Introduction to rule-based modelling with GroIMP

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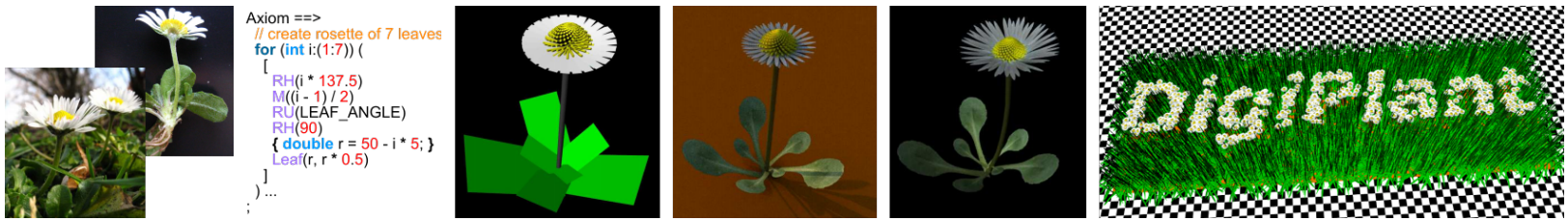
Georg-August University of Göttingen, Germany
Chair for Computer Graphics and Ecological Informatics

18.11.2010 / DigiPlant seminar, ECP, France



Outline

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GroIMP (open-source)

- **Gro**wth-grammar related **I**nteractive **M**odelling **P**latform
- Editable GUI, possible configuration:

Menu
Methods

3D Toolbar

3D View

Text Editor

File Explorer
Shaders
Charts
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XL Console
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Attribute Editor
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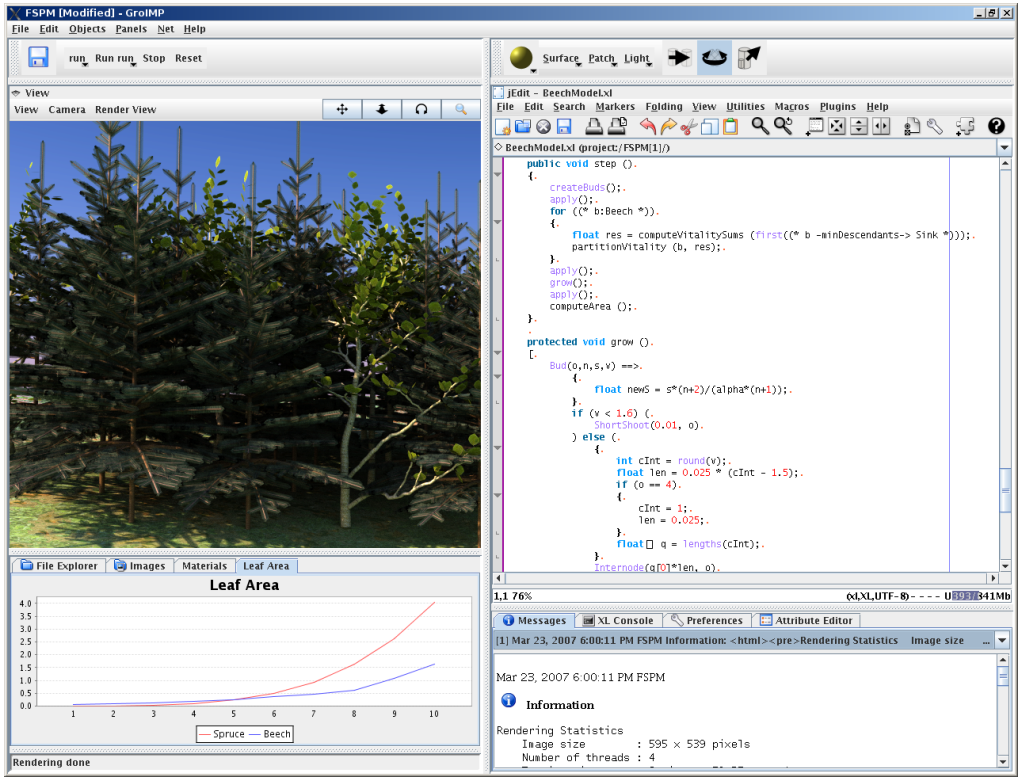

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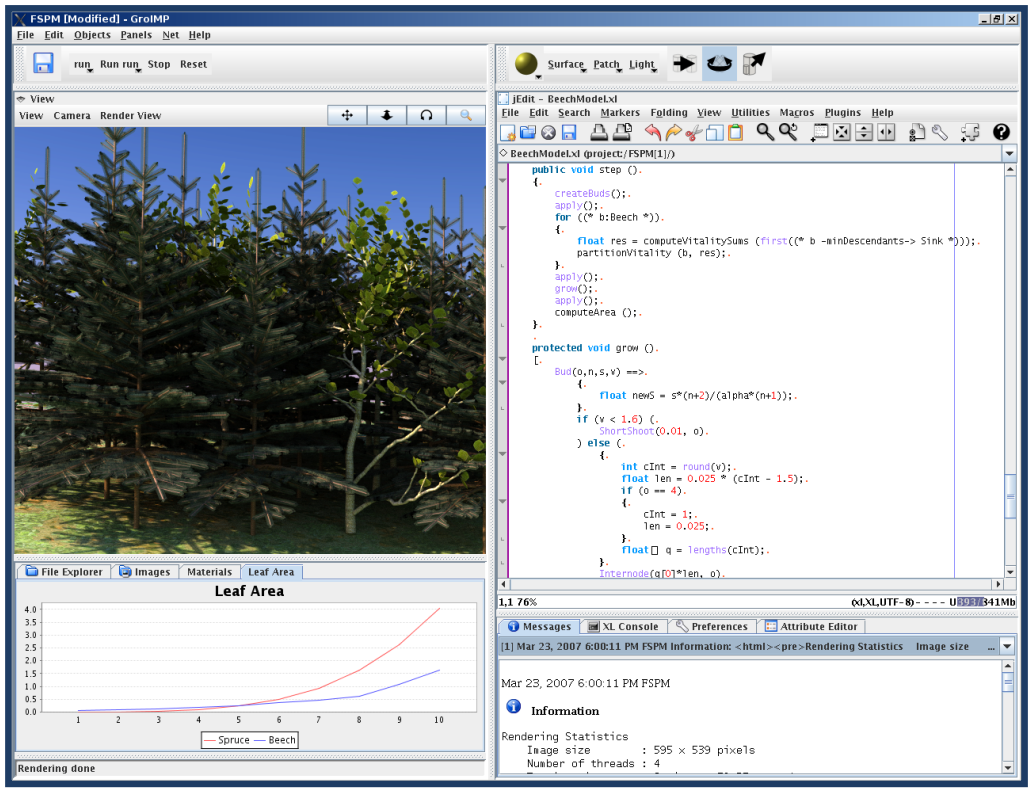

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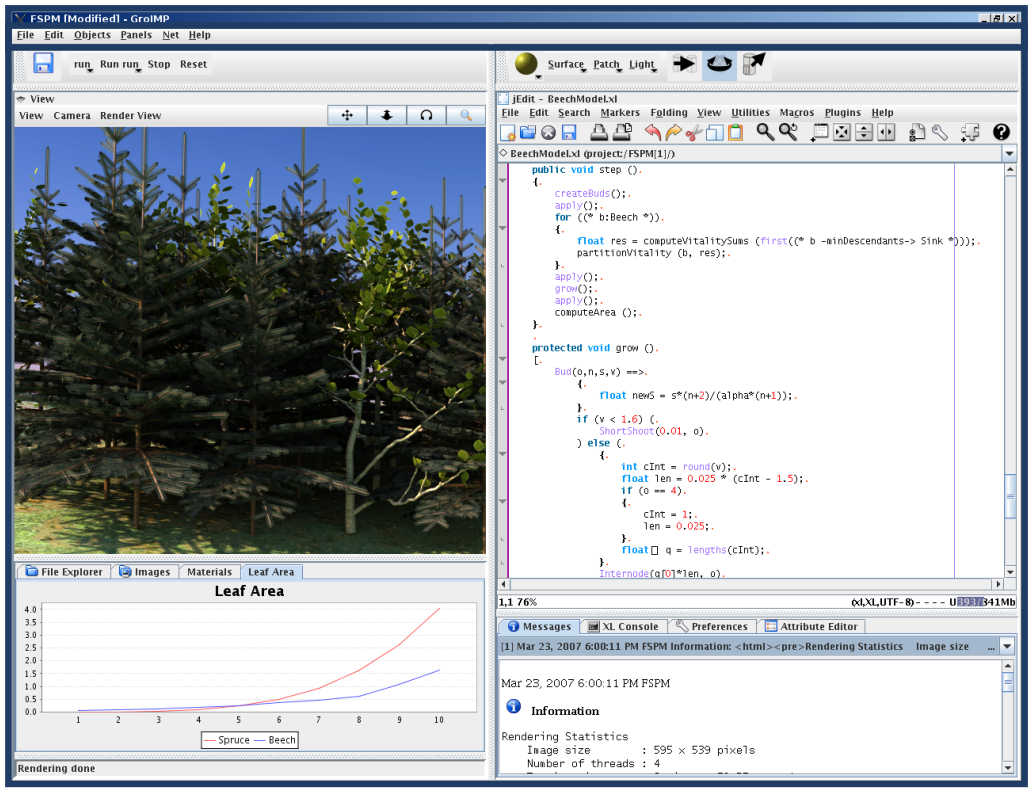

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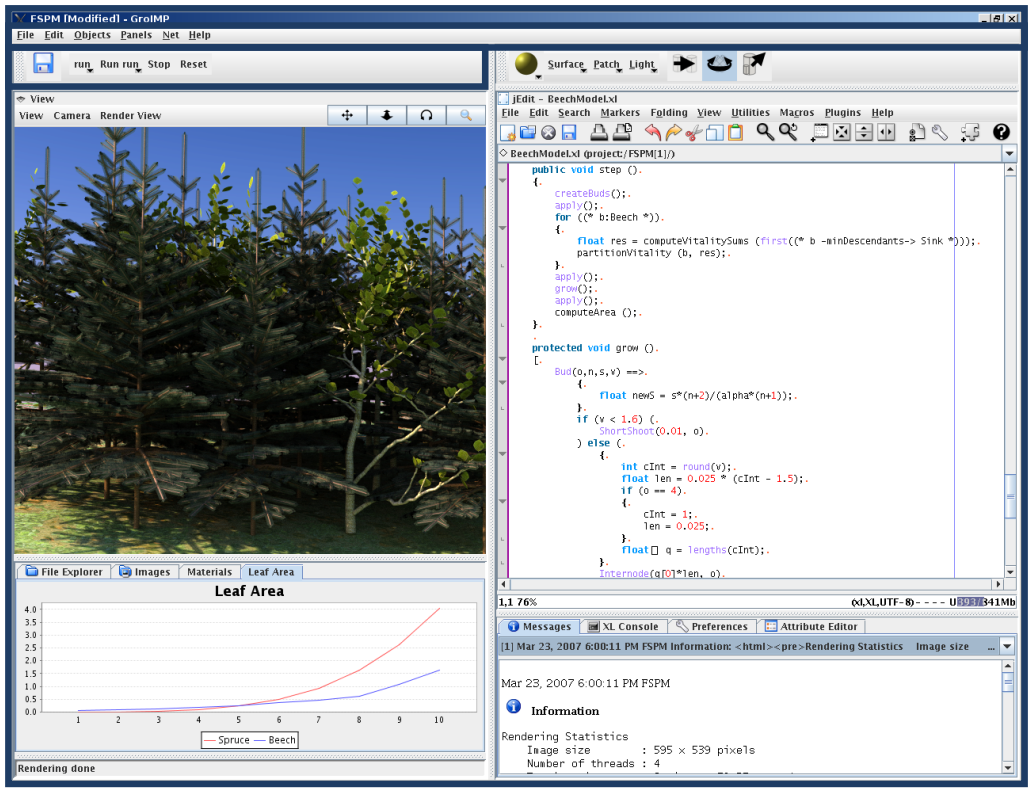

