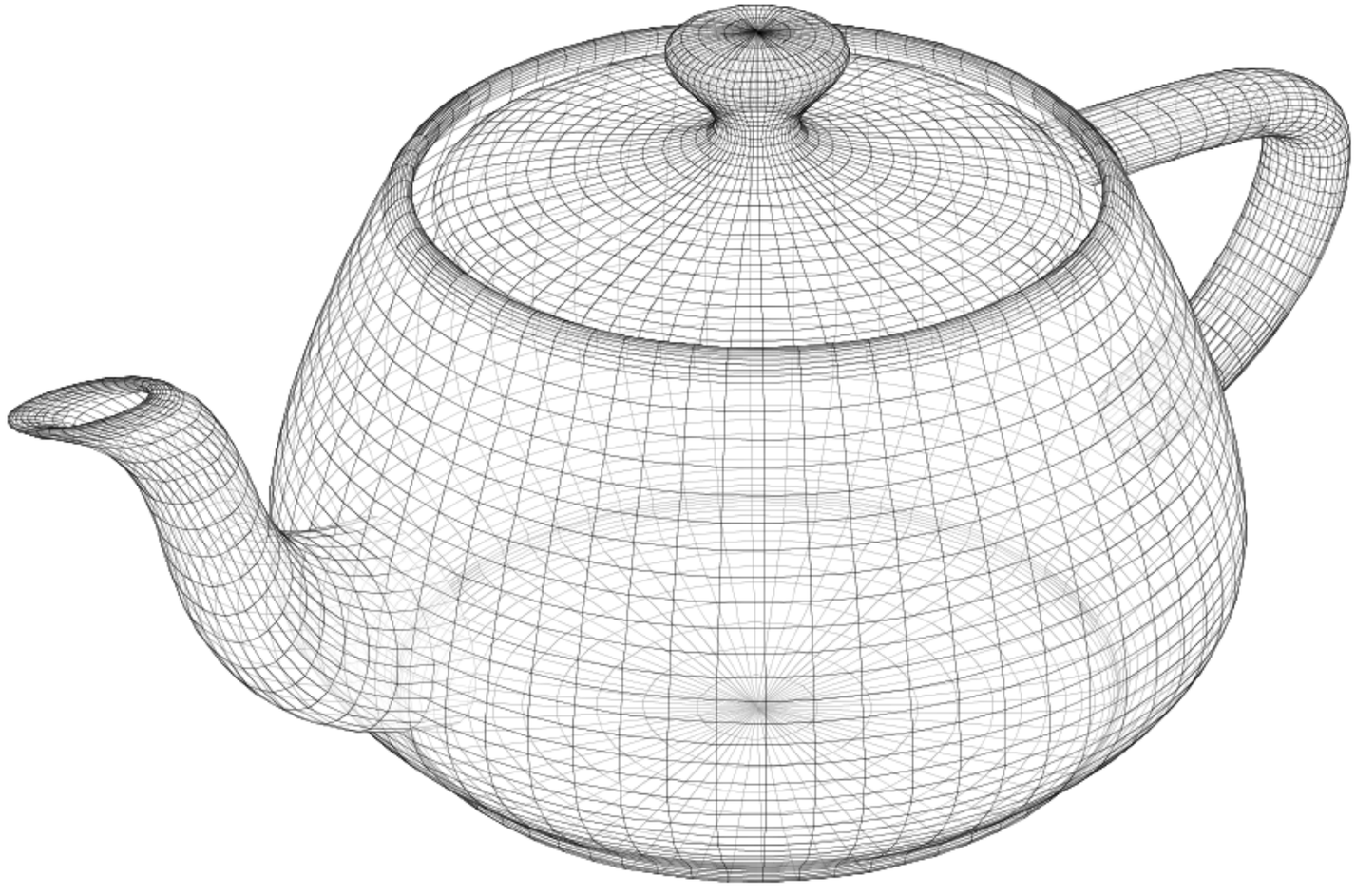
$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} \sin u \\ \cos 2u \end{bmatrix}$$

- Fairly convenient to render
- Disadvantages:
  - not a unique representation
  - shape may not be intuitive



