Survey of Geometric Methods for Modeling of Virtual Vegetation

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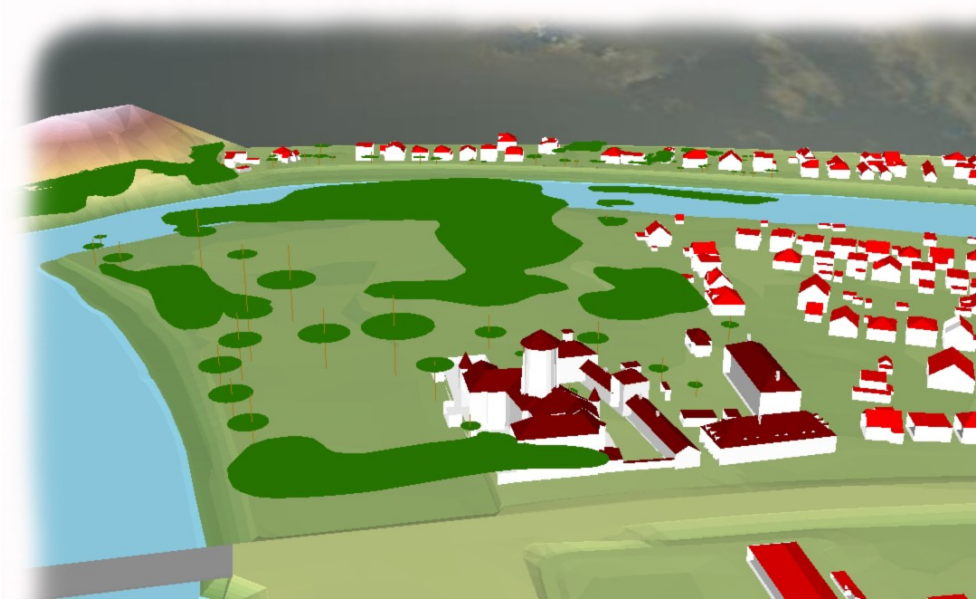
Motivation

- Geometric methods for tree modeling
- Realistic representation of trunks and branches
- Difficulty to define exact representation of branch junctions

- Reconstruction of trees in virtual city, parks

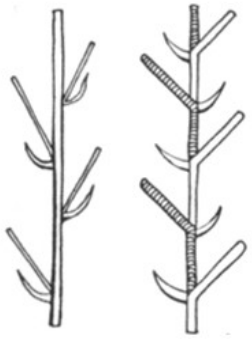


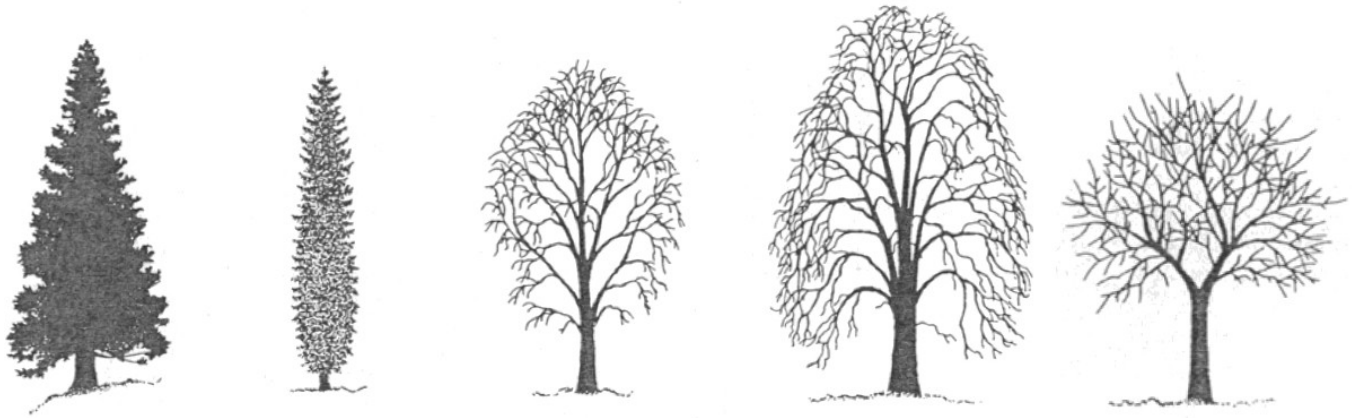
Content

- Botanical representation
- Geometric representation
  - Detailed
    - Geometry of branches
  - Global
  - Multiscale
- Approaches to plant modeling
- Conclusion

