Rendering Natural Scenes with Generalized Object Instancing

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Why the Outdoors?

- Great beauty
- Geometric and material complexity
- Many modes of light transport
- Challenging to many classic algorithms

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College of Agricultural Sciences

Evaluating Rendering Algorithms

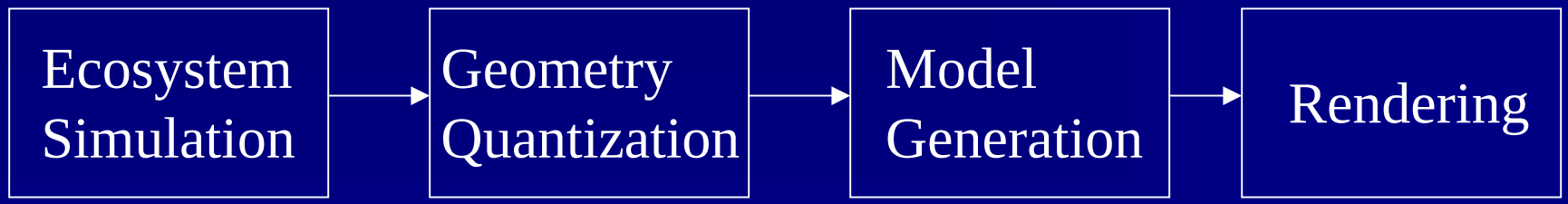
- Geometric Complexity
  - Millions of primitives
- Material Complexity
  - BRDFs and many texture maps
- Illumination Complexity
  - Multiple scattering, atmospheric effects

IBR?

- Acquisition is difficult
  - Complex visibility, translucency
- Close up views?
- If synthetic scene, must render anyway

Progress in Modeling

- Ecosystems with tens of thousands of plants
- Controlled levels of abstraction



Controlled Descent Into Complexity

- REYES
- Probabilistic rendering of particle systems

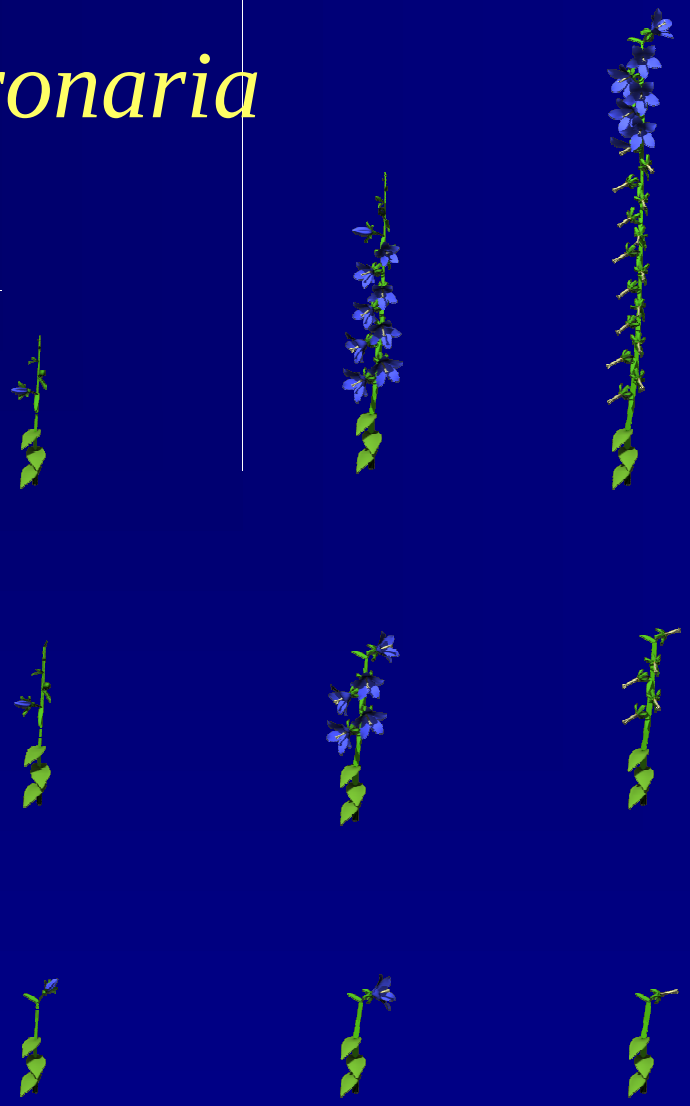
Generalized Instancing

- Lossy geometric compression
- Parametrized by more than transformation
  - shader
  - textures
- Opportunity for precomputation