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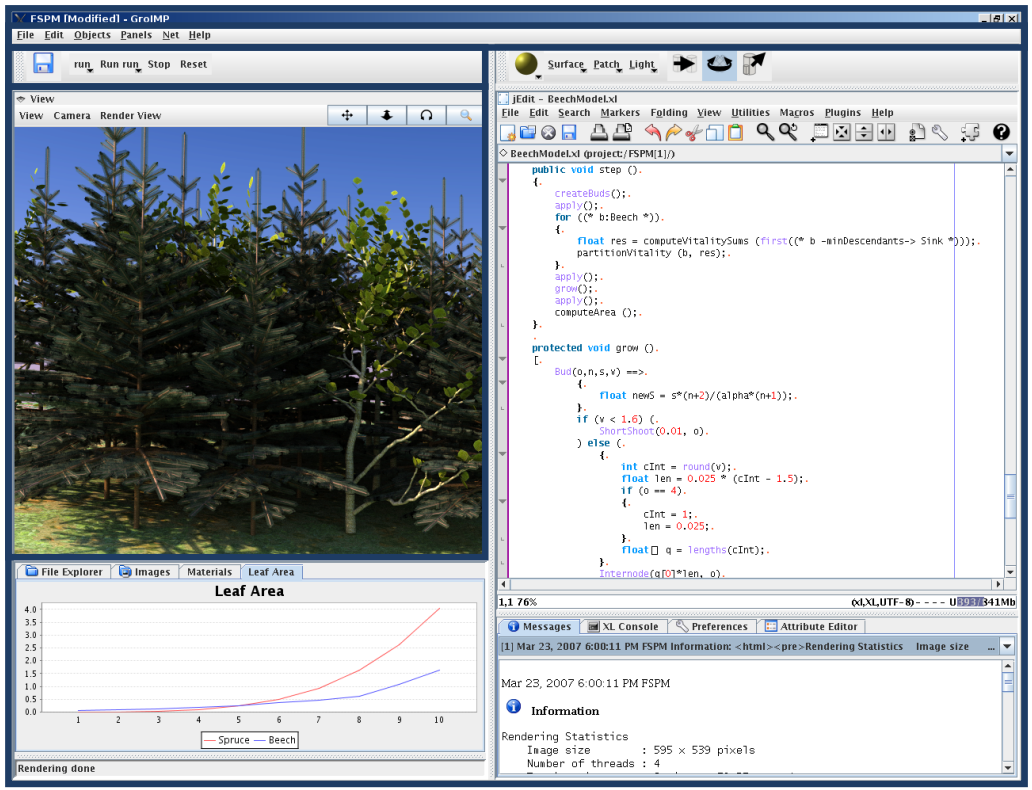

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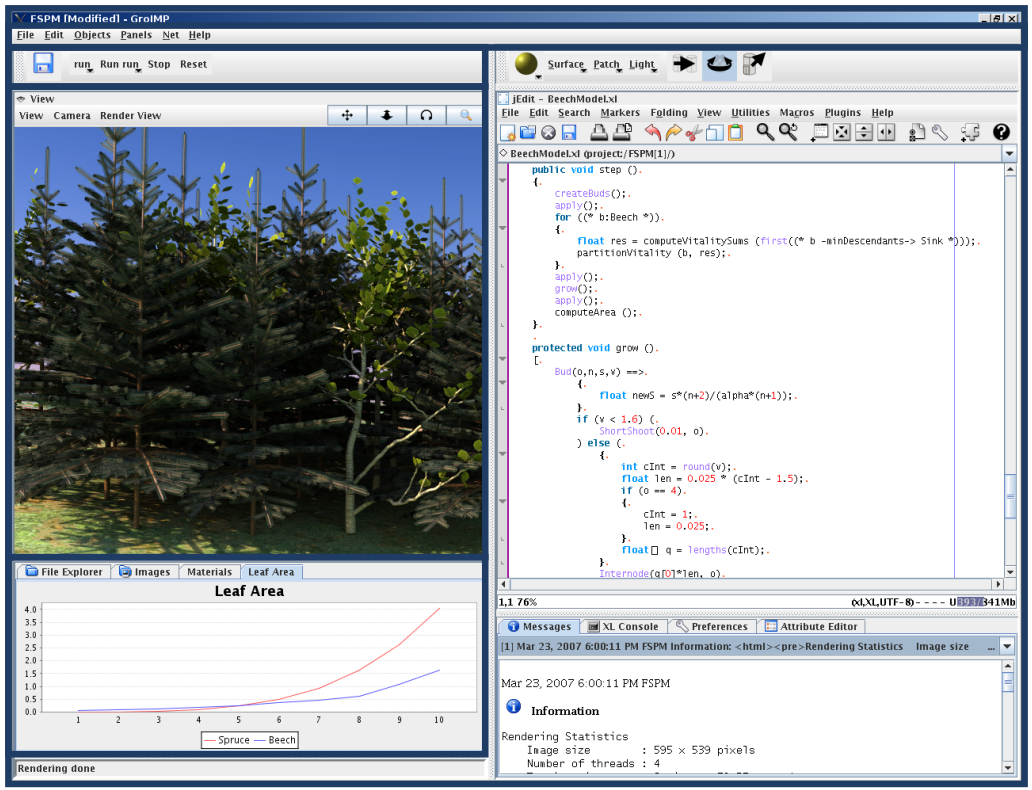

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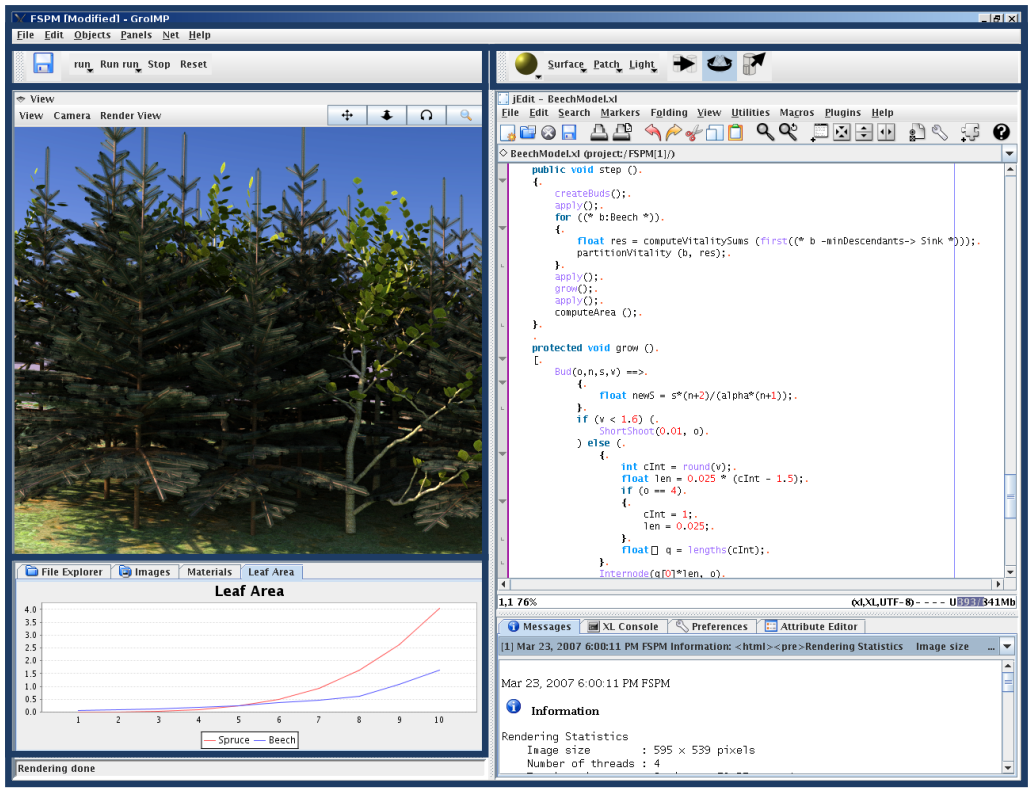

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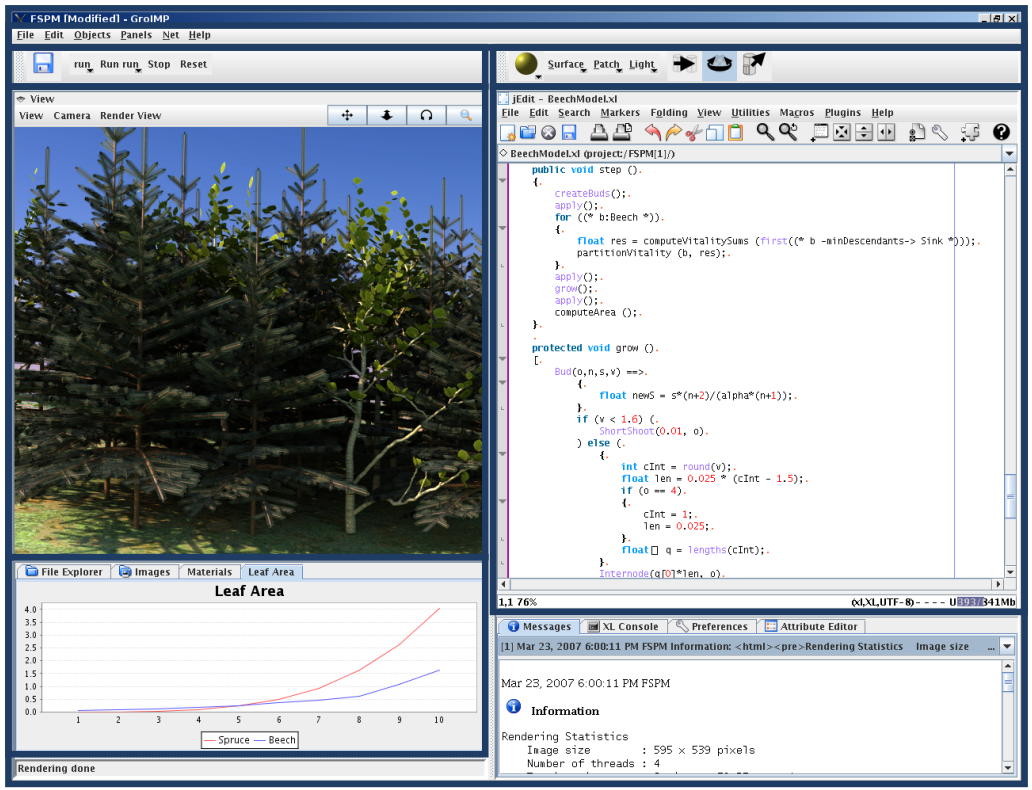

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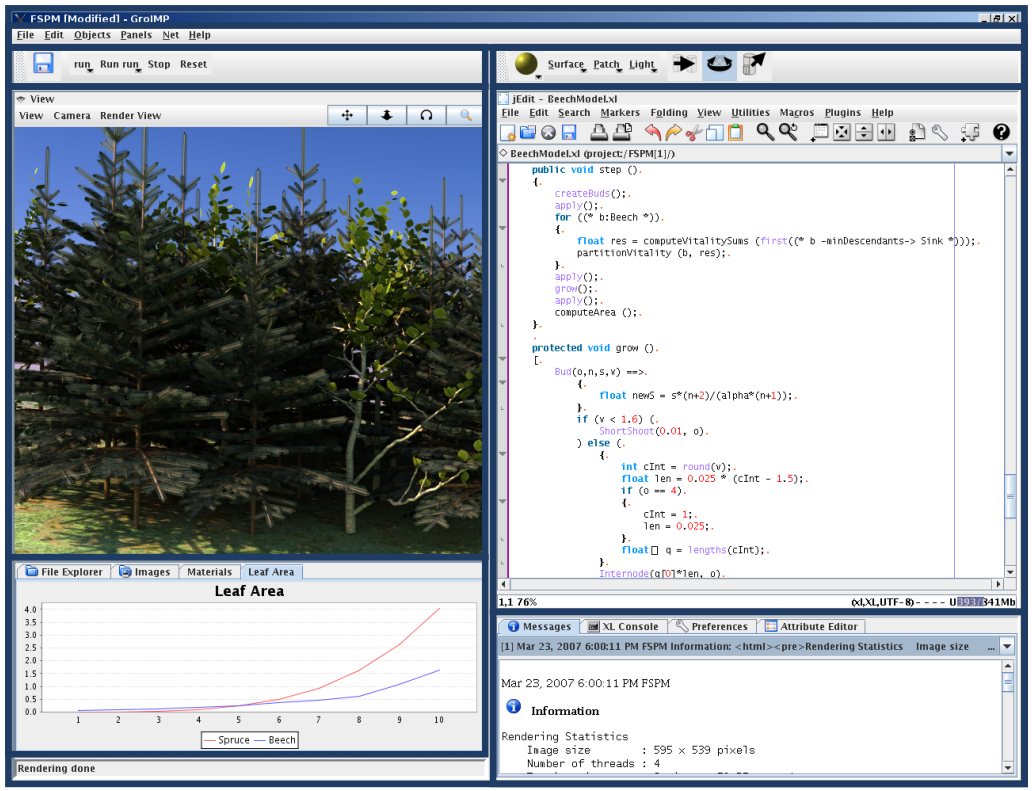