Botanical Representation

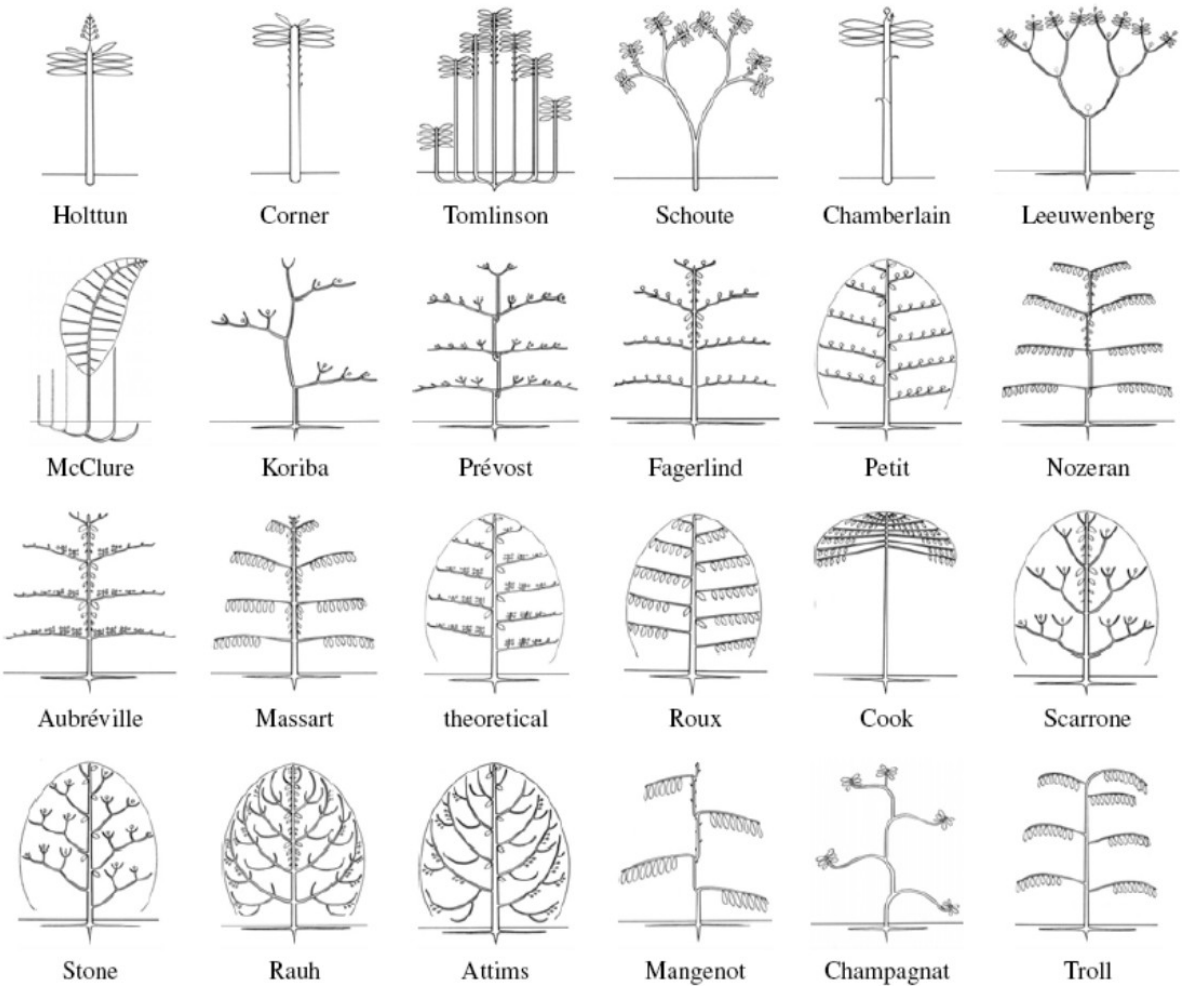
- Tree – trunk, crown (branches, leaves)
- Global characteristics
  - Acrotonic branching pattern (trees)
  - Basitonic branching pattern (shrubs)
  - Mesotonic branching pattern
- Local characteristics
  - Monopodial branching type
  - Sympodial branching type