Geometry Quantization

- A way to do lossy compression of geometry
- Quantize parameter space

Lychnis coronaria

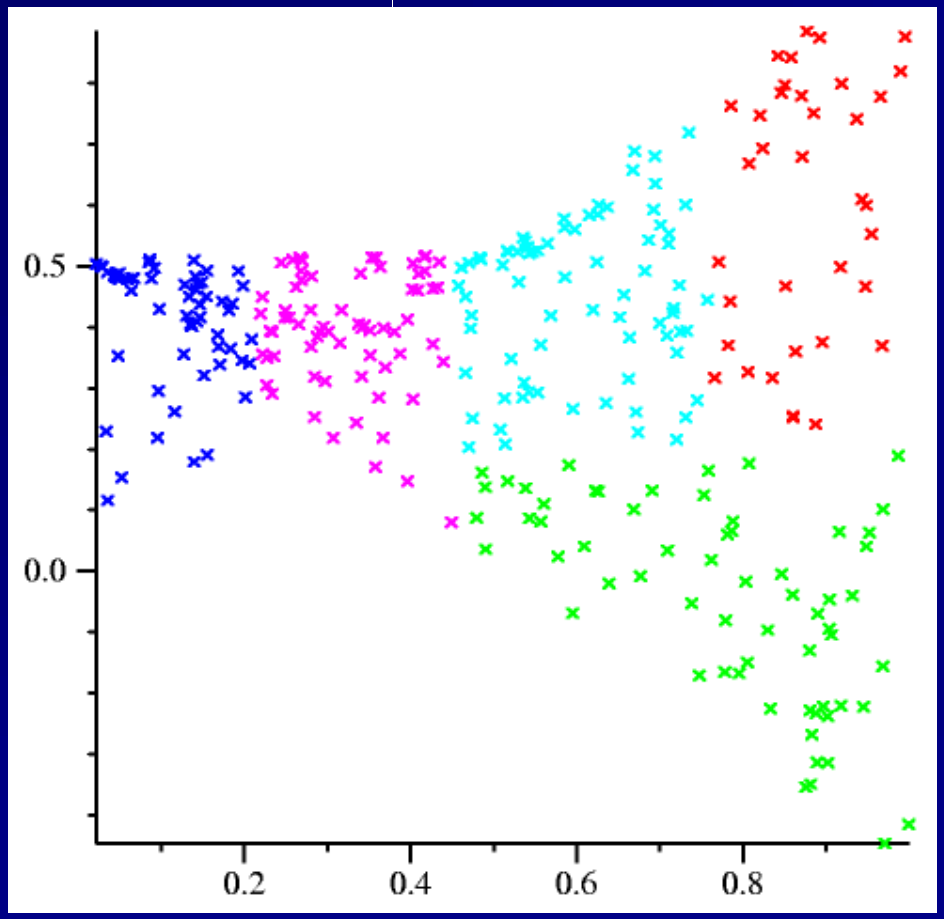


Vigor

Age

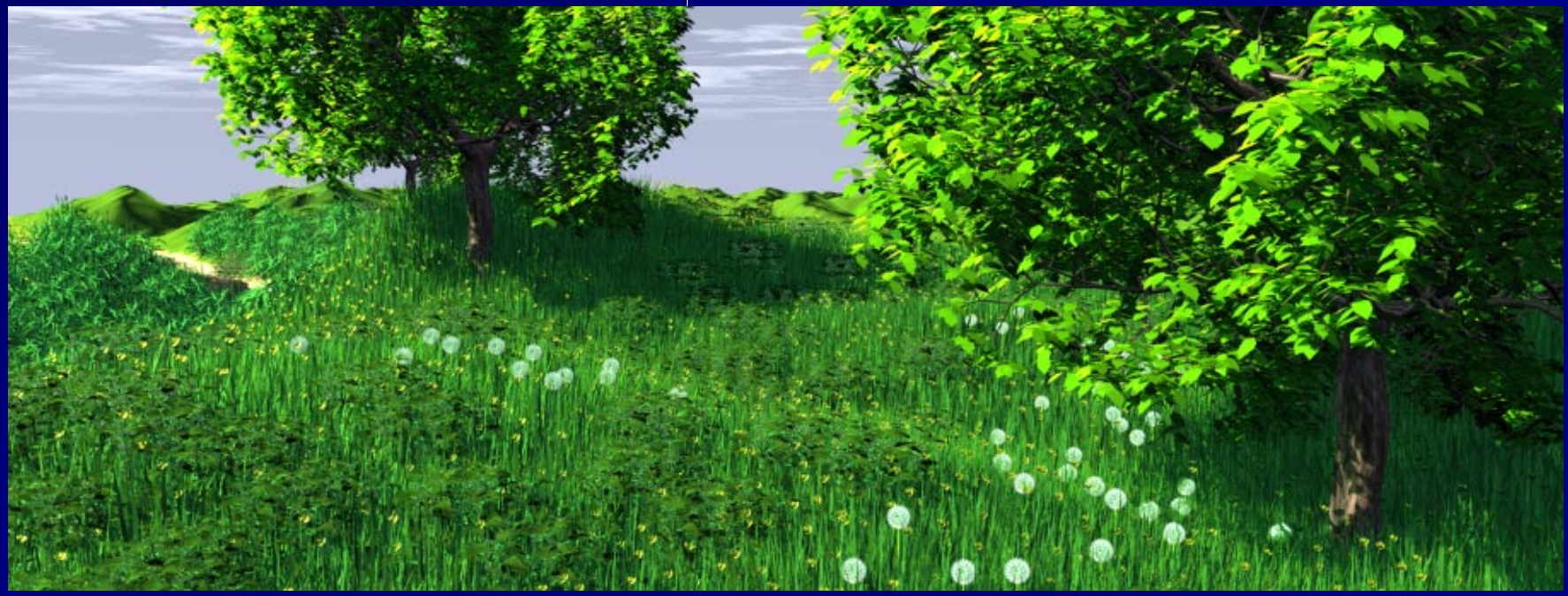
Sample Distribution

Vigor



Age

Result



17 Million triangles
8 hours to render
30,000 individual plants
Originally 580MB
15:1 compression

Problems: How Much Error?

- Some dimensions may be more important
- Non-linear effect of parameter changes
- Requires careful construction of L-system
- No accounting for neighbors

Possible Algorithm

- Register candidate models
  - Horn, Besl, Fisher, Turk & Levoy…
- Incorporate non-uniform scaling
- Ability to match sub-parts
- Include in error term:
  - Color/Material
  - Context

Implications

- Can lazily pick instances
- Satisfy error bound in perceptual space
- No need to modify L-systems, etc.
- Non-procedural models?