In Three Dimensions

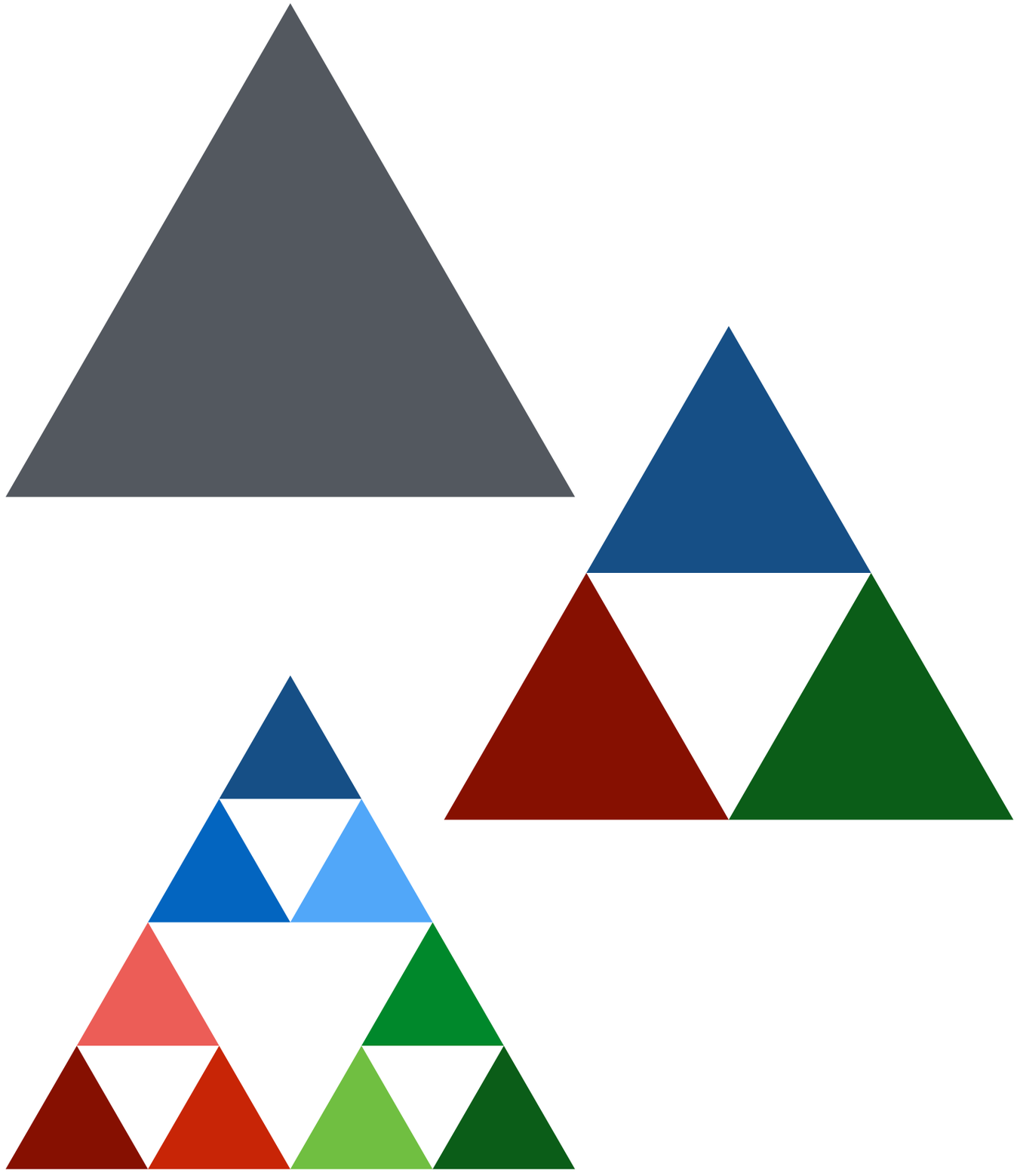
Patches parameterized on u, v

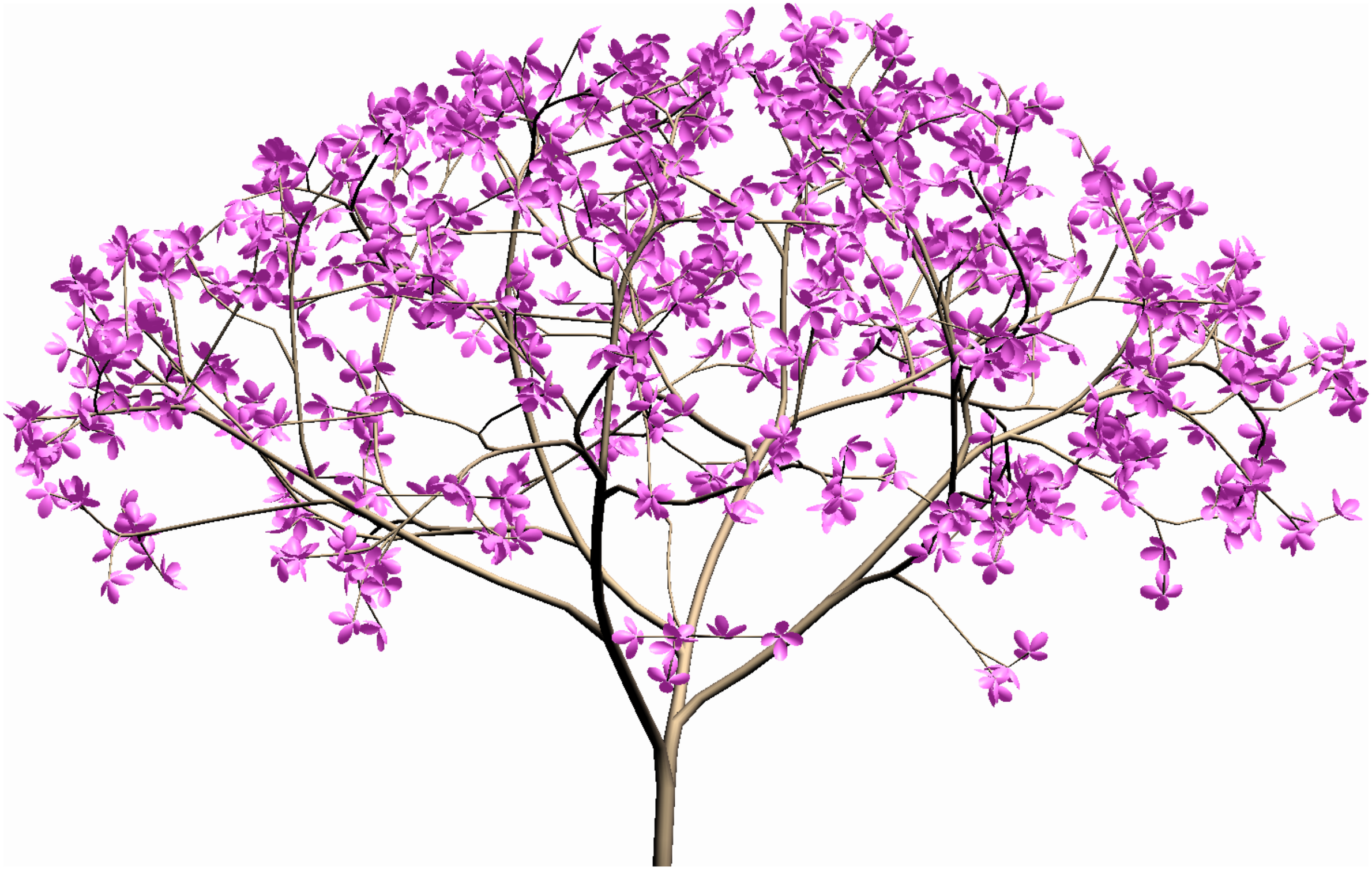


["Utah Teapot", 1975]

Generative Functions

- Examples include
  - fractals, L-systems
  - subdivision schemes
  - textures, noise
  - terrain
- Maps very well to computer code
- Excels at describing a narrow set of phenomena





[from A. Runions, B. Lane & P. Prusinkiewicz, *Eurographics Workshop*, 2007]

Things to Remember

- Every representation has advantages and disadvantages!