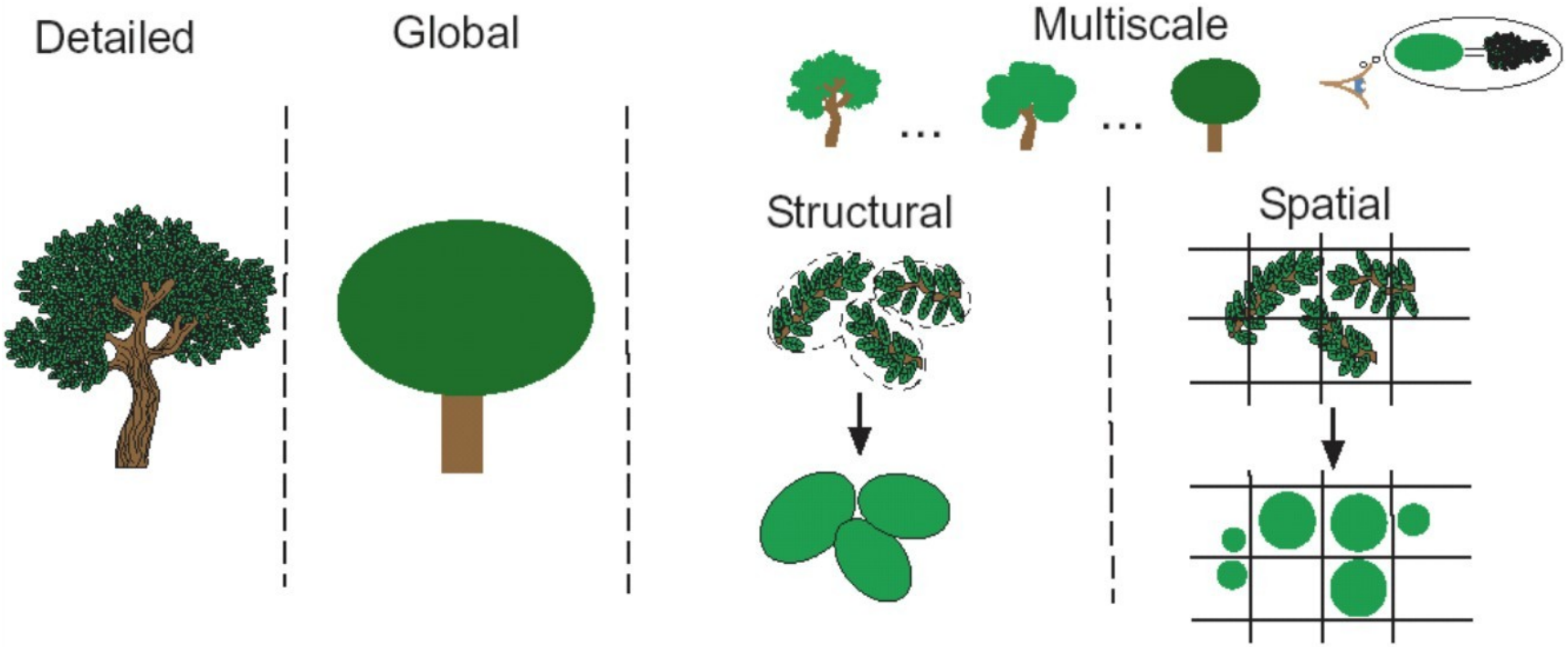


Architectural Models

- 23 (24) tree architecture models (Hallé, Oldeman & Tomlinson, 1978)

