



Shape Matching and Retrieval

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Content-based 3D Shape Retrieval

- Huge amount of 3D shape models available on the internet and domain-specific databases
- Creating a model from scratch takes much time
- Text-based searching does not work in many cases

Terminology

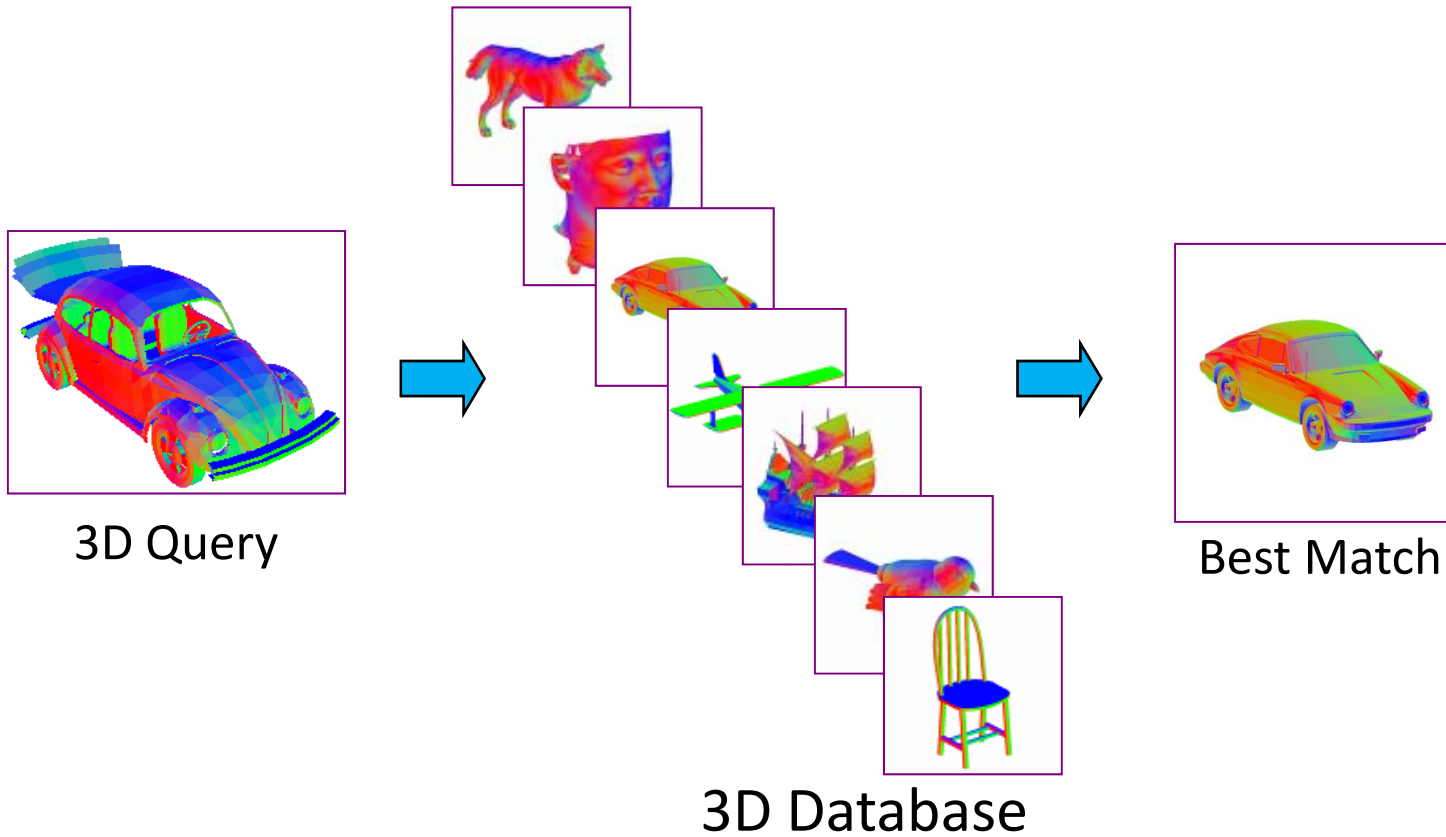
- Matching: given two 3D shapes A and B determine their similarity
 - → dissimilarity measures
- Retrieval: given a query object and a database of models find the most similar ones
 - → indexing, build a data structure to speed up the search

Shape Matching

- How similar do they look?



