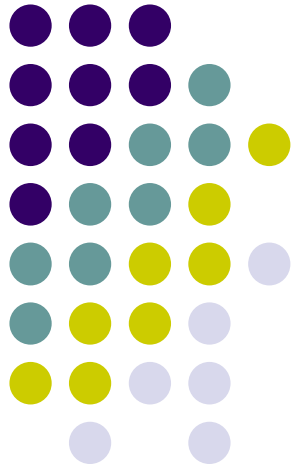
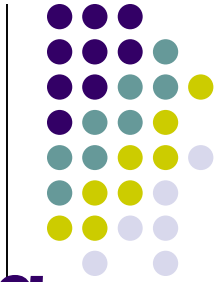
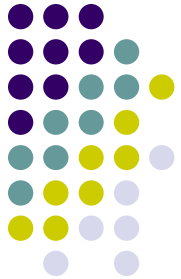
Geometric Modeling





In the fields of science, engineering, and architecture, a model is constructed so that…

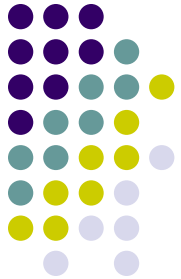
- the object's essential information stands out in the model and
- we can analyze important aspects of the object by observing the model.



In order to be concise and analytic…

a model may be different from the object which the model represents in its scale, complexity, and appearance.

For instance, a model of a building may be built on a scale of 1:1000 so that the model can be placed on a desk and examined by architects from any angle.



A mathematical model of a complex natural phenomenon may be…

built by choosing only the parameters which play important roles in the phenomenon of *interest* in order for us to explain or predict nature.

In recent years a mathematical model formulated on the computer is …

visualized as graphical image which we can understand intuitively. This process is called "visualization."

In visualization…

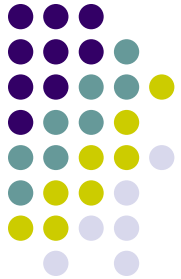
- Insignificant attributes of the object may be discarded
- Shapes and colors may be given to the components of the object which are invisible to us in nature
- An object is simplified and given a new appearance to become a model which is conceivable to us

In the fields of art, design, advertisement, communication, and other, a model on the computer can be…

- a representation of a physical object which is being designed or analyzed

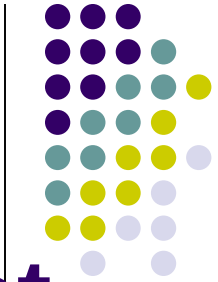
  or

- an object itself.



When a computer model represents nothing but itself…

the words "model" and "object" are used interchangeably.



Geometric modeling is a subject in 3D computer graphics which…

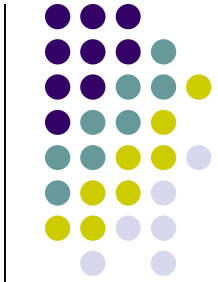
studies shapes of objects.

Other characteristics of an object, such as color, surface texture, density, material, temperature, and pressure are not in the scope of geometric modeling.

A representation method is…

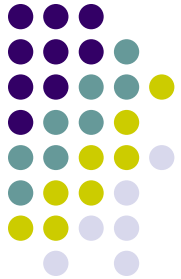
- a set of rules used to describe the shape of a geometric model.

E.g., Maya uses a particular representation method for 3D geometries that allows users to create, save, load, and modify 3D geometries.



Using a representation method…

- A physical object can be measured and its shape can be represented as a geometric model on the computer.
- The shape of a non-existing object can be created directly on the computer and represented as a geometric model.



Three major types of representation methods are…

- Surface models
- Solid models
- Volume models

Why do we need multiple types of representation methods?

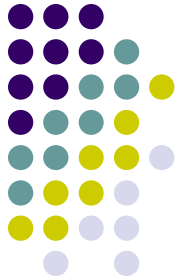
It is because each type has advantages and disadvantages. You need to select the most appropriate model type, depending on your purposes and applications.

Each model (i.e., representation method) requires different modeling, manipulation, and rendering techniques.

Models/Applications

Type of 3D models	Example of applications
Surface models	Computer animation
Solid models	Engineering, manufacturing, computer aided design (CAD)
Volume models	Scientific visualization, medical visualization

For instance…



- When an architect pre-visualizes the exterior of a building under consideration for a customer,

  surface models may be appropriate to use.
- When an architect wants to predict the stress on a structure constructed with a new material,

  solid models may be used.
- When an architect simulates the effect of dust of varying density on lighting in a room,

  a volume model is probably the most appropriate.

Intuitively…

- A a volume model represents…

  the contents and shell of an egg.

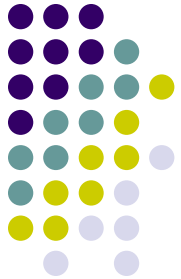
- A solid model represents…

  the complete egg shell and the space enclosed by the shell.

- A surface model represents…

  a fraction of the egg shell or the complete shell.

Surface vs. Solid



- Surface models can represent a surface that encloses a finite amount of space (volume) and a surface that does not enclose a finite amount of space. The former is called a **closed surface**, the latter is an **open surface**.
- Solid models always represent surfaces that enclose finite volumes, i.e., closed surfaces.

Solid vs. Volume

- Solid models always have **crisp** surfaces.

Vs. Volume models can have **fuzzy** surfaces and can represent fuzzy stuff, e.g., smokes and clouds.

- The interior of a solid model is always considered **homogeneous**.

Vs. The interior of a volume model can be **inhomogeneous**.