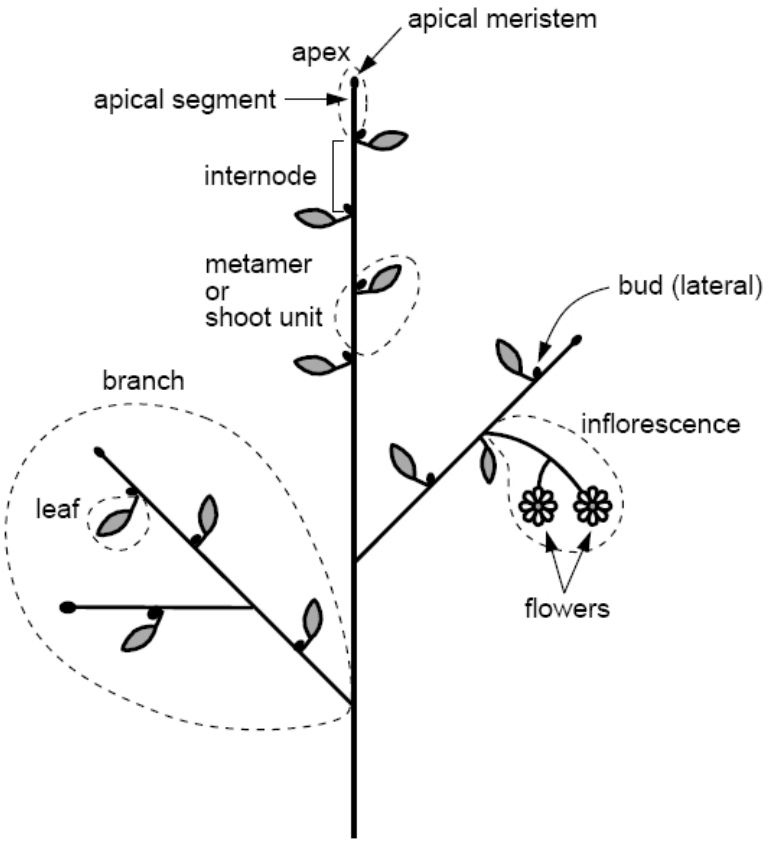


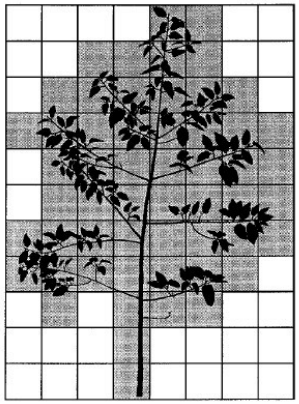
Geometric Representation

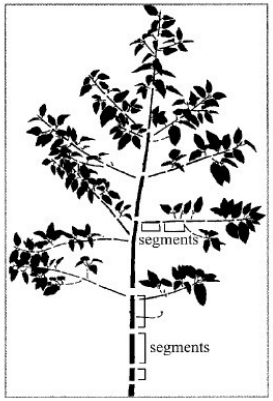


Detailed Representation

- Modular structure of plants
  - Spatial decomposition
  - Organ-based decomposition
    - Geometrical decomposition
    - Topological decomposition

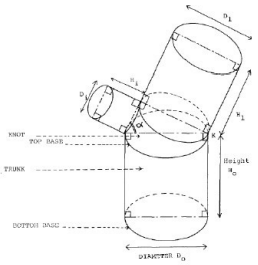
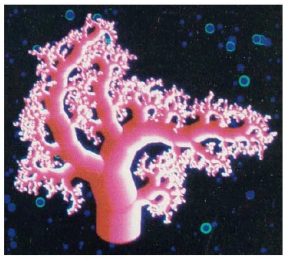




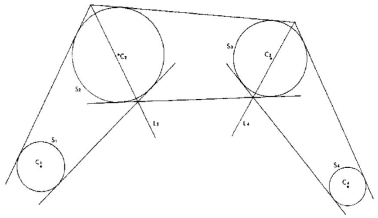


Geometry of Branches

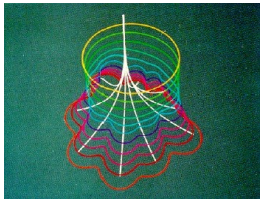
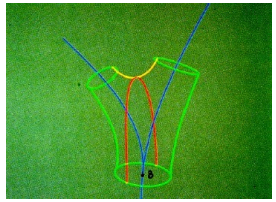
- 3D cylinders