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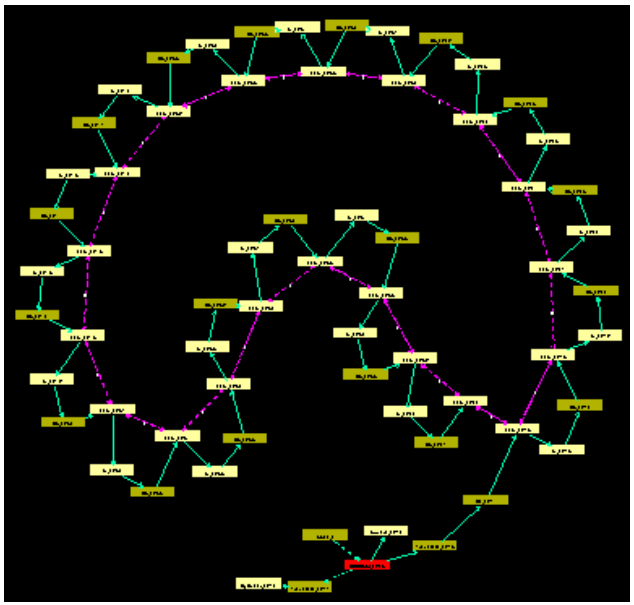
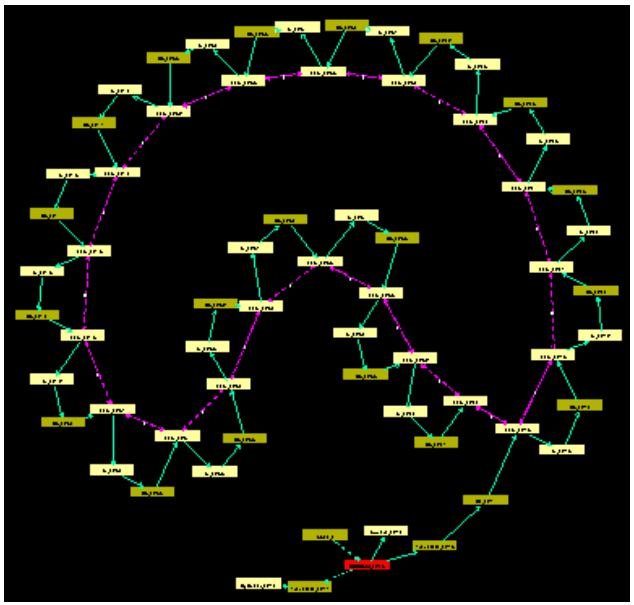
Outline

RGG

- **R**elational **G**rowth **G**rammars
- Graph structure rewriting formalism
- L-systems included as subset (parallel rewriting of strings)
- Plant structure and development described by RGG
  - Plant as an assemblage of organs or modules (nodes) which are connected (by edges)
  - Rules describe how the structure develops



RGG



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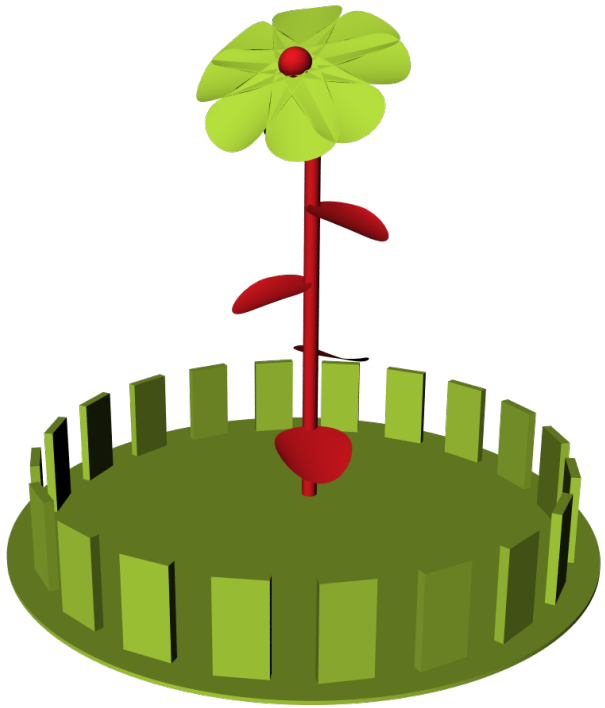
Graph structure - example

- Node
- Edge
  - Successor
  - Branch
  - User-defined



(Smoleňová, Hemmerling)

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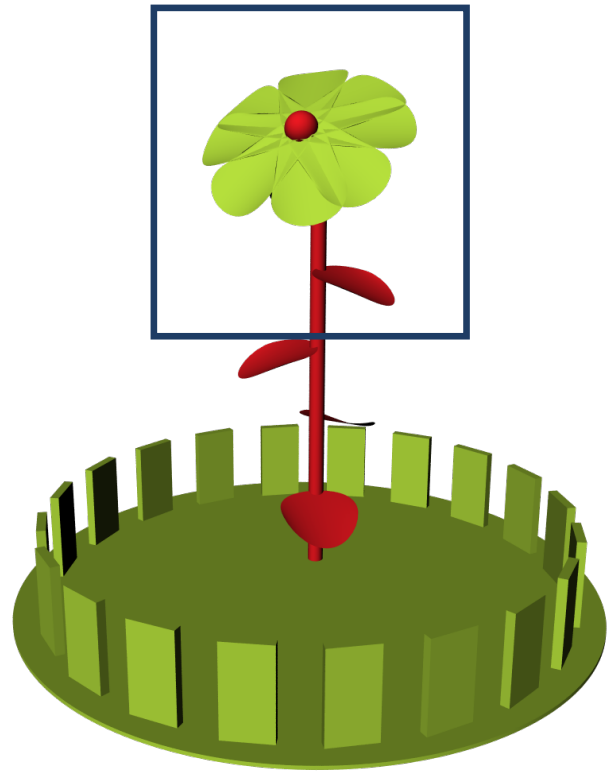

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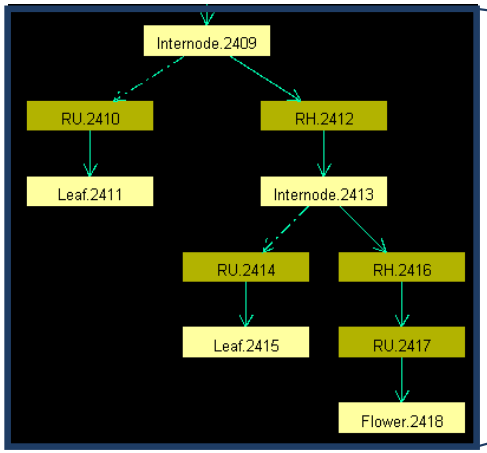

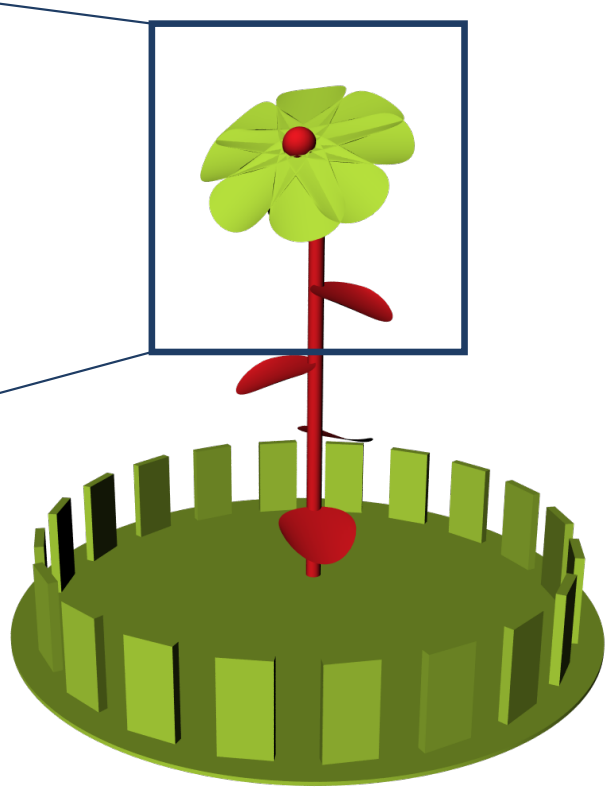

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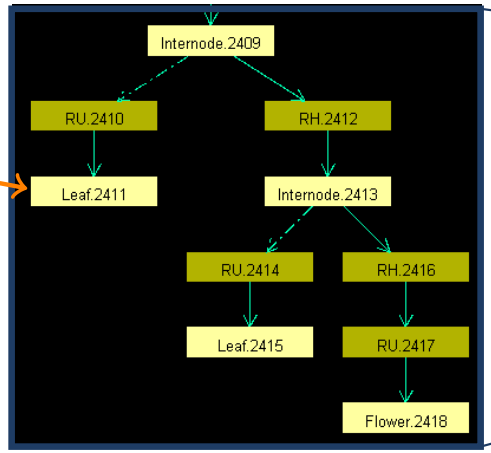

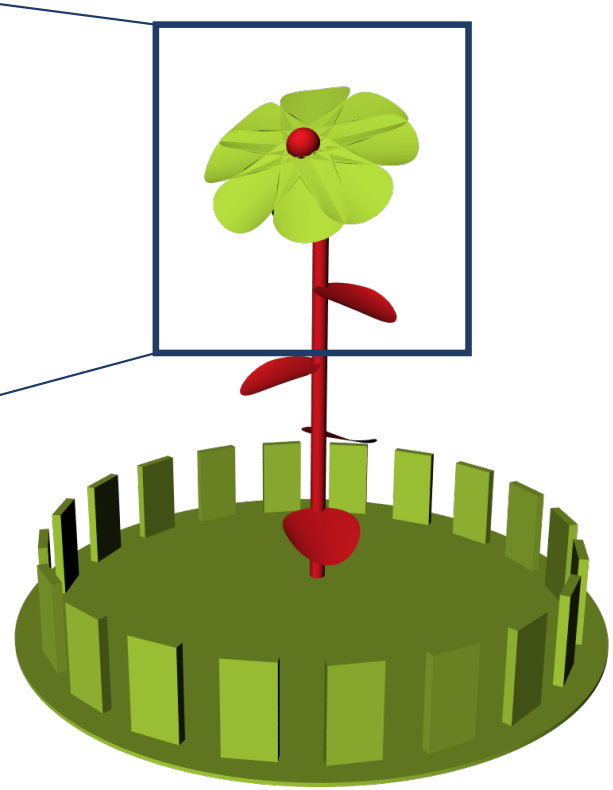

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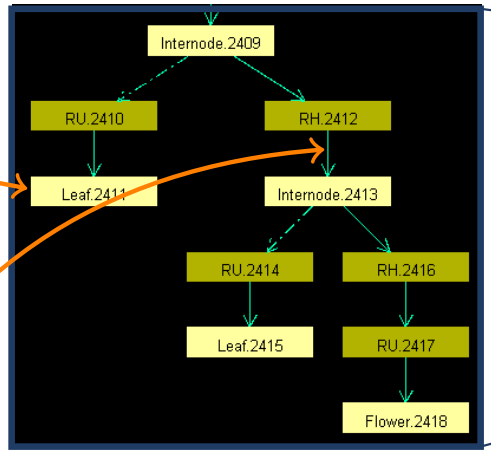