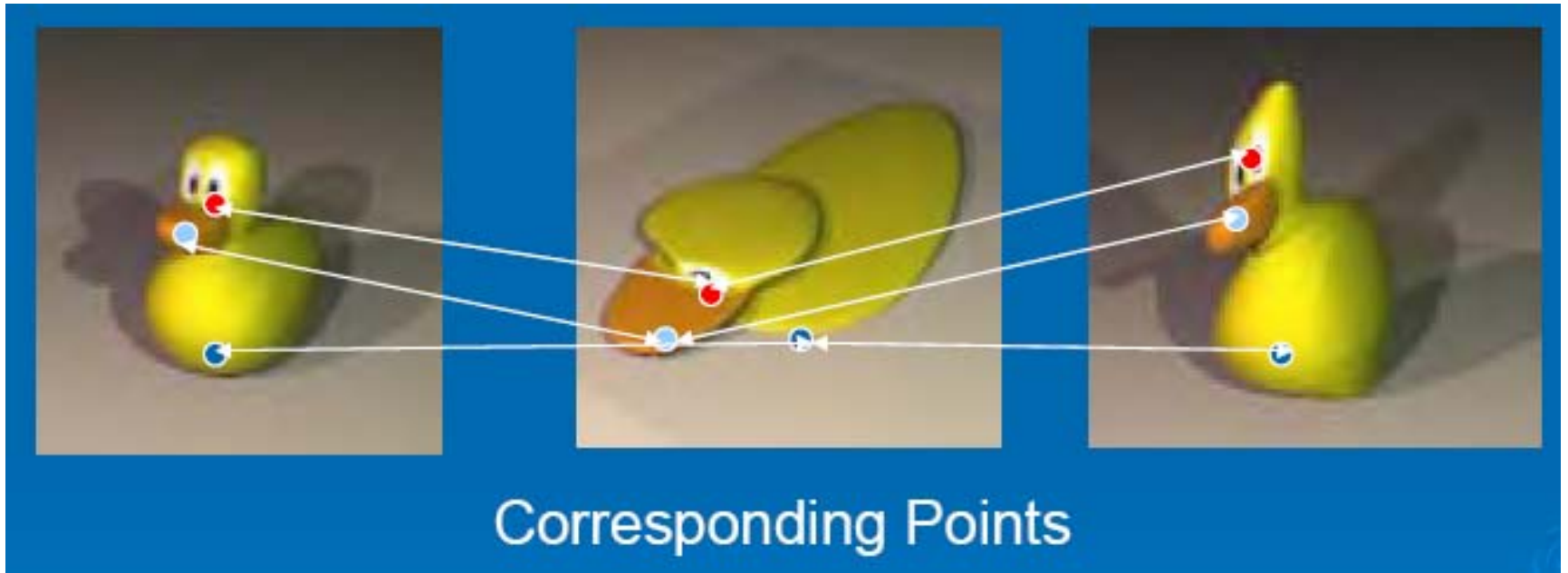
Shape Retrieval



Applications

- Retrieval
- Recognition and classification
- Registration (Alignment)
- Morphing and deformation
- Approximation