- Cone-sphere




- Generalized cylinders

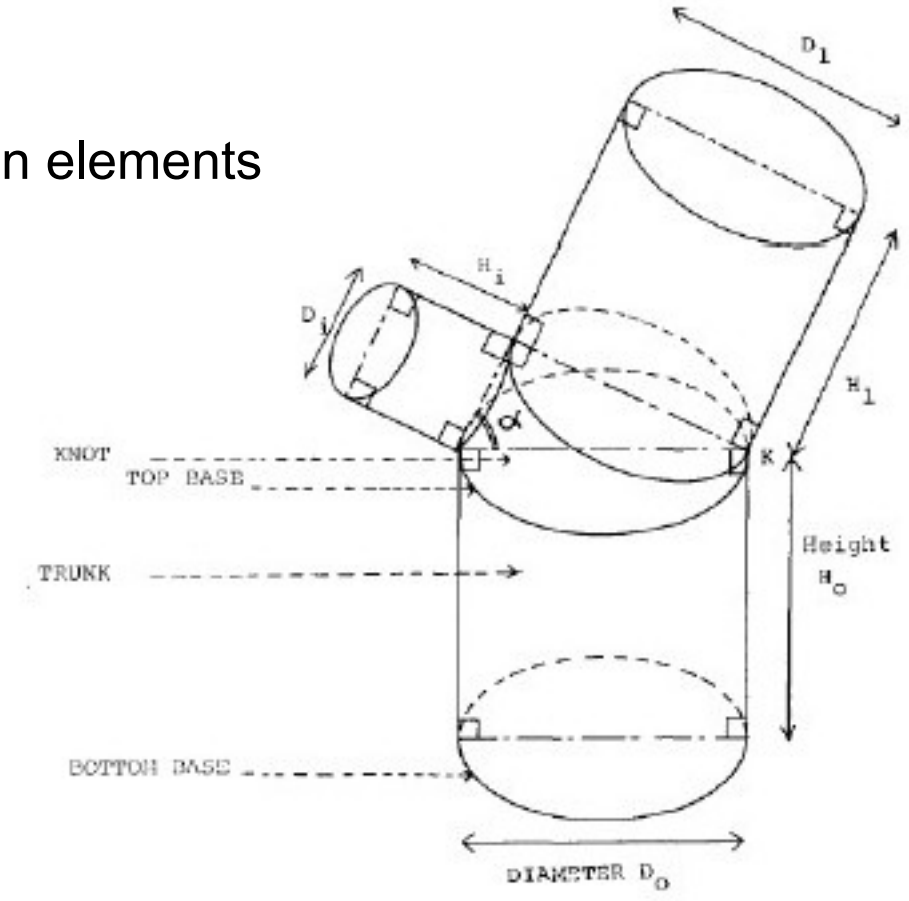




- Implicit surfaces


- Subdivision surfaces

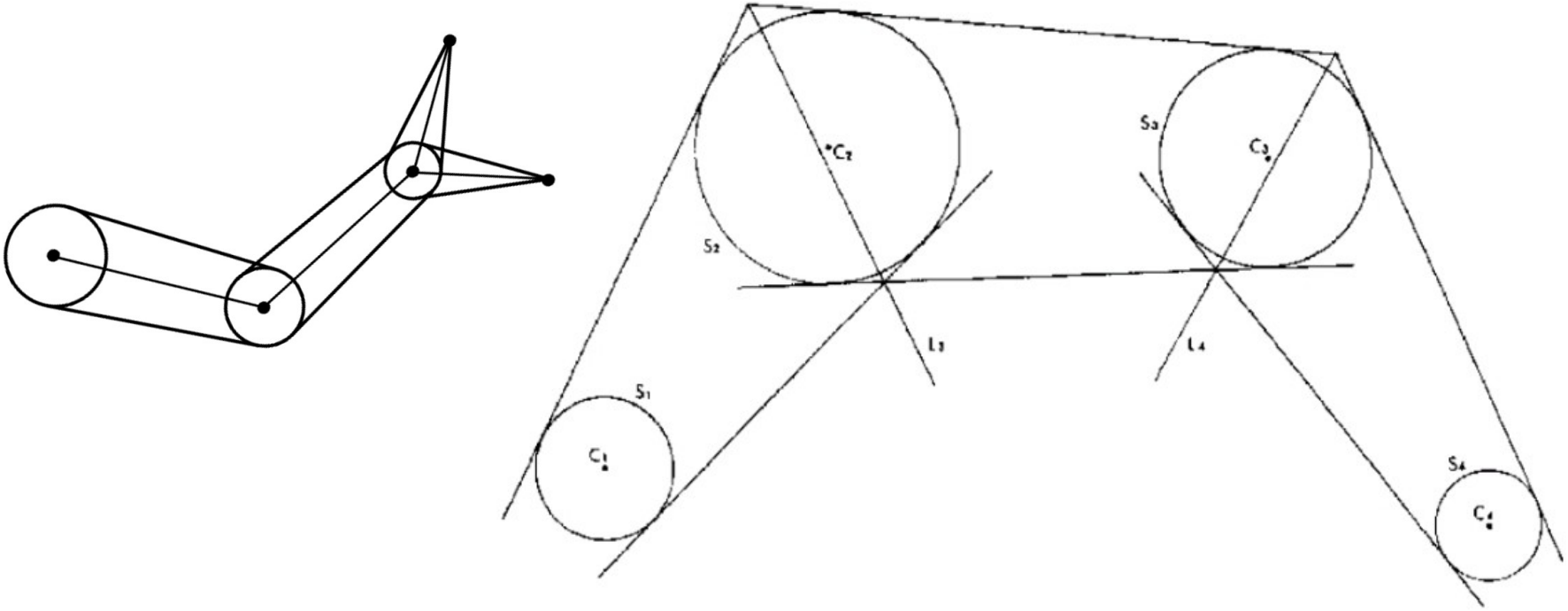
3D Cylinders

- Branch segments as cylinders with different diameter and height
- Rules of generating model
- Gaps or discontinuities between elements



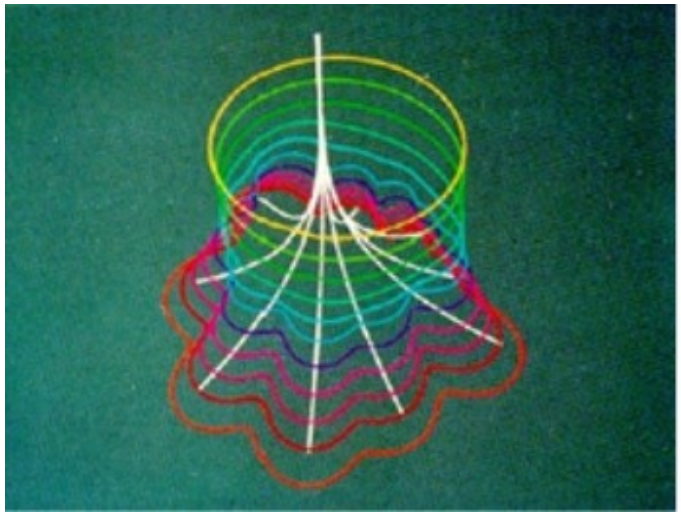
Cone-Sphere

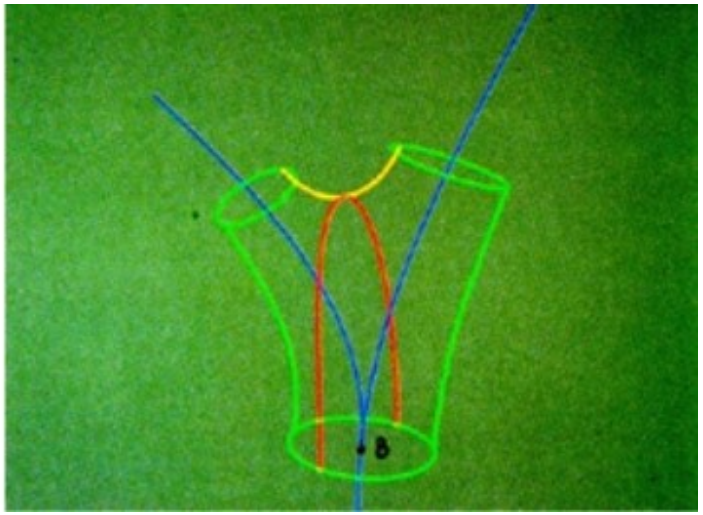
- Consists of two spheres, together with the part of the cylinder or cone tangent to the two spheres and lying between them