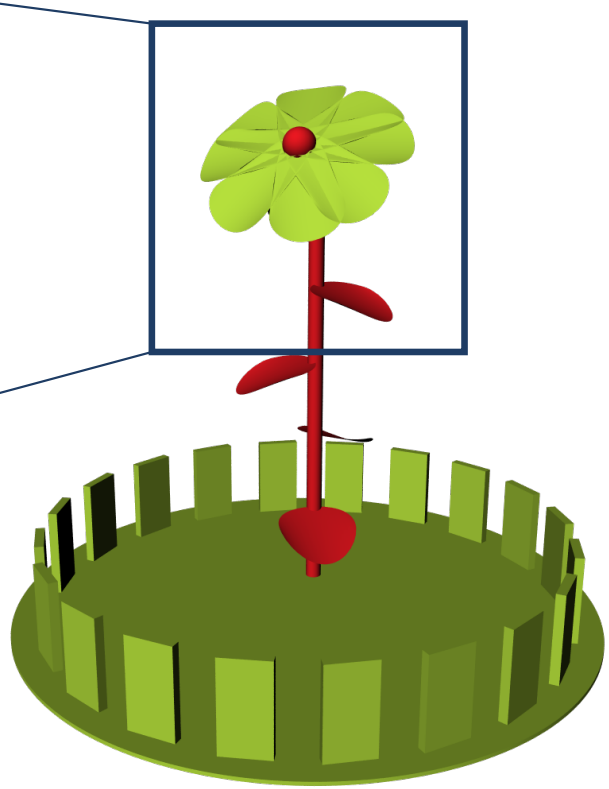

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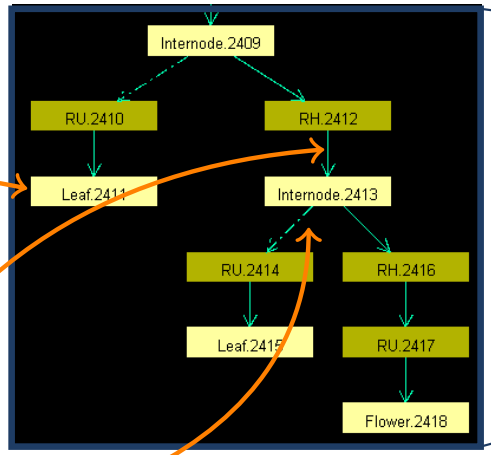

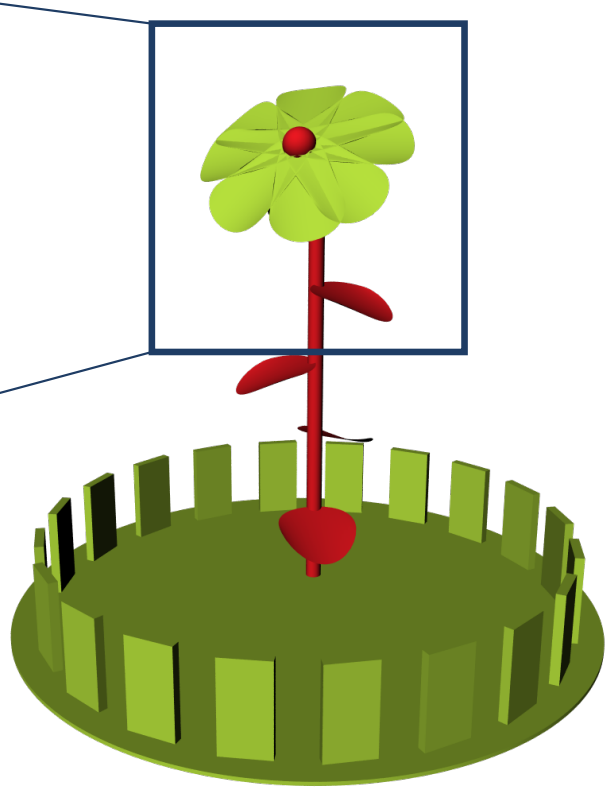

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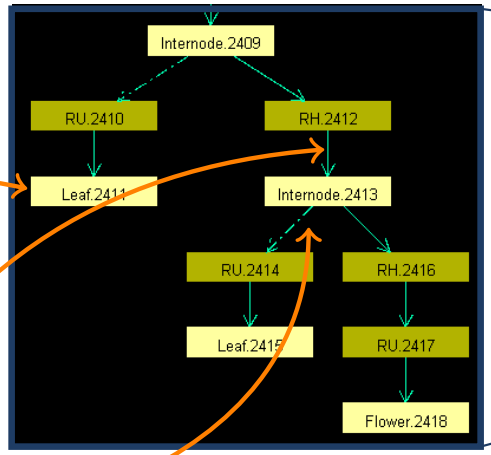

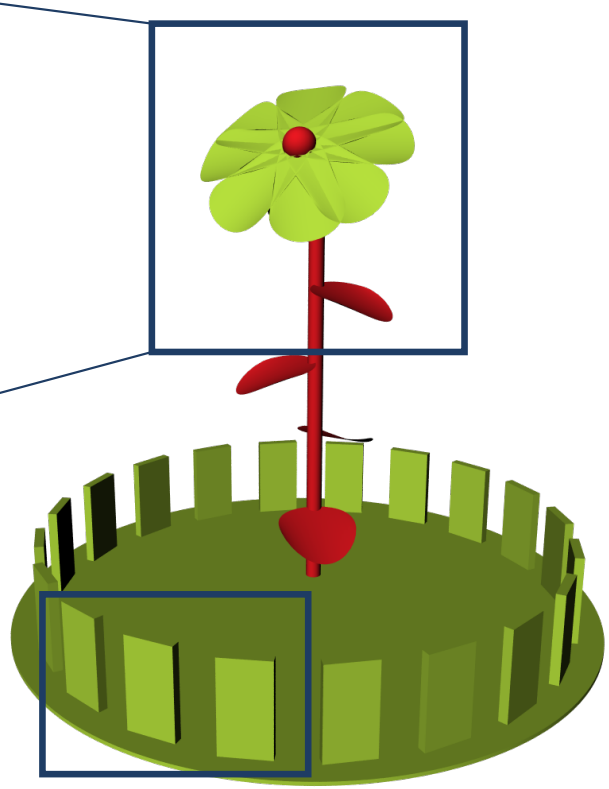

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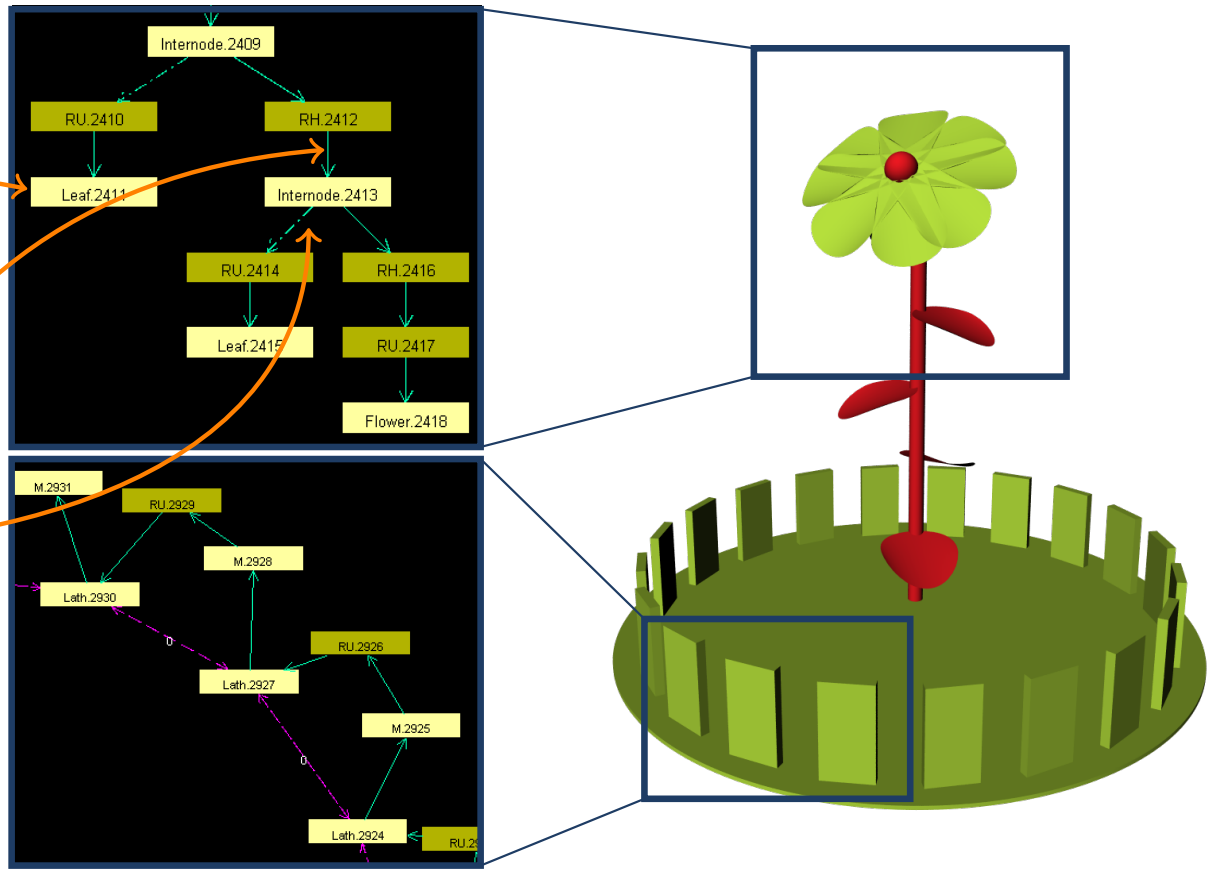