Deformation and morphing



Recognition

- Chinese characters

好 → 好

- Fingerprints



5. Loop.



6. Central pocket loop.

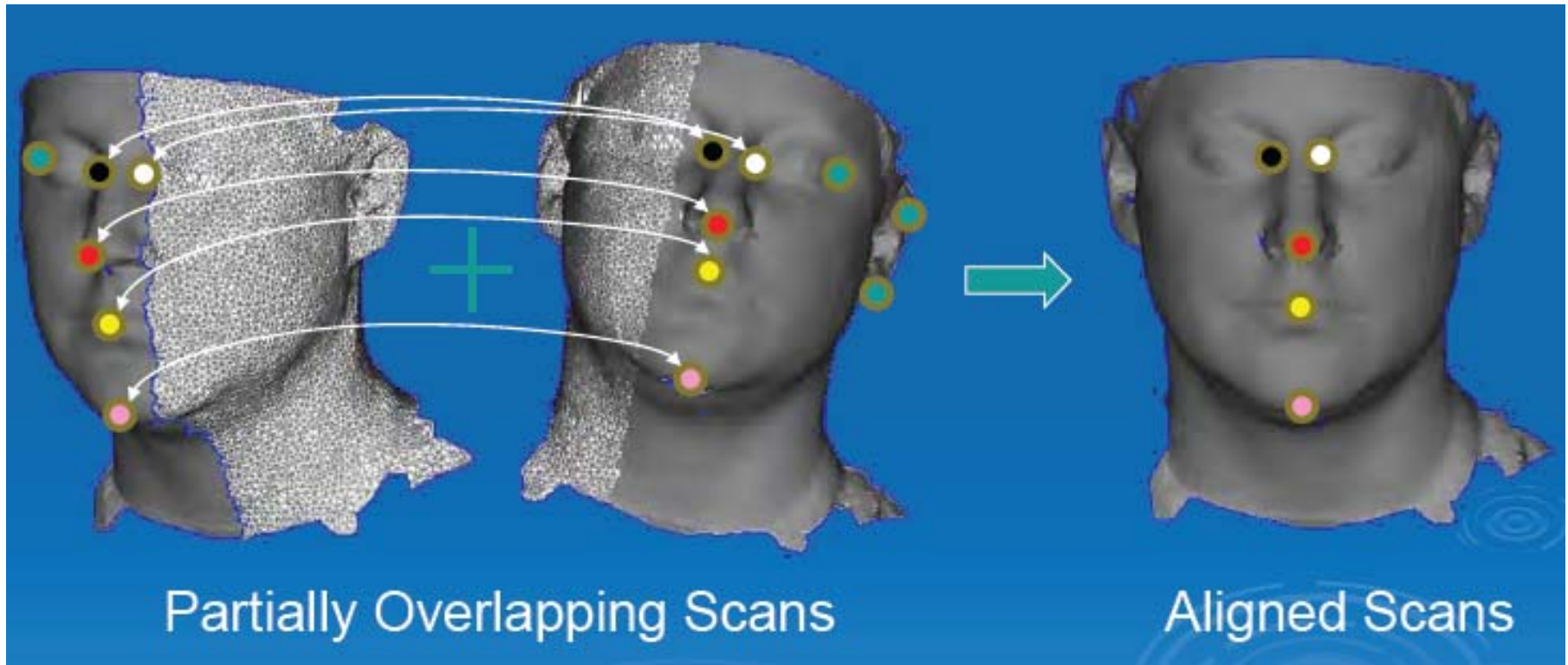


7. Plain whorl.

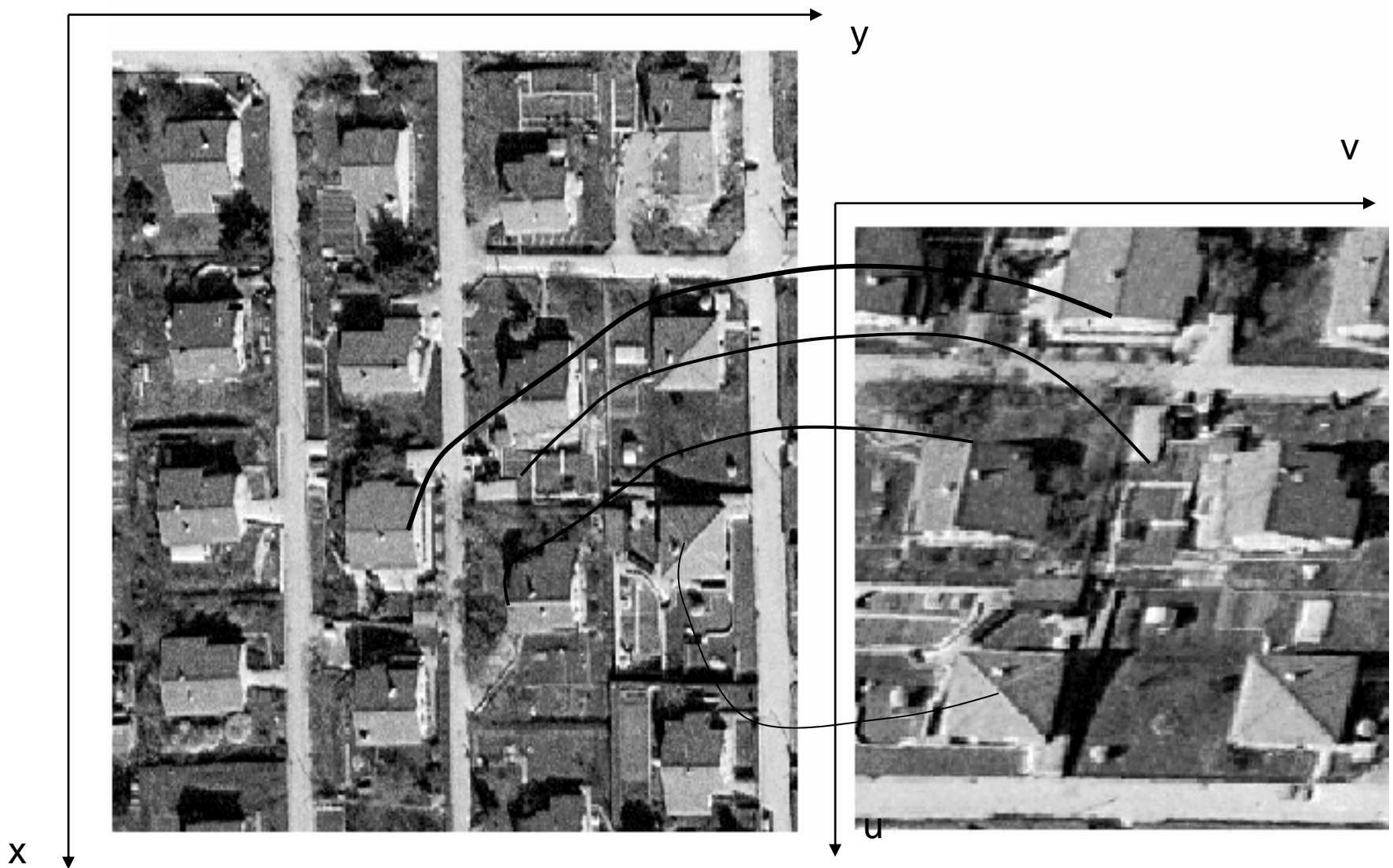


8. Double loop.

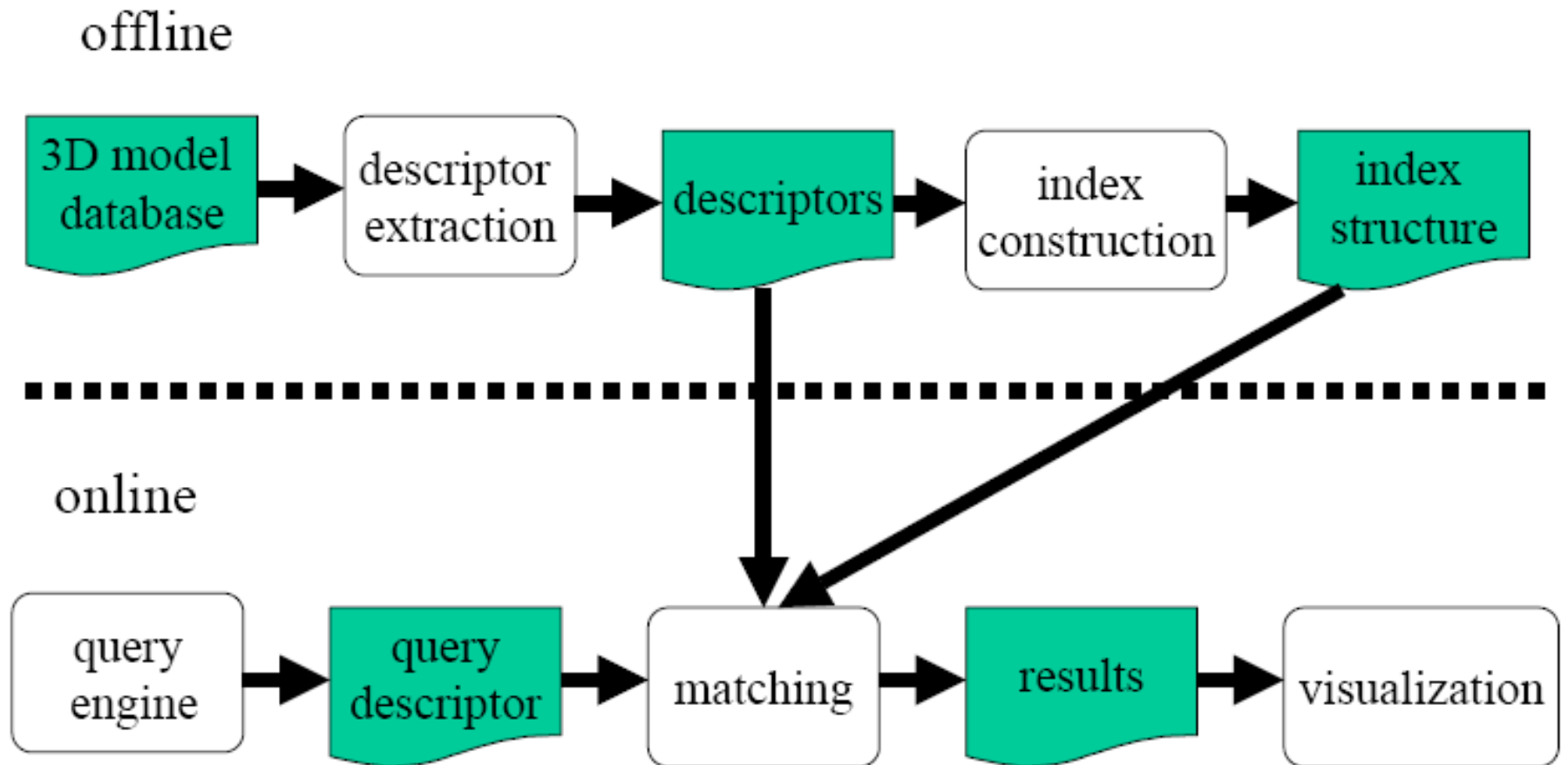
Registration



Registering Image ${}^1I_{t1}$ to ${}^2I_{t2}$



Conceptual Framework



Normalization

- Normalize for size by scaling
- Normalize for translation by moving the center of mass of a model to the origin
 - Or use a translation-invariant descriptor
- Normalize for rotation by aligning the principal axes of a model to the x-, y-and z-axes
 - Or use a rotation-invariant descriptor

3D shape retrieval aspects

- Efficiency
- Discriminative power
- Partial matching
- Robustness

Methods

- Explicit Methods