- Discontinuities at the inner side of the elbow
- Blending method; helps for individual limbs, not for branching points



Generalized Cylinders

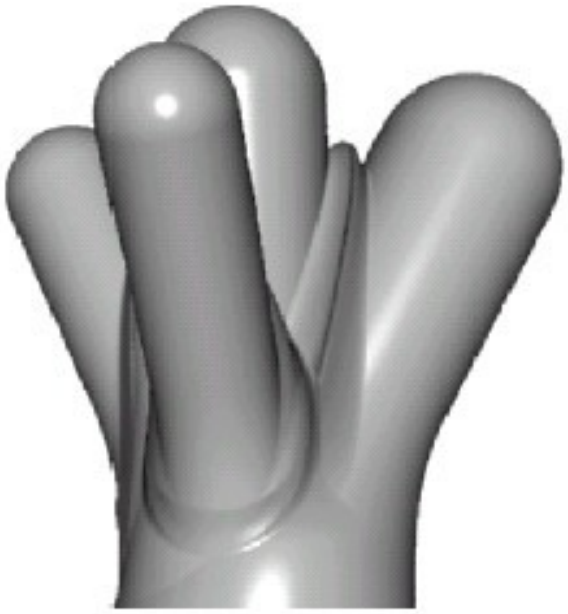
- Trees – 3D points and their connections
- Limbs – generalized cylinders represented as space curves that interpolate the points (axes) and cross sectional contours perpendicular to the curve
- Trunks – non-circular cross sections
- Surface – created by connecting circular disks