Instancing to manage complexity,
not just generate it

Challenges in Illumination

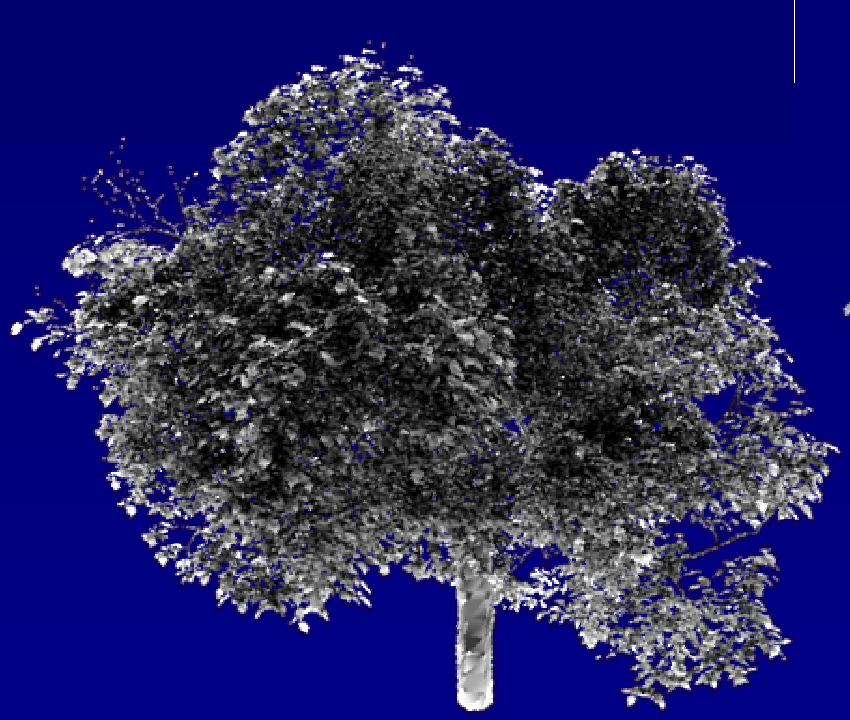
- Lighting and material model
- Making it efficient
  - Reeves/Blau, Max et al, Daubert et al, Patmore...

Precomputed Illumination

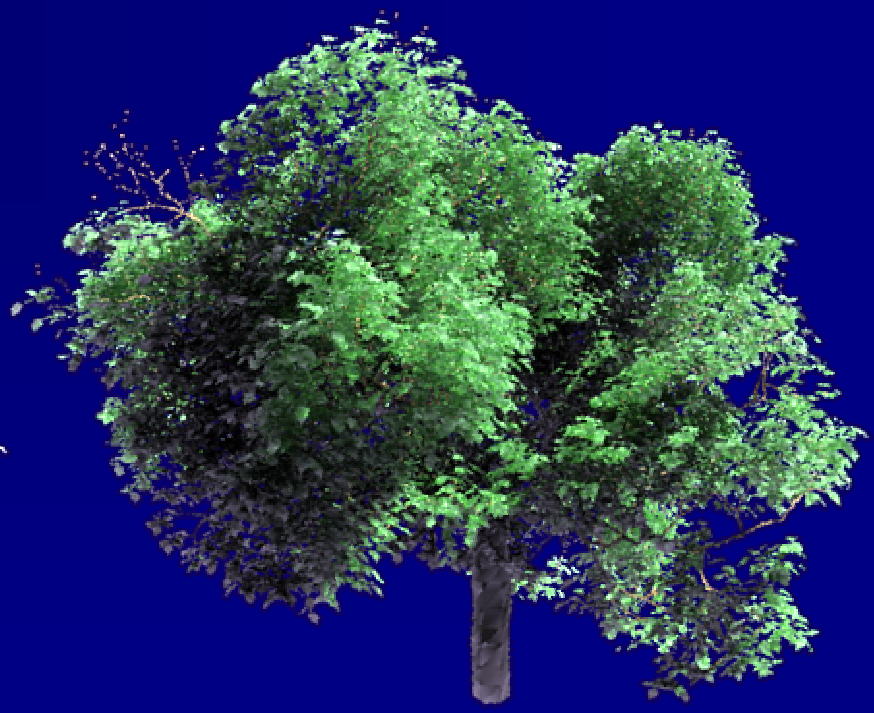
- Classic idea (shadow maps, …)
- Amortize over all uses of an instance
- Be independent of any lighting environment

Instance Independence

- Precomputed sky visibility



25 minutes



1.5 minutes

Other Possibilities

- Probabilistic shading parameters (Reeves/Blau)
- Leaf area index (Ross, Baldocchi, ...)
- Volumetric clusters (Sillion, Drettakis)

- Global accessibility (Miller)
- Basis-function lighting (Dorsey et al, …)

Conclusion

- Innovation in modeling is driving rendering
- Perceptual error metric for shape x BRDF?
- Fight the good fight to delay the onset of complexity

Acknowledgements

- Pat Hanrahan
- Przemek Prusinkiewicz, Radomir Mech, Oliver Deussen, Bernd Linterman