- Topology Based Methods
- Shape Descriptors

1. Explicit Method

ICP Algorithm

(Iterative Closest Point Algorithm)

[Besl & McKay 1992]

- Inputs
 - points from two raw scans, initial estimation of the transformation, criteria for stopping the iteration.
- Output
 - refined transformation
- Steps
 - Associate points by the nearest neighbor criteria
 - Estimate transformation parameters using a mean square cost function
 - Transform the points using the estimated parameters
 - Iterate (re-associate the points and so on)

Cons

- The establishing of correspondences is difficult
- Performances pair-of of-models basis is time consuming
- Can not be used for the retrieval of models from large databases in runtime

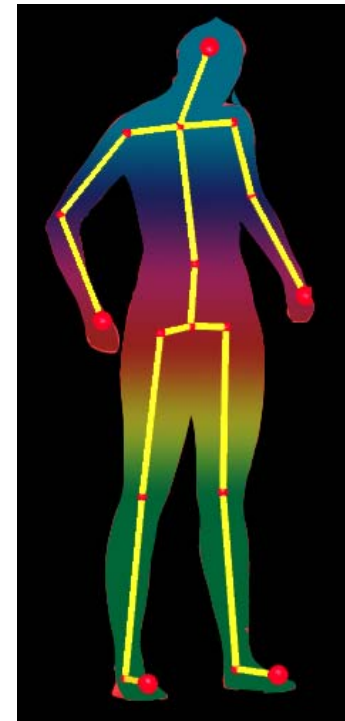
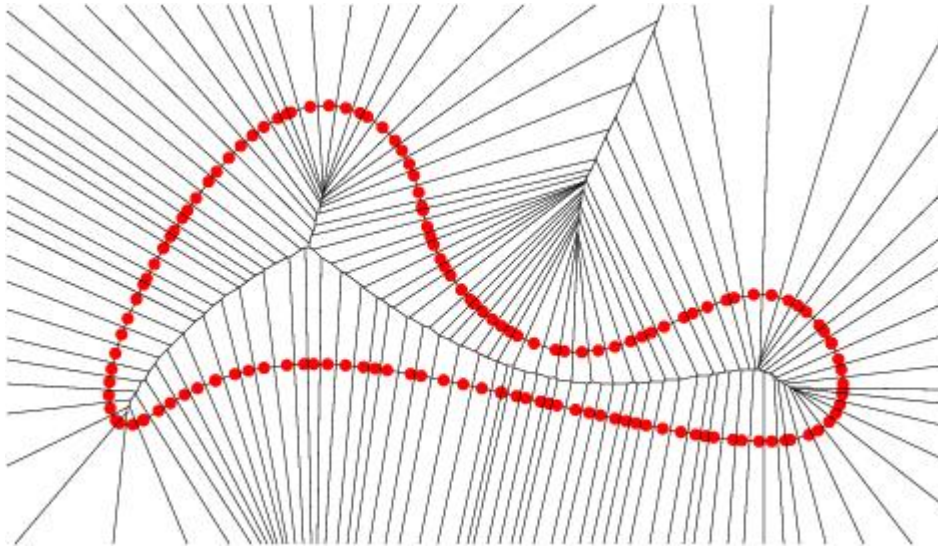
2. Topology-based Methods