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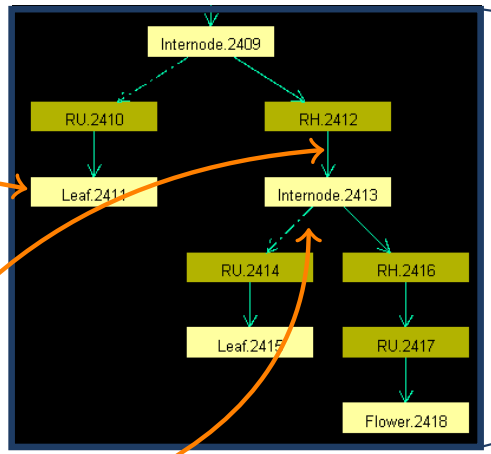
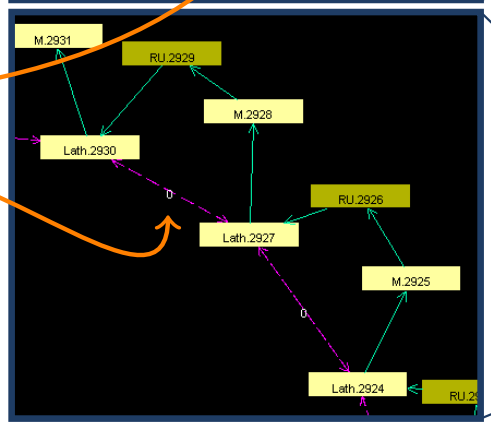
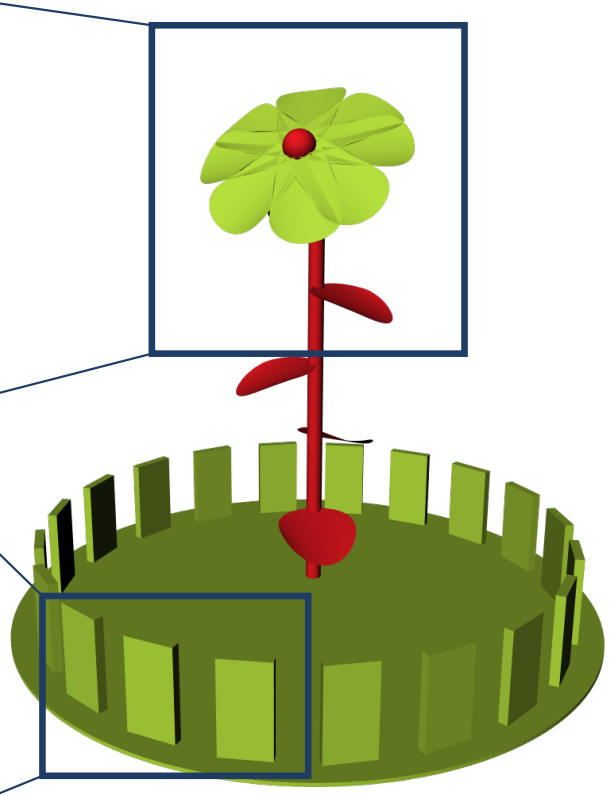
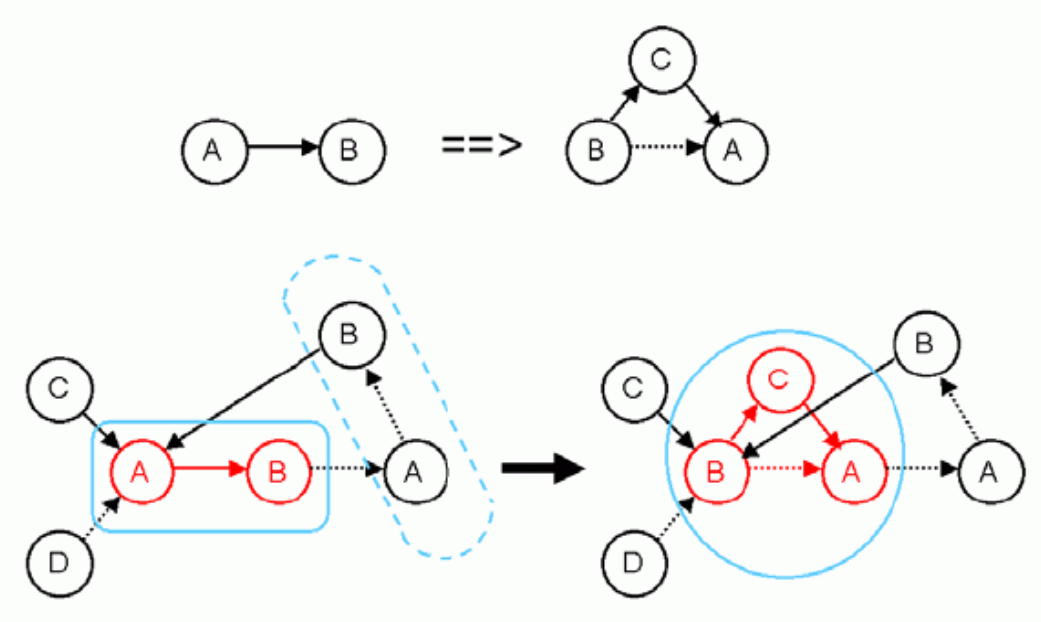






(Smoleňová, Hemmerling)

Graph rewriting - example



Complete RGG rule

(* context *), left-hand side, (condition)

==>

right-hand side {imperative code}

Outline

XL

- e**X**tended **L**-systems language
- Implementation of RGG formalism
- Based on Java (object-oriented)
- Rule-based and Java code can be freely mixed and nested
  - [ ] rule block
  - { } code block (in Java)
- Different types of rules
  - ==> L-system rule
  - ==>> general graph rewriting rule
  - : : > application rule (only parameters are changed)

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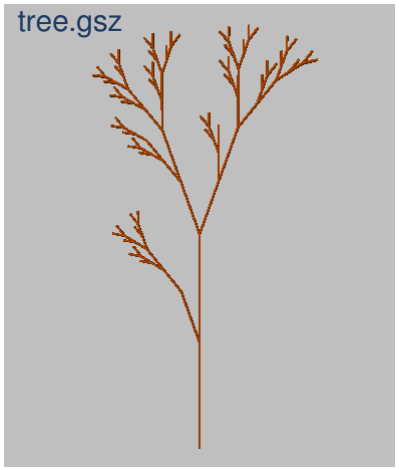
Outline

Simple examples presenting features of XL

- L-system rules (==>)
  - Bracketed, parametric, context-sensitive, stochastic L-systems
- Other rules (==>>, ::>)
- Combination of Java (imperative, object-oriented) and rule-based programming
- Edge types
- Queries, aggregation operators
- Rate assingment operator (to solve ODE's)
- Instantiation



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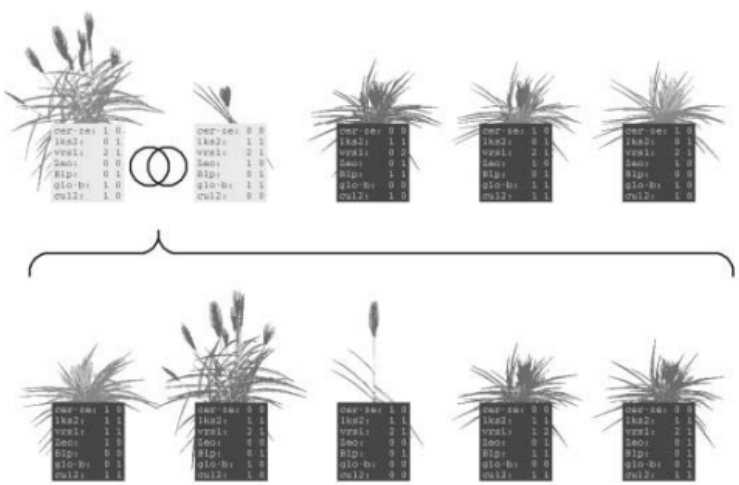
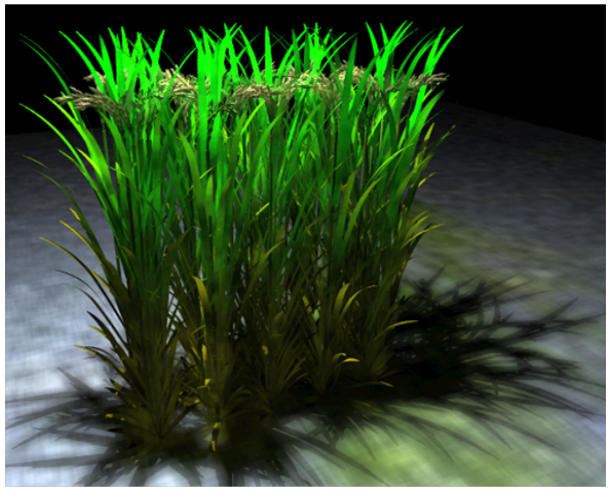
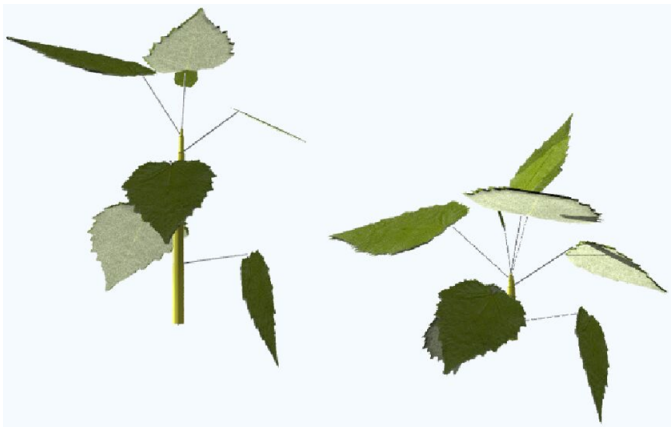
Barley, rice model

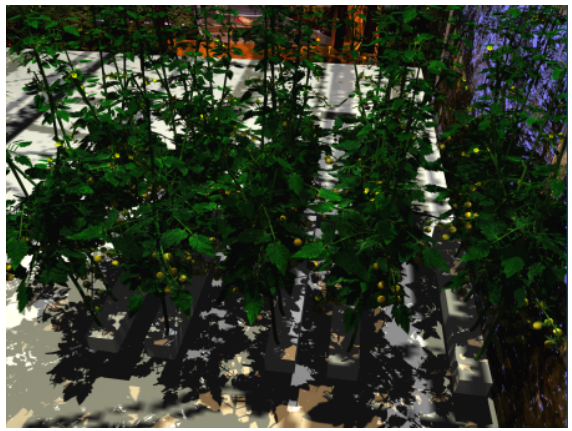




(Buck-Sorlin et al. - Smoleňová et al. - Xu et al.)

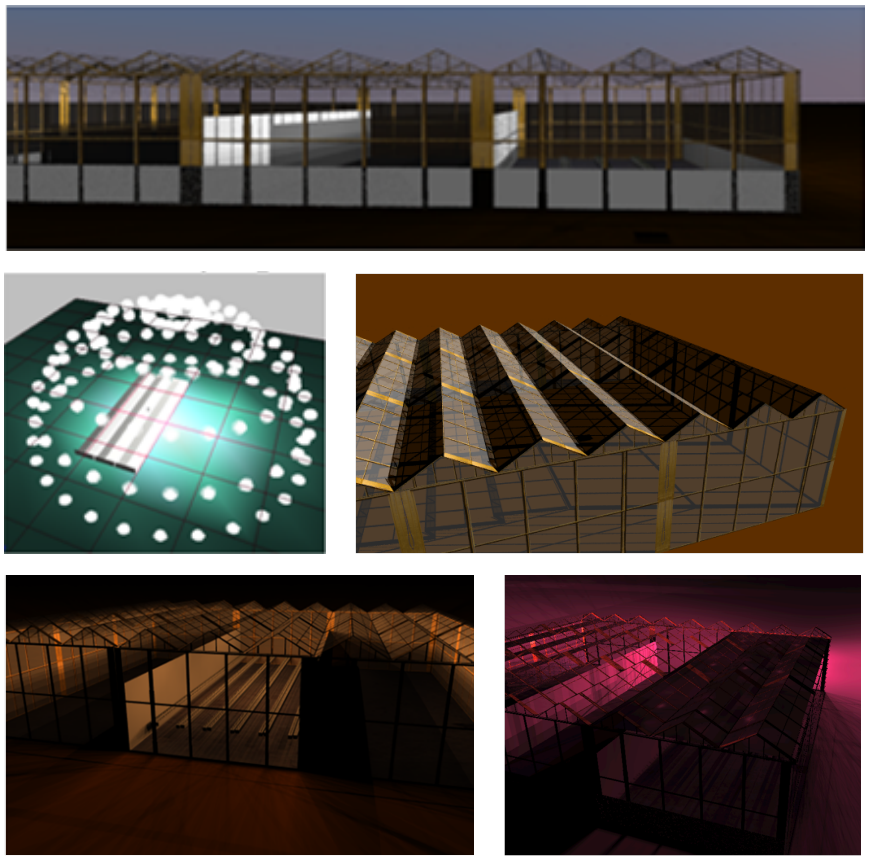
Poplar, rapeseed, arabidopsis, tomato model

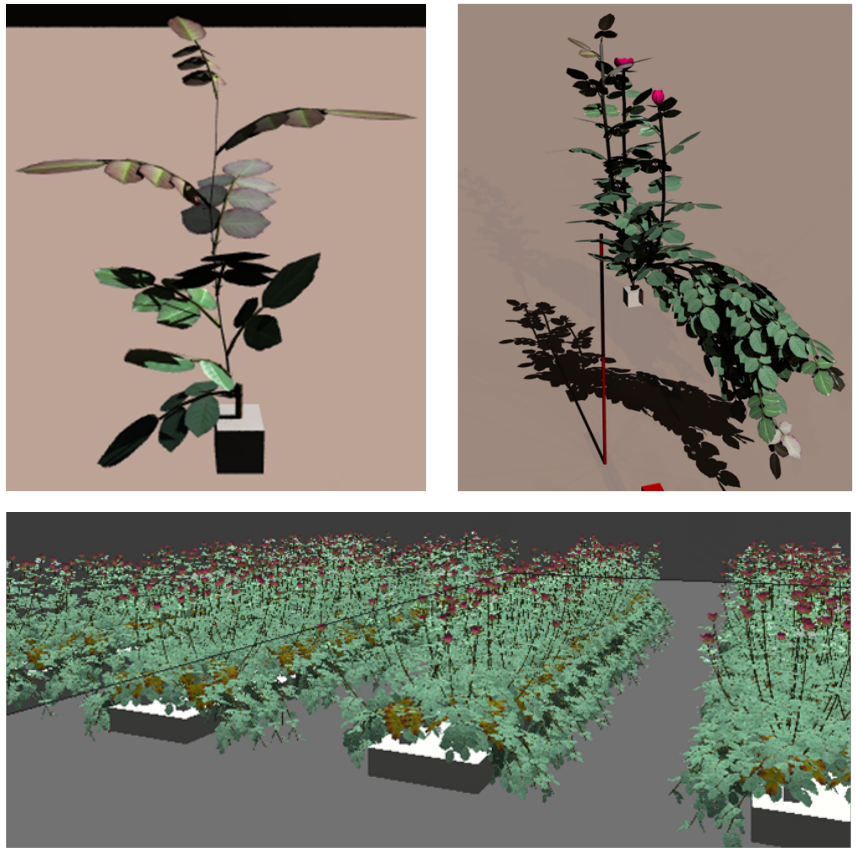


(Buck-Sorlin et al. - Groer et al. - Evers - Buck-Sorlin et al.)

