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The 3D construction set for plant modelling

integrated in XL

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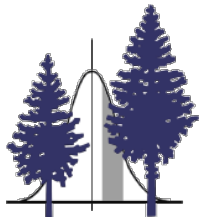
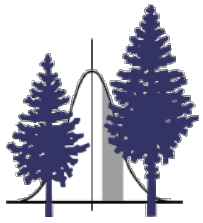


Institut für Forstliche Biometrie und Informatik

Concept

- rule-based object generation
- created form Deussen and Lintermann, realised in the commercial software xFrog
- combination of two modelling concepts:
  1. procedural modelling
     - "objects will be programmed" - parameteriseable algorithm
       e.g. particle systems, trees of strands, fractal models
  2. rule based modelling
     - "objects will be result" - reapplication of rules to an initial state
       e.g. L-systems, CSG-Modelling, iterate function systems

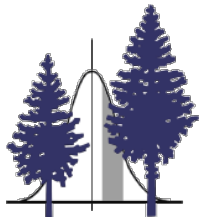


Concept - implementation

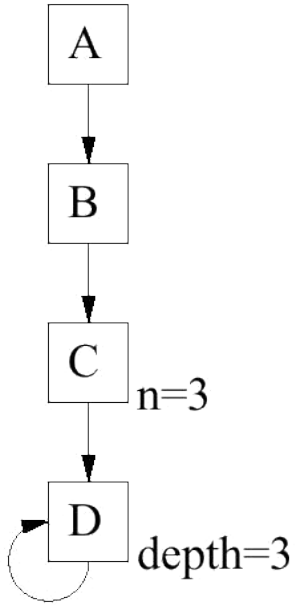
- rule system is defined by an directed graph
- procedural part is provided by the nodes

$\Rightarrow$ a model is described by two parts:

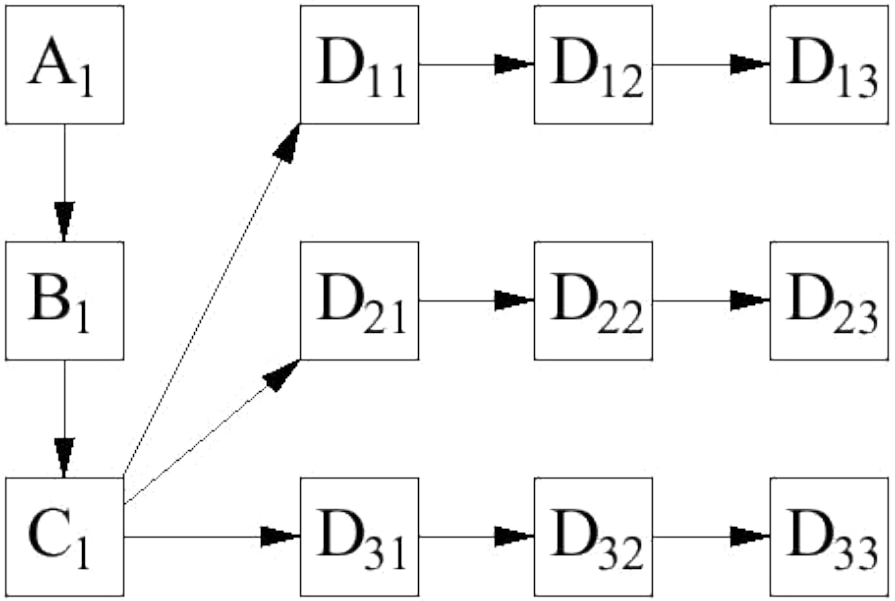
  - graph structure
  - set of parameters



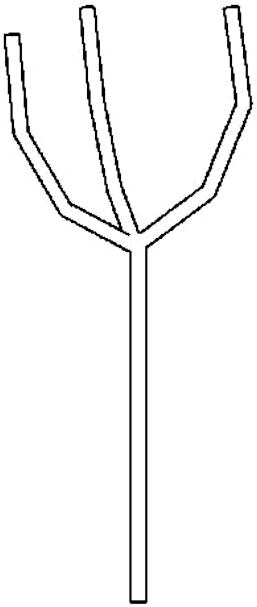
Working procedure



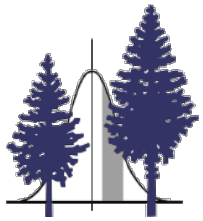
p-graph



instantiation-tree



geometry



Construction set - ”old”

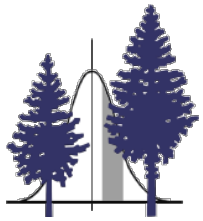
Tree Basic component for trees, creates the geometry of a stem and multiplies subsequent components as branches. Parameters are the distribution of branches, their scale, angle etc.

Horn A component that places other components on a user-defined curve. It is used for stalks, twigs, etc.

Hydra Multiplies subsequent components on a curve with any direction to the direction of the parent component.

Wreath The functionality is integrated in the Hydra block.