Types

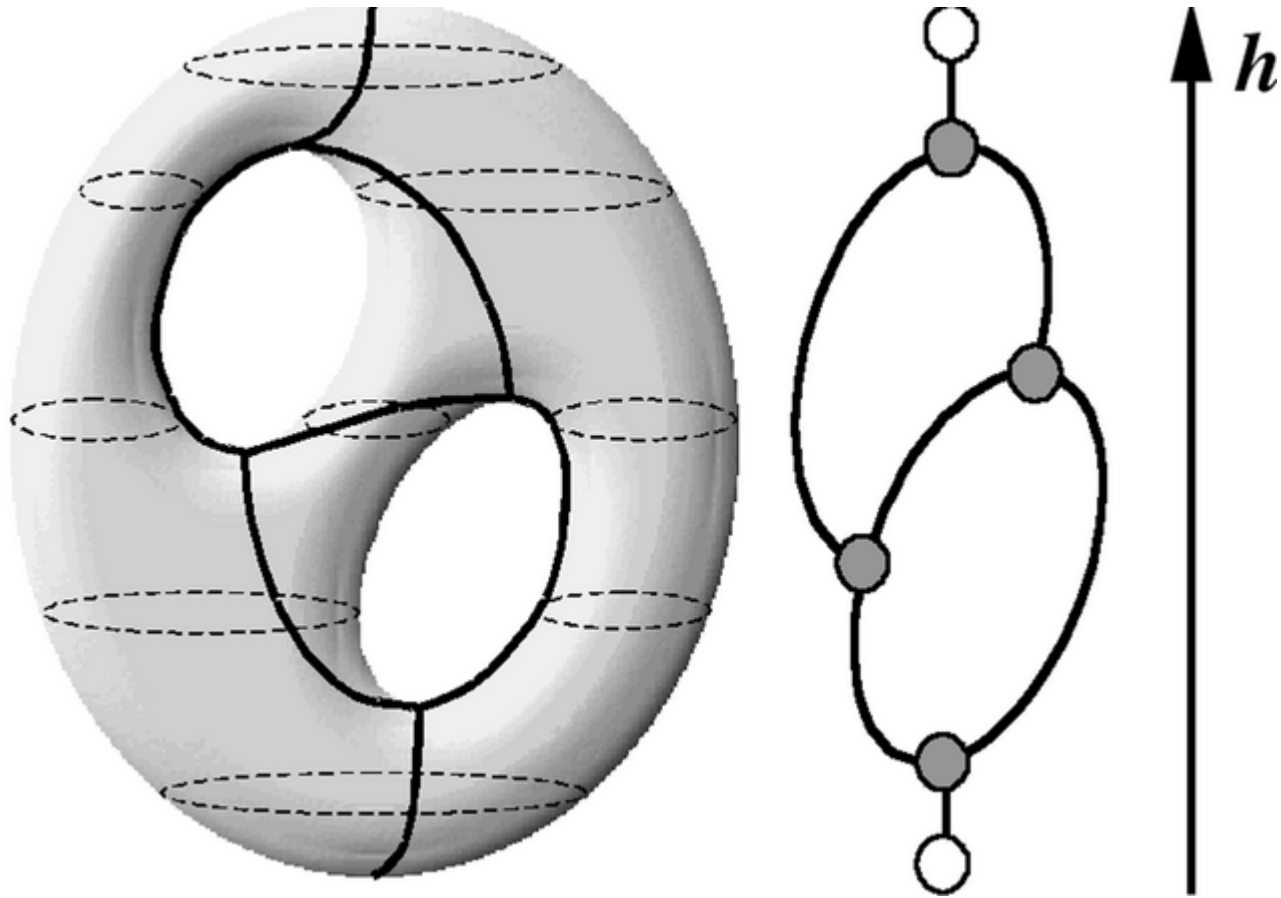
- Skeleton based similarity
- Reeb graph based similarity
- ...

Skeleton

- Medial axis



Reeb Graph



3. Shape Descriptor

See more detail in
“Shape Descriptor.ppt”

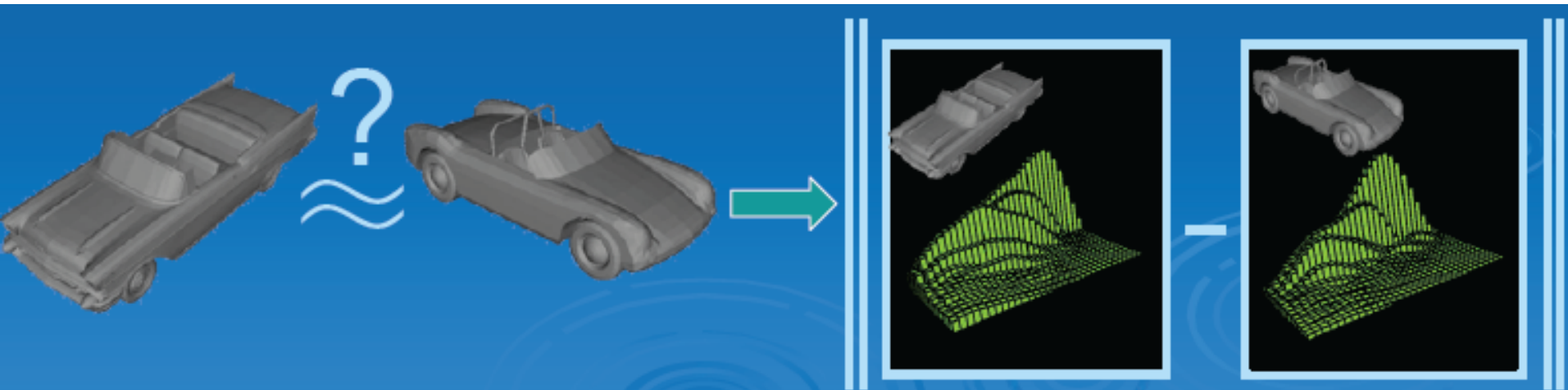
Shape Descriptor

- Structured abstraction of a 3D model
- Capturing salient shape information



Approach

- Represent each model by a shape descriptor
- Compare shapes by comparing their shape descriptor