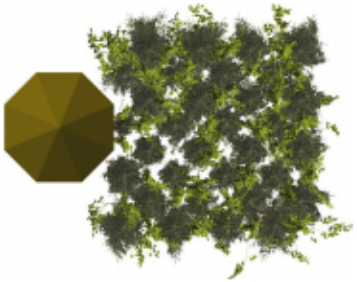
Cut-rose model

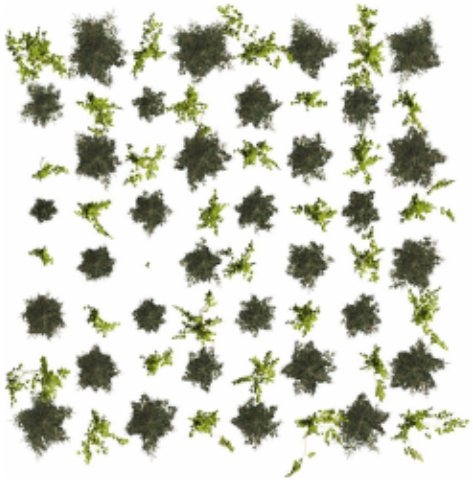




(Buck-Sorlin et al.)

Tree competition (beech, spruce)





(Hemmerling et al.)

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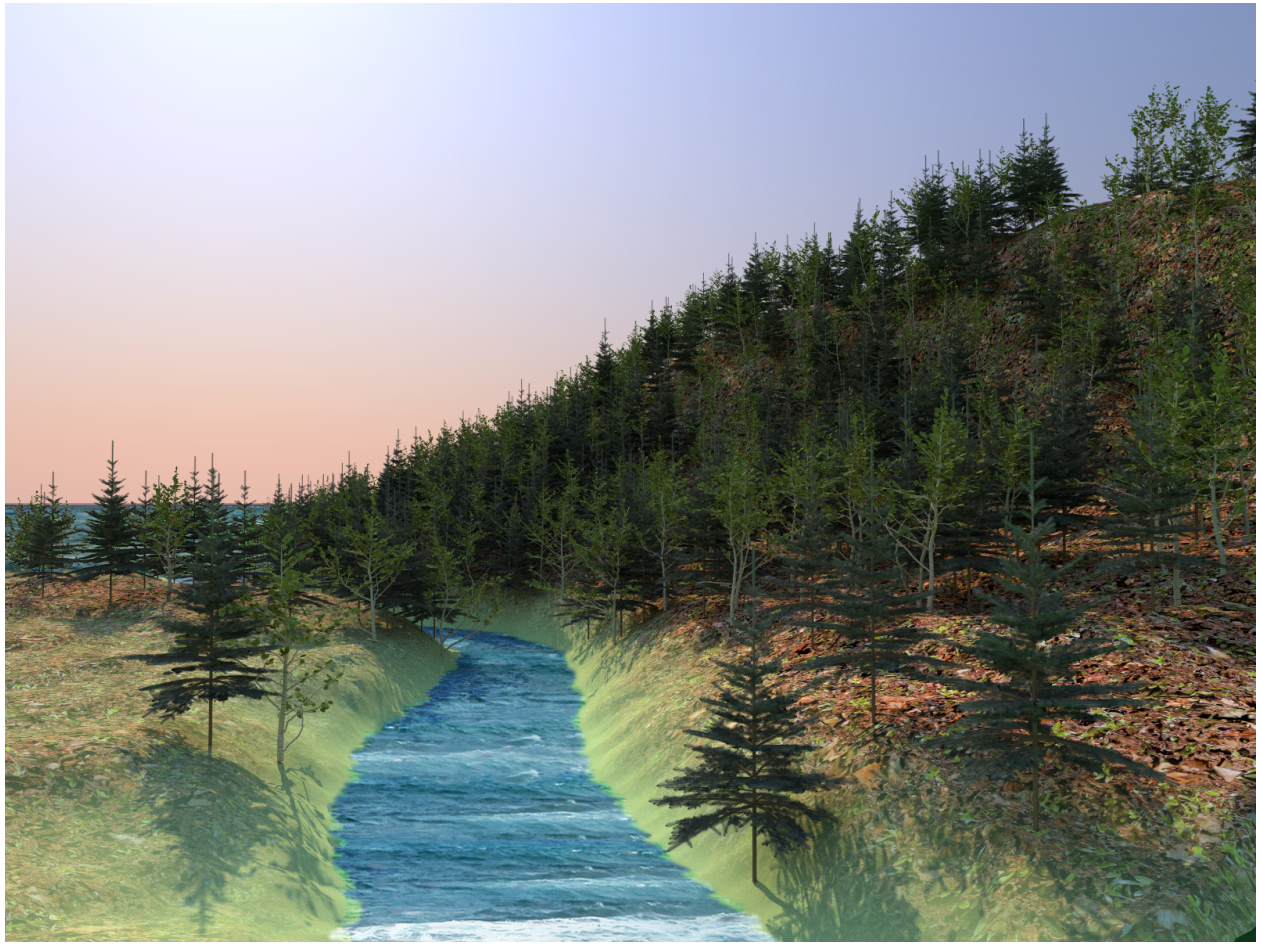


(Hemmerling et al.)

Outline

Virtual scenes

(Rogge et al.)

Reconstruction of trees (Branitzer park, Cottbus, Germany)

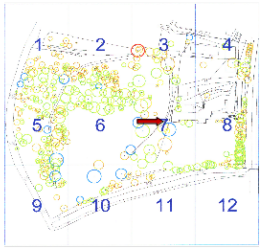
(Rogge)

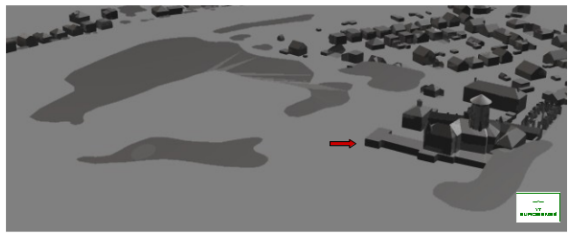
Reconstruction of trees (Branitzer park, Cottbus, Germany)

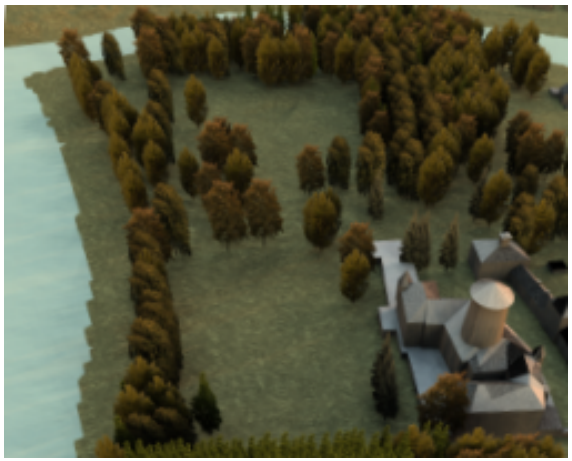
Original

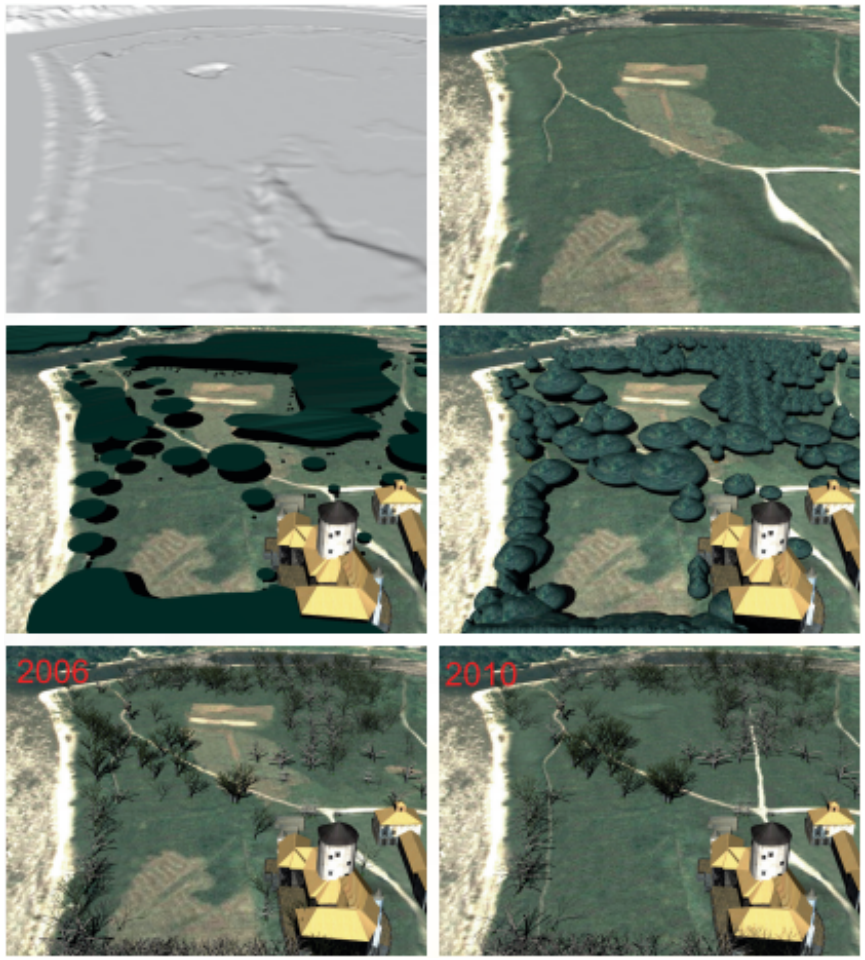
(Rogge)

Reconstruction of parks (Budatín park, Žilina, Slovakia)