Implicit Surfaces

- Used for modeling smoothly blending branching structures
- Non-smooth features as branch bark ridges, bud scale scars
- Process all branching structures regardless of their complexity
- Computationally expensive

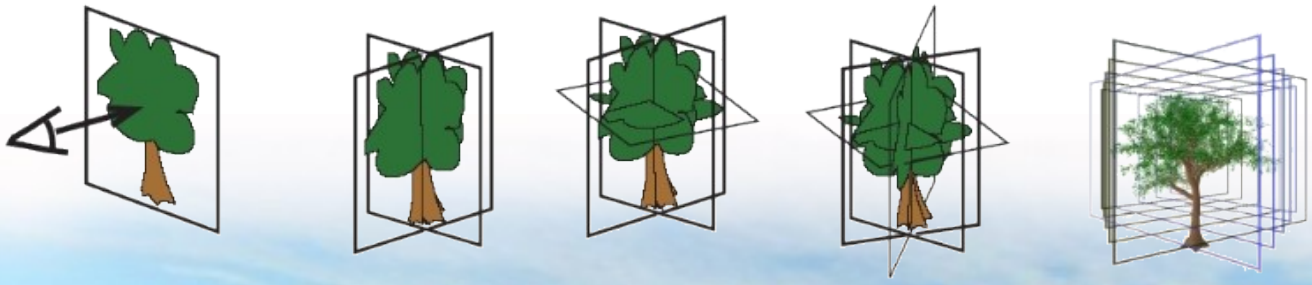


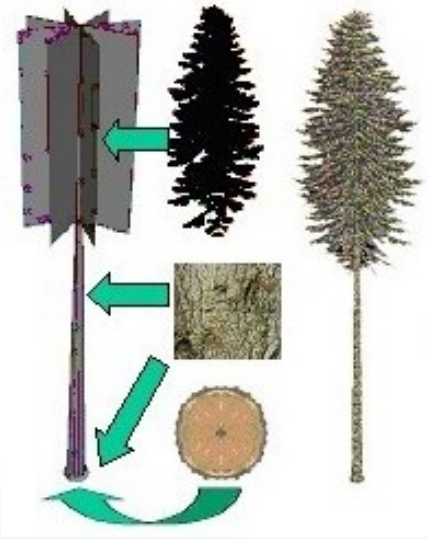
Subdivision Surfaces

- Smooth surfaces
- Mesh build by recursively refining an initial coarse surface
- Rule based mesh growing system as an extension of parametric L-systems where each parametrized symbol represent the face of the mesh
- Multi-resolution technique
- Difficult to create initial subdivision mesh

Global Representation

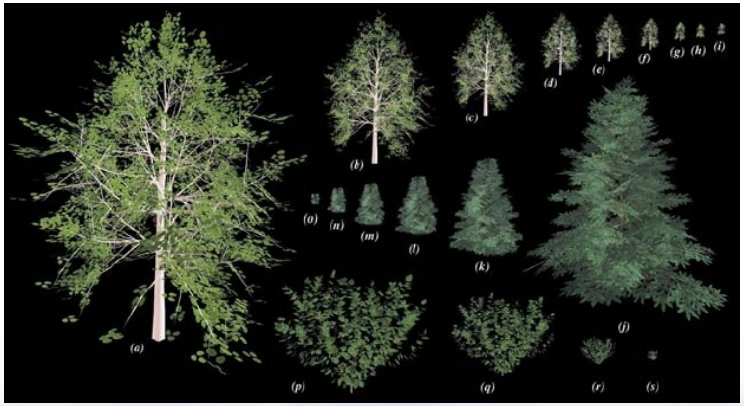
- Lowest level of complexity
- Trees considered as a whole, represented with a single or few primitives
- Adapted for distant views