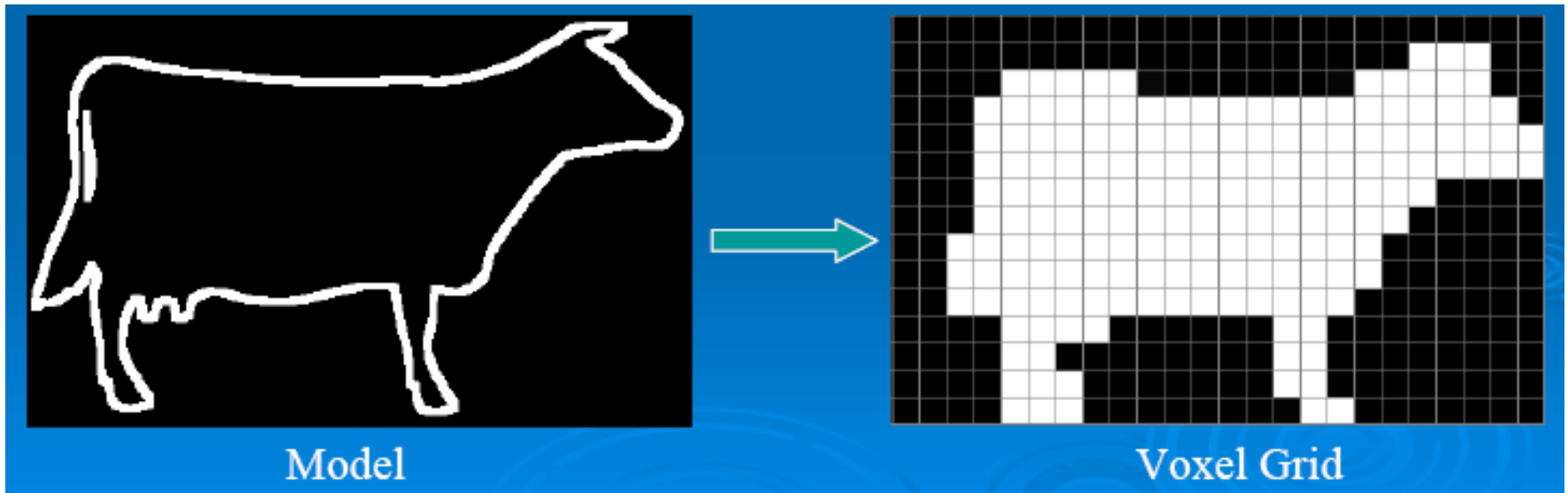


Shape descriptors

- Volumetric Representations
- Surface Representations
- View-Based Representations