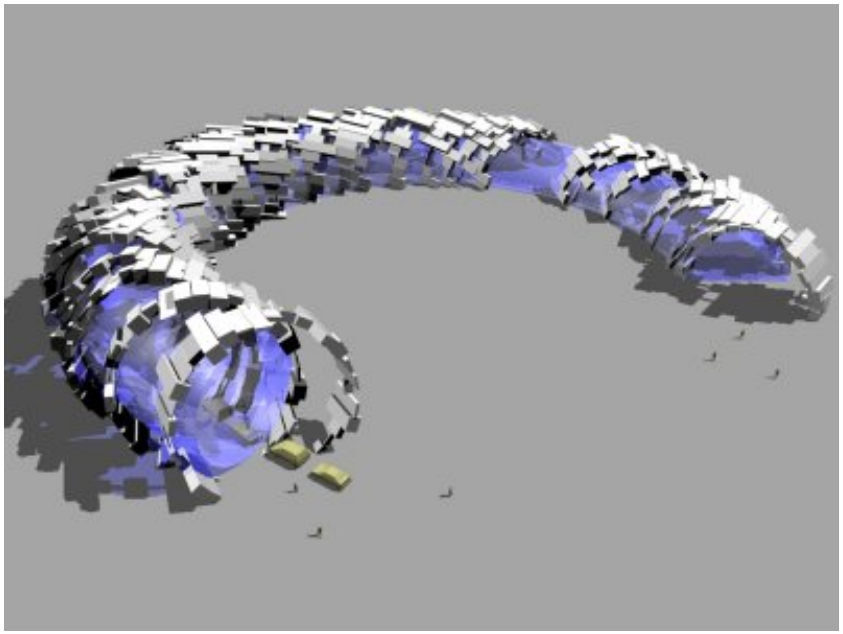


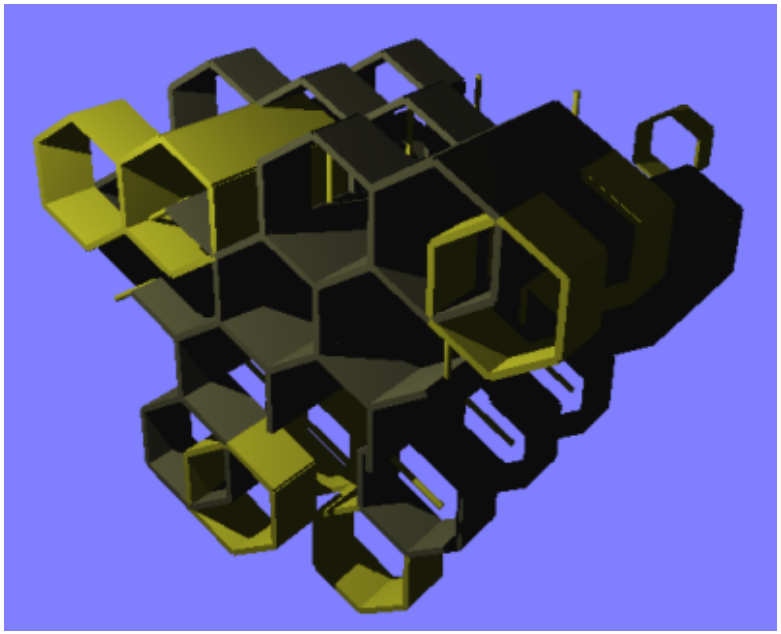




(Smoleňová et al.)

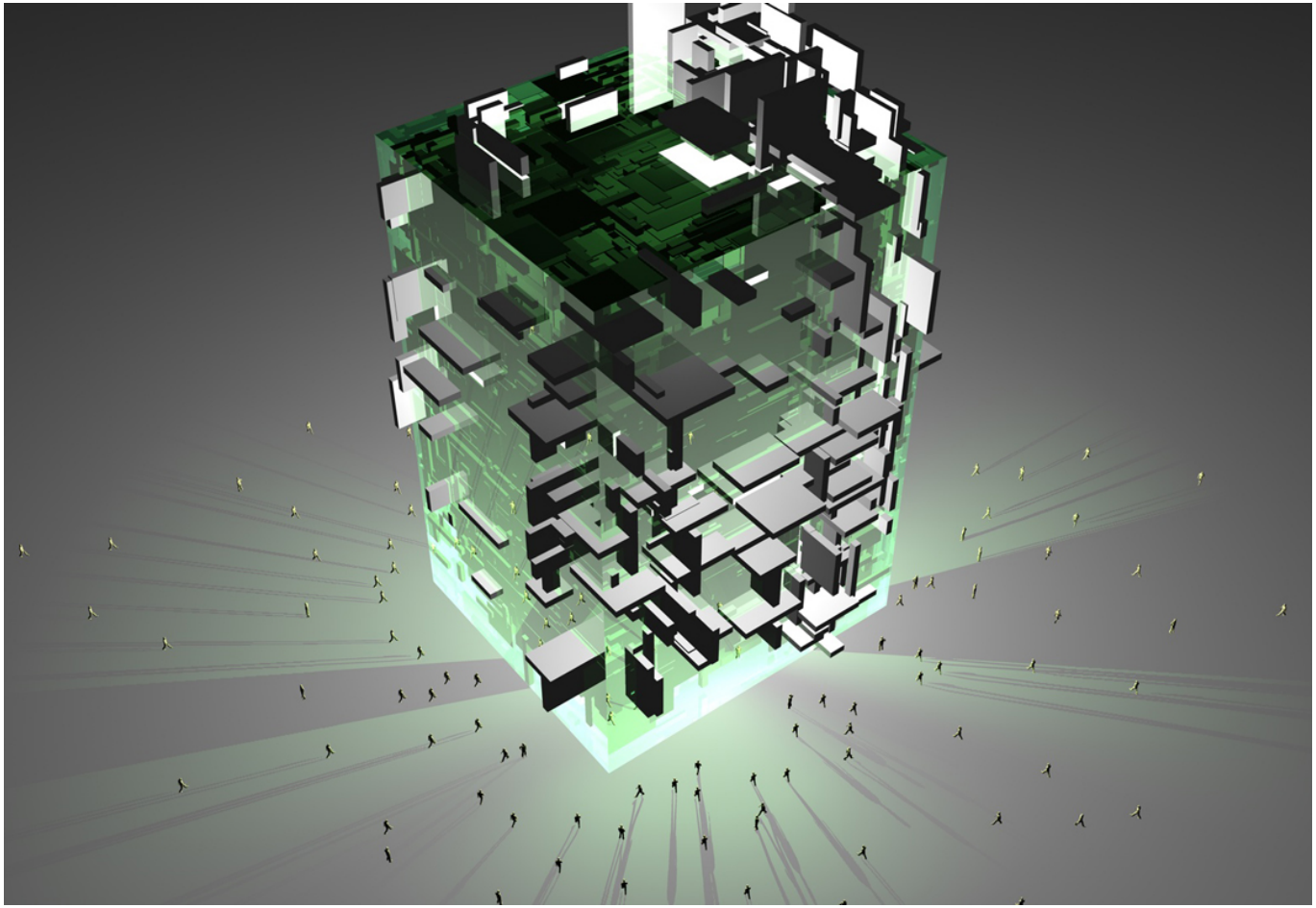
Architecture





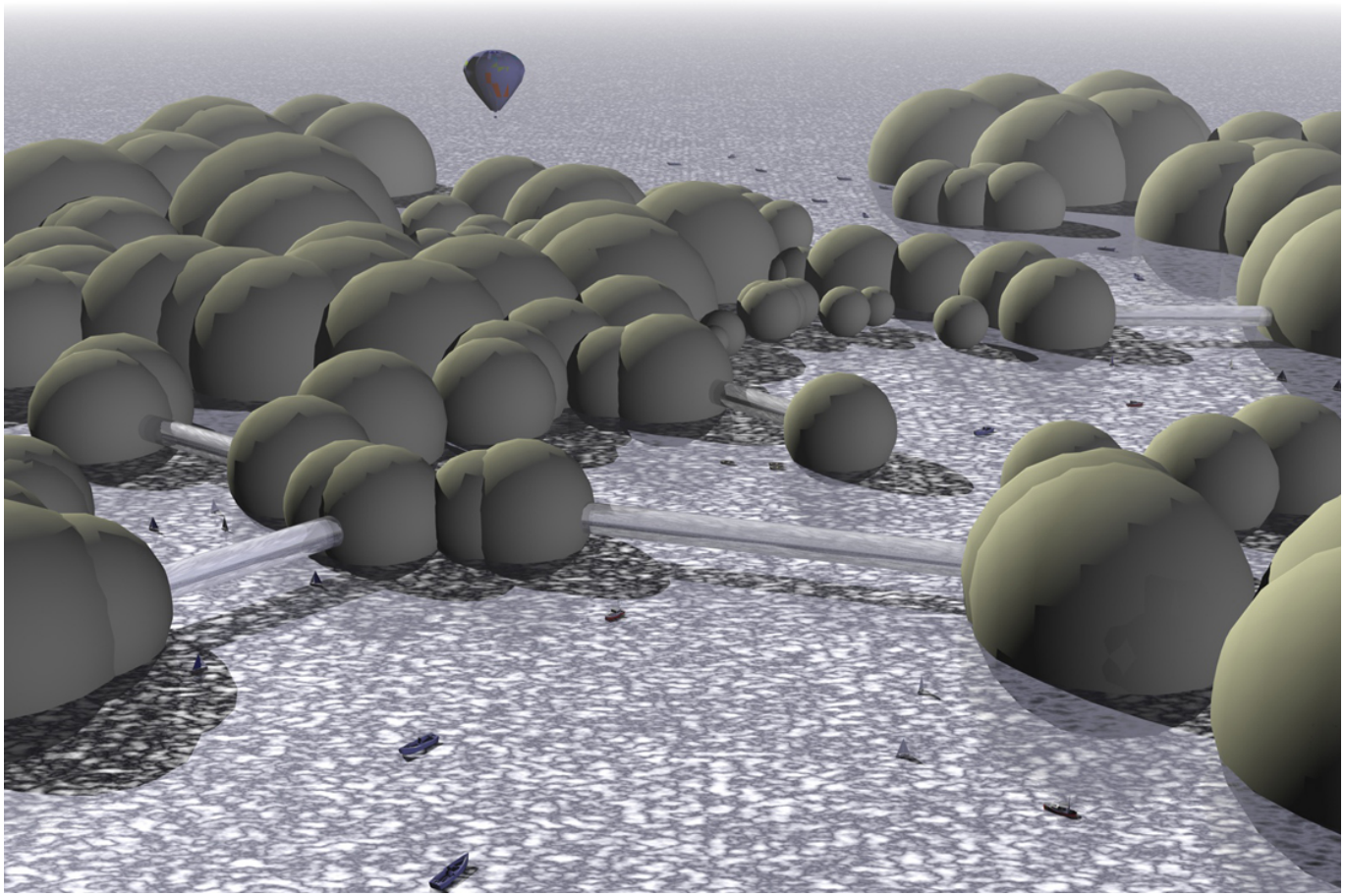
(Liang - Koch)

Architecture



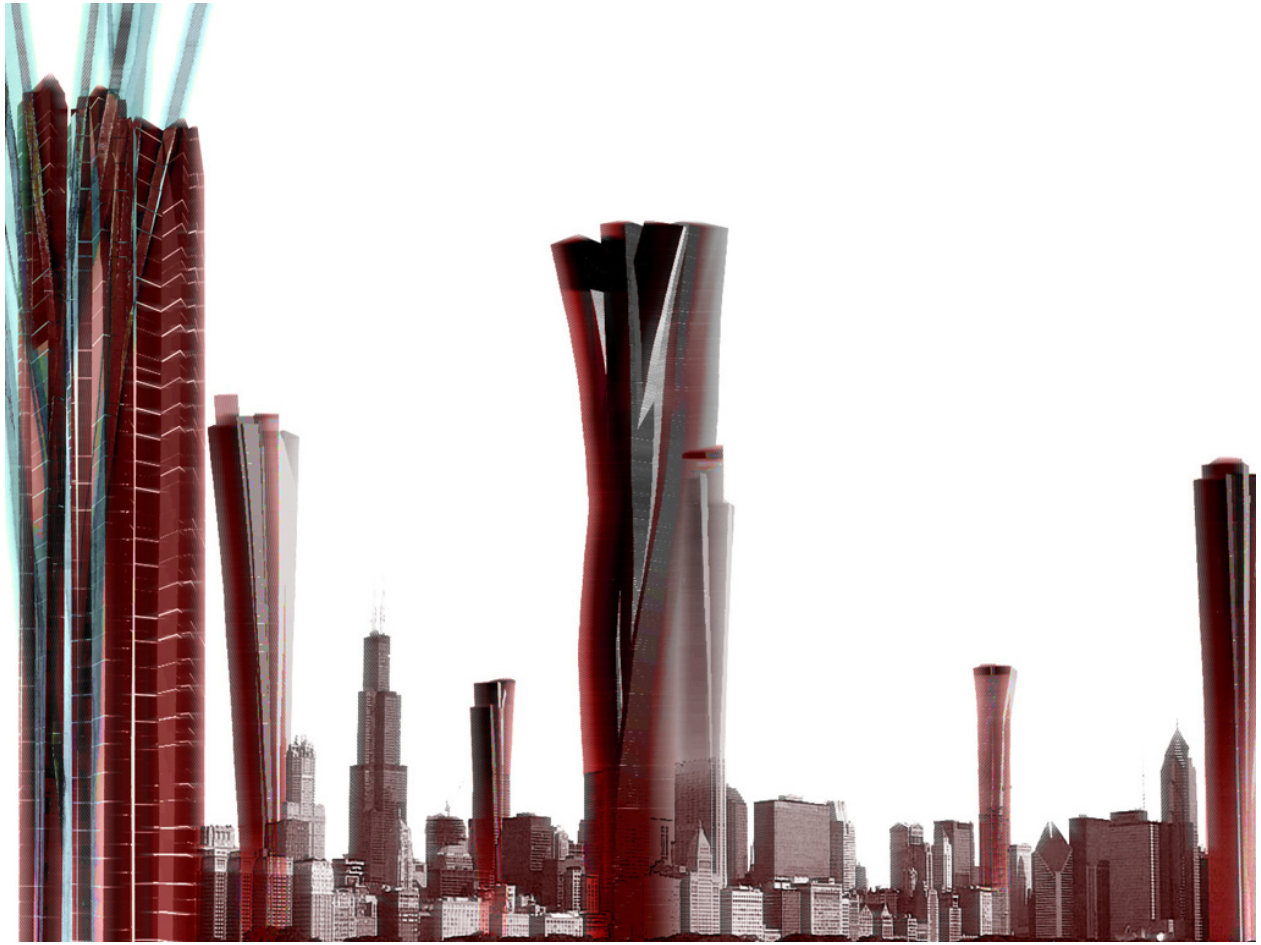
(Liang)