Multiscale Representation

- Representation with adaptive complexities, LOD
- Multiscale hierarchy based on structure or spatial representation of trees

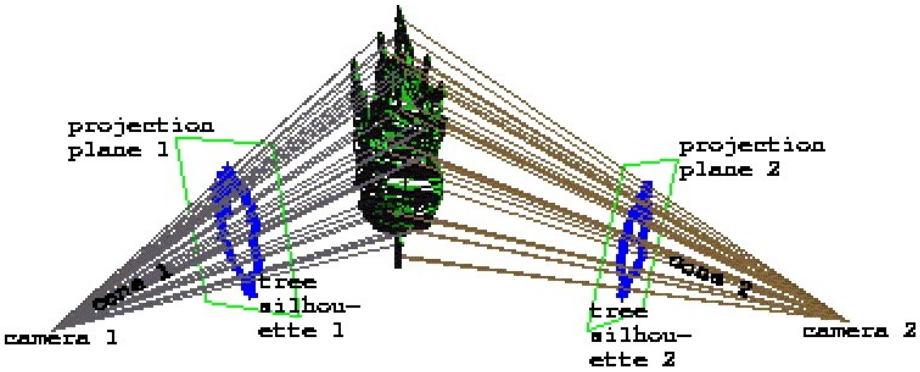


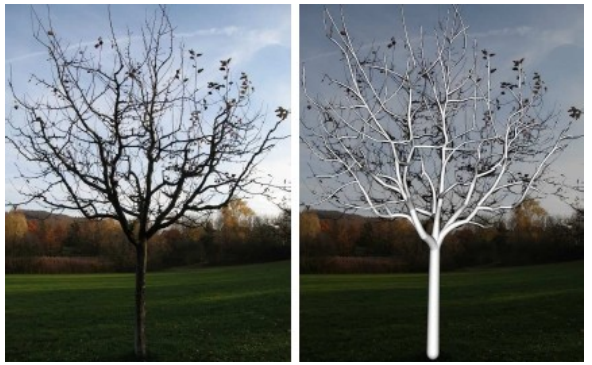
Approaches to Plant Modeling

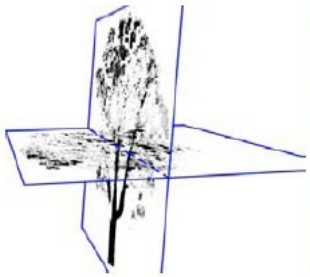
- Rule-based
  - L-systems (Kurth, 1994, Prusinkiewicz et al., 1990)
  - Geometric rules (Weber et al., 1995)
  - Botanical rules (De Reffye et al., 1988)

Approaches to Plant Modeling

- Image-based
  - Visual hull (Sakaguchi et al., 1999, Shlyakhter et al., 2001)
  - Volumetric approach (Reche et al., 2004)
  - Photogrammetry (Tan et al., 2007, Quan et al., 2006)

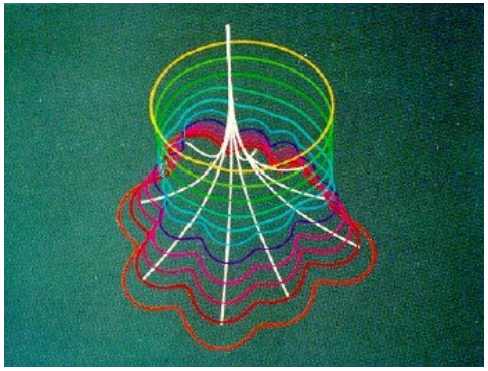
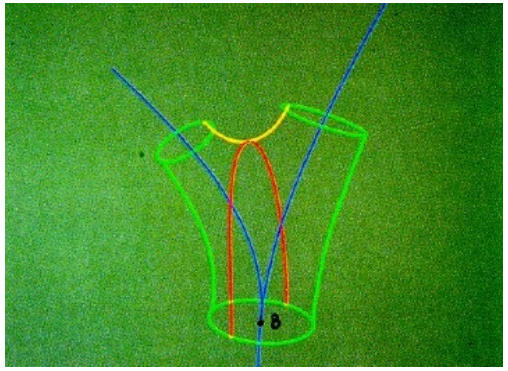






Conclusion

- Several geometric methods for modeling of branching structures of trees
- Continuous model from a discrete set of geometric primitives
- Realistic representation of trunk and branches
- Representation of branch junctions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Thank you for your attention.

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