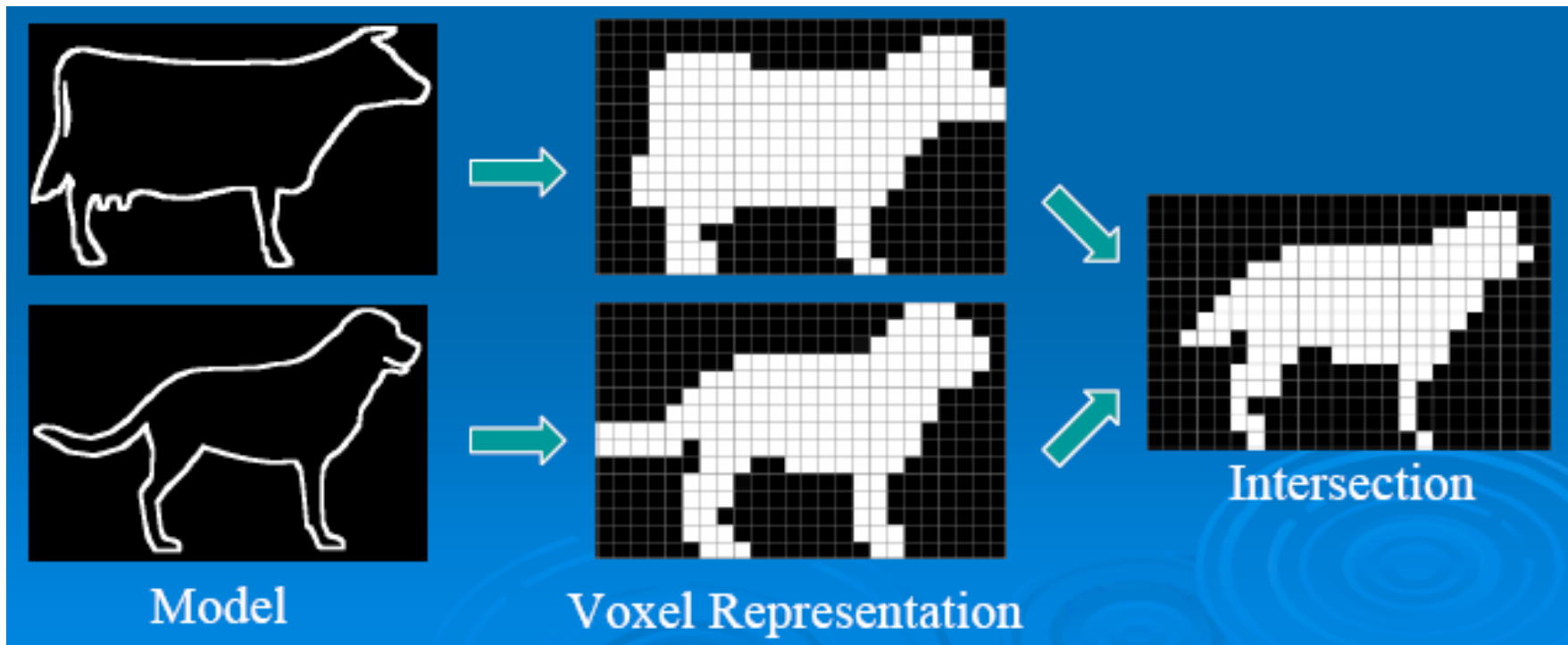
Volumetric Representation

- 1/0 voxels

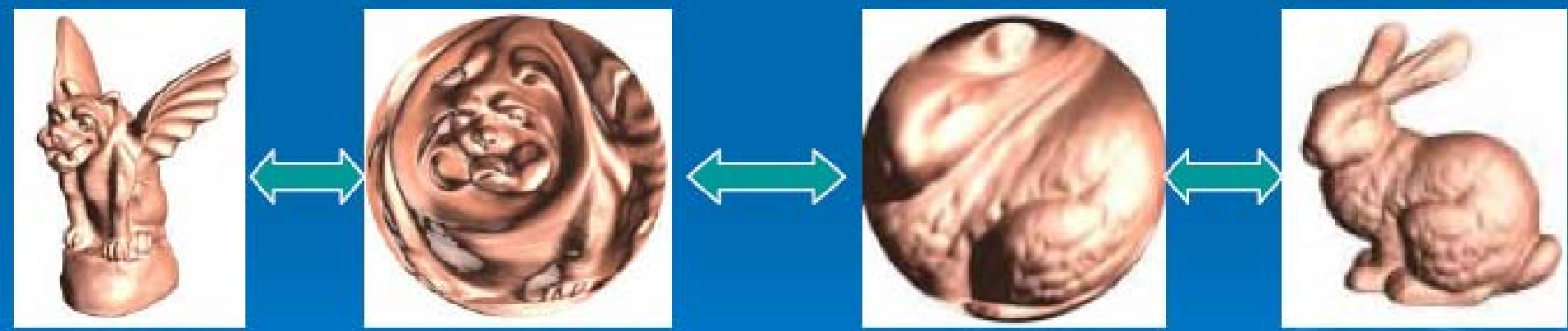


Volumetric Representation

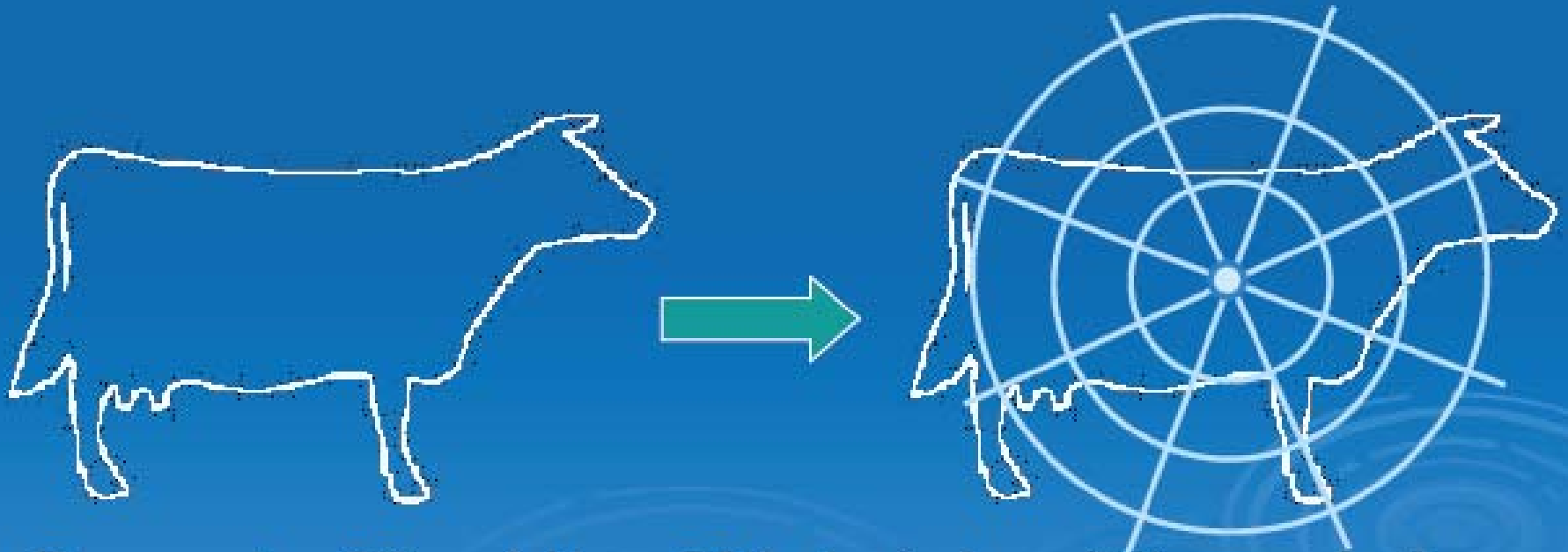
- By measuring the overlaps of volumes



Spherical Parameterization