Architecture



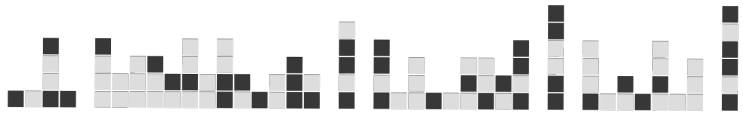
(Liang)

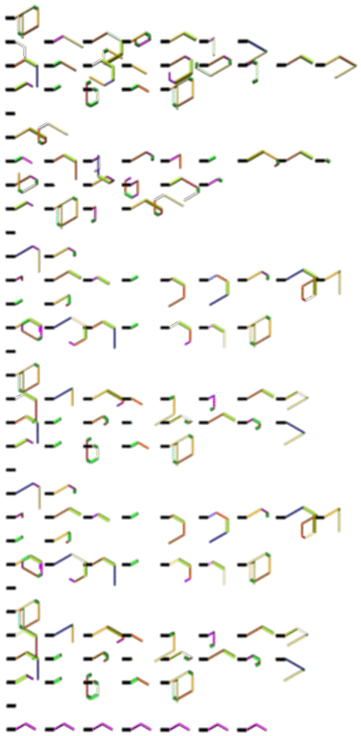
Architecture

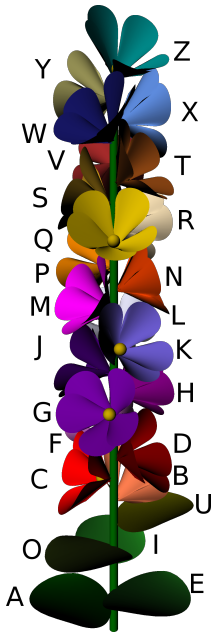


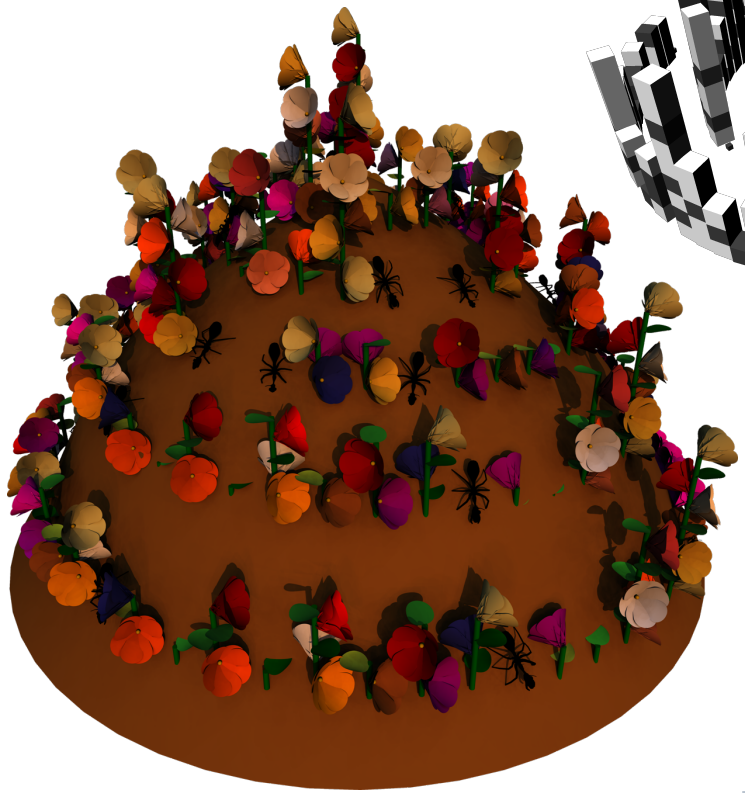
(Jarchow)

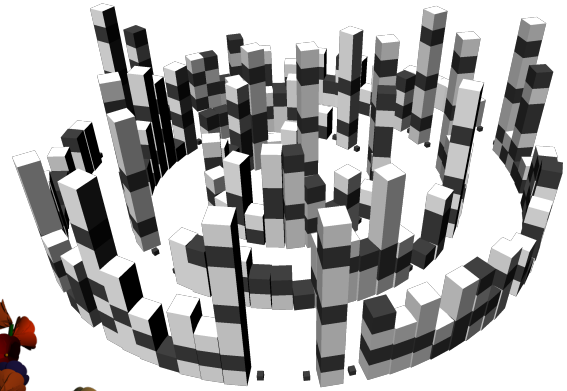
Text visualization (Yesterday, Beatles)







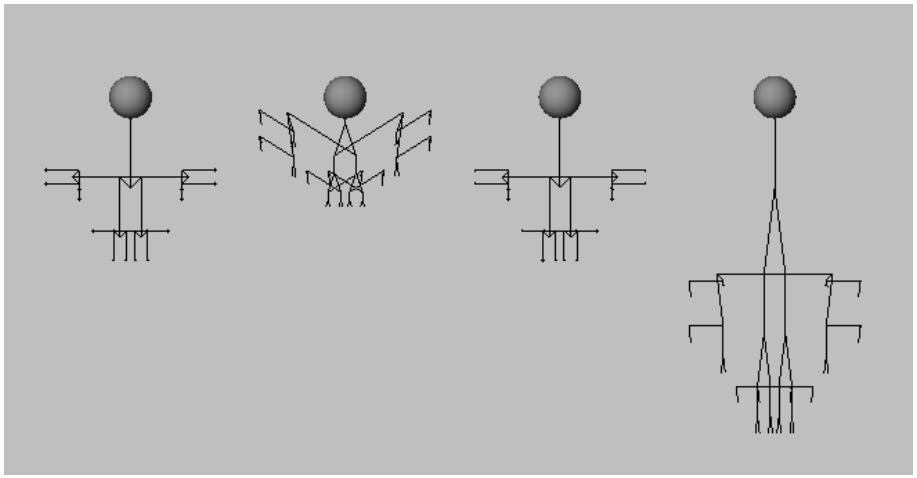


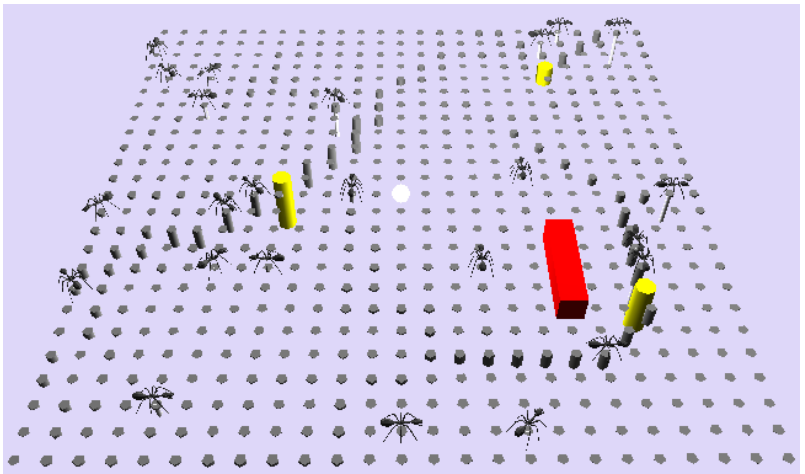


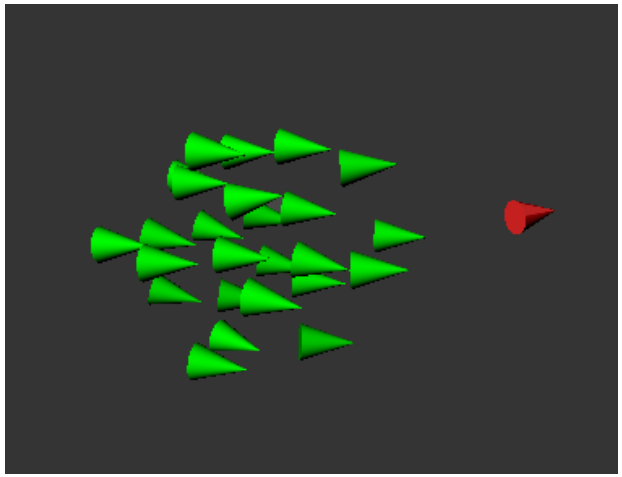
(Smoleňová, Ferko & Hemmerling)

Outline

Biomorphs, artificial ants, boids



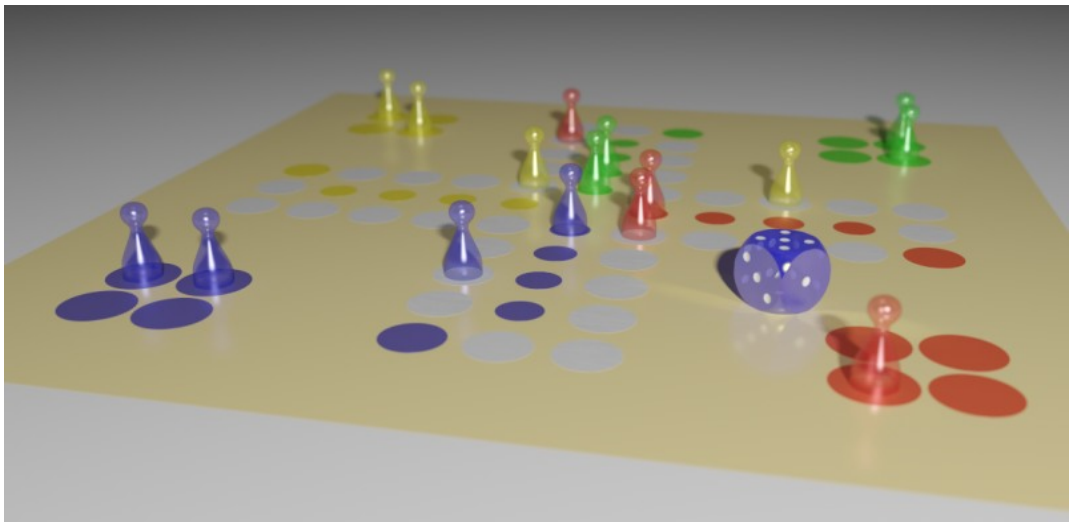




(Kniemeyer - Kniemeyer - Hemmerling)

Outline

Ludo, snooker



(Kniemeyer - students at BTU Cottbus)

Work in progress

- Extension of GroIMP/XL for component-based modelling
- Implementation of GreenLab, LIGNUM model using rule-based approach
- 2D graph layouts, point cloud processing (Octave Etard)
- Interface between forest growth simulator SIBYLA and GroIMP
- And more . . .

More information:

http://www.grogra.de
http://sourceforge.net/projects/groimp

Kniemeyer, O. 2008. Design and implementation of a graph grammar based language for functional-structural plant modelling
http://opus.kobv.de/btu/volltexte/2009/593/

Thank you for your attention.

More information:

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