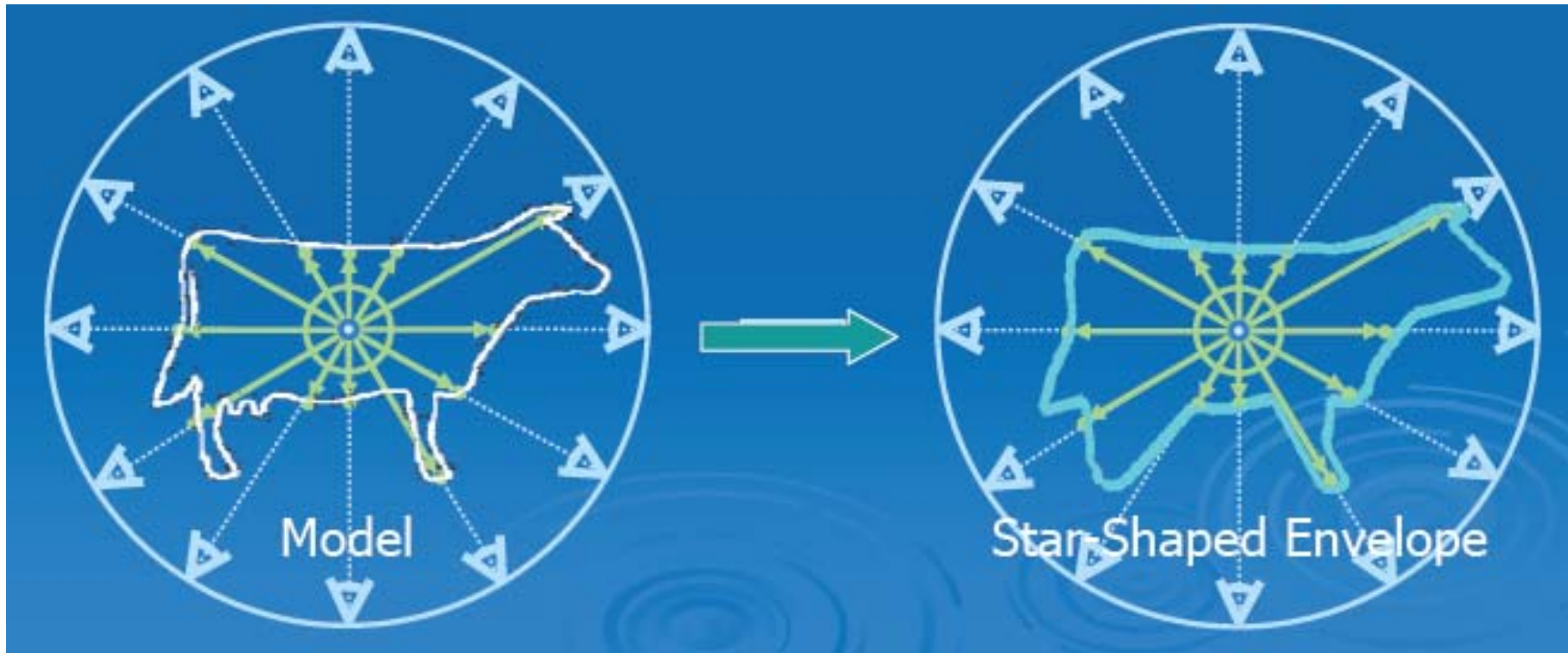


Shape Histograms

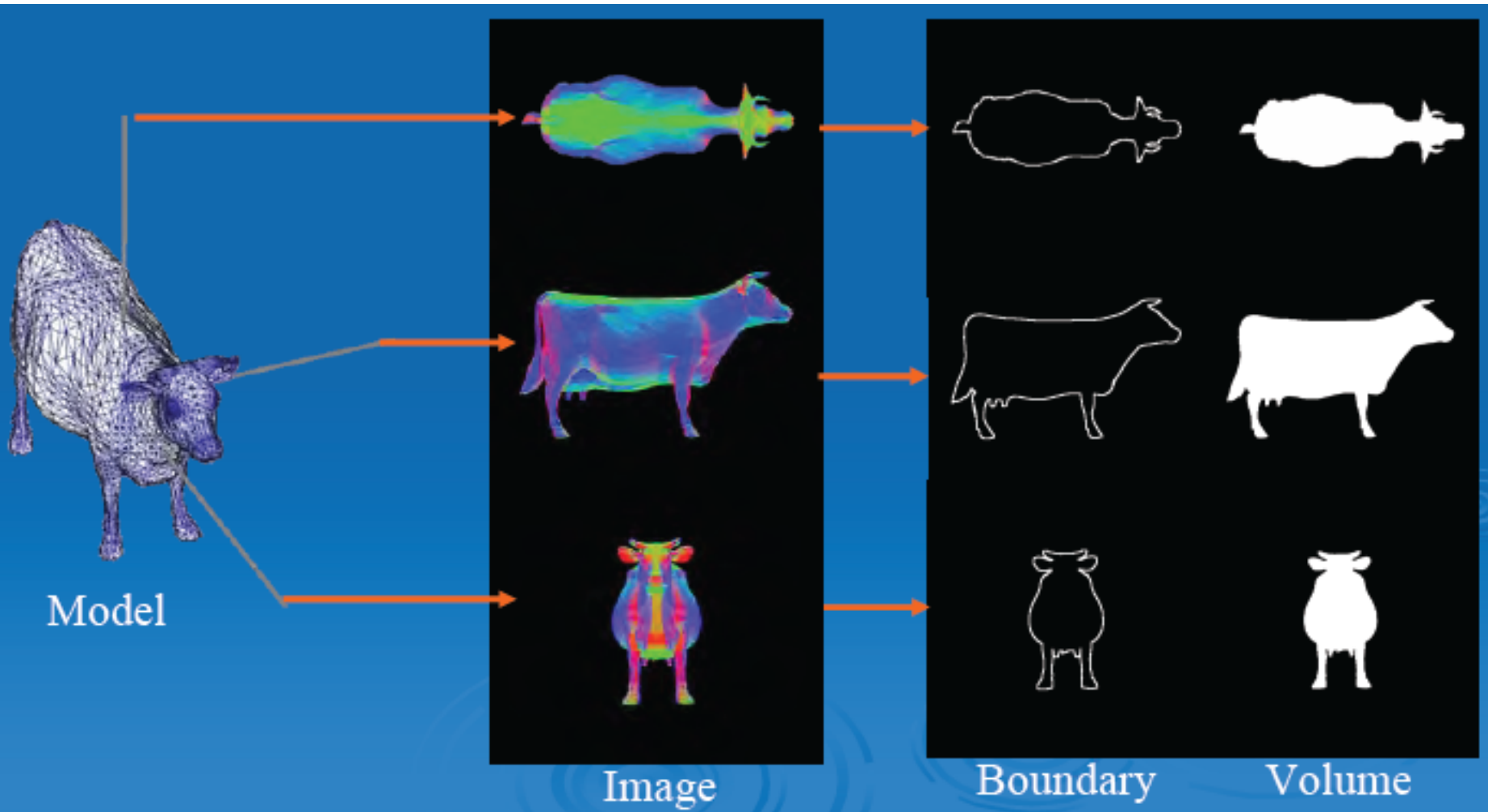


Represents a 3D model by a 3D (spherical x radial) array of values

Spherical Extent Function



Light Field Descriptor



Recap

- Very hot topic!
- Very useful
- Trend...

Discussion