PhiBall Multiplier that distributes all connected structures on a section of an ellipsoid according to the golden angle.



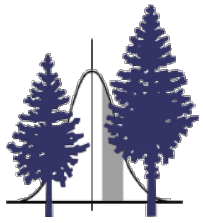
Construction set - "new"

Arrange Main block for arranging large numbers of instances on an area according to user-defined terrain data.

Variation Allows you in combination with an multipling-block to variate the generated instances, like sequential, spread, exceptions or random.

BlockScale Scaling block, enables scaling depending on internal variables.

BlockColor Enables coloring depending on internal variables.



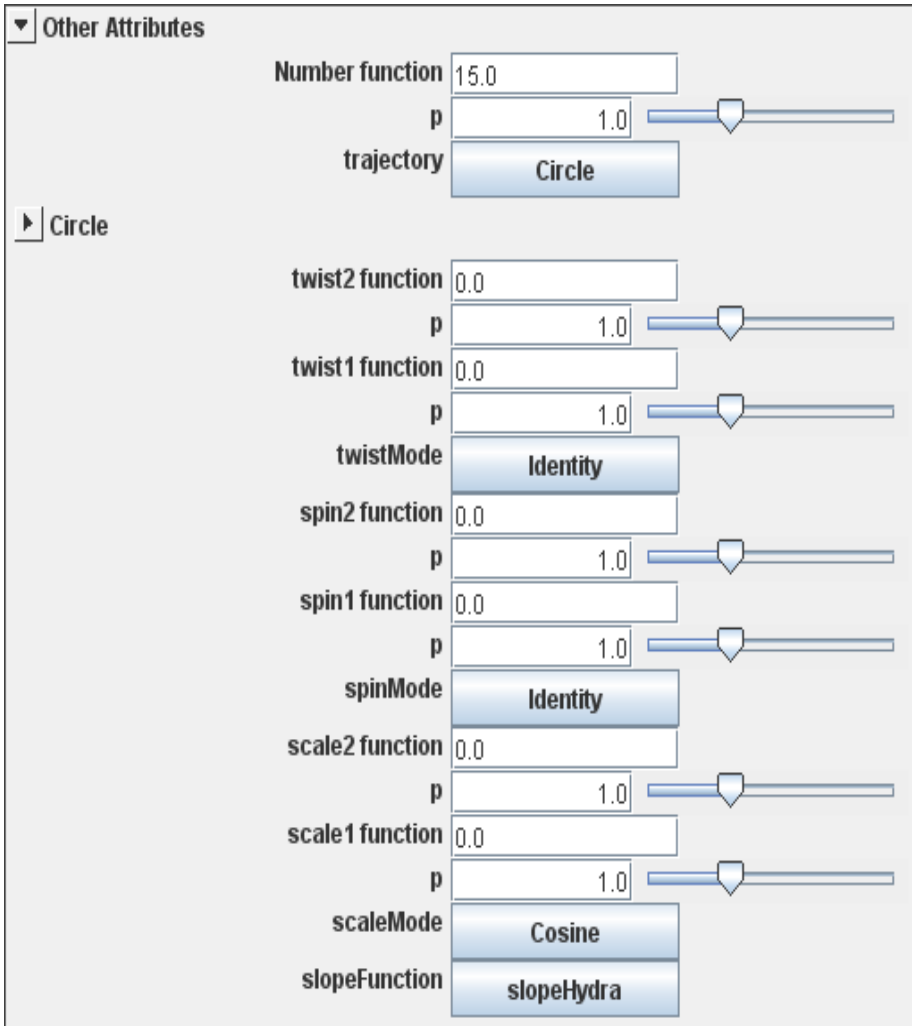
Hydra block - attributes

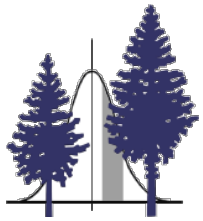
XL-Code:

```
1  Hydra(<x>).(...)
2
3
4  setNumber(<x>)
5
6
7  setTrajectory(<BSplineCurve>)
8
9
10 setRadius(<x>), setRadius(<x1>, <x2>)
11
12
13 setTwist1(<x>), setTwist2(<x>),
14 setTwist(<x1>, <x2>)
15
16
17 setSpin1(<x>), setSpin2(<x>),
18 setSpin(<x1>, <x2>)
19
20
21 setScale1(<x>), setScale(<x>),
22 setScale(<x1>, <x2>)
23
24
25 setSlopeFunction(<FloatToFloat>)
```

$x, x1, x2 \in [Strgin, double]$

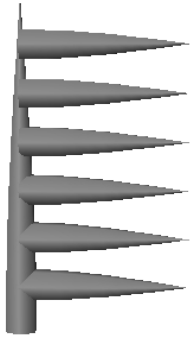
attribute window





Edge types

- **MULTIPY-edge:**
  - standard edge
- **CHILD-edge:**
  - is only used by the tree and horn block
- **NEXT-edge:**
  - identifies different part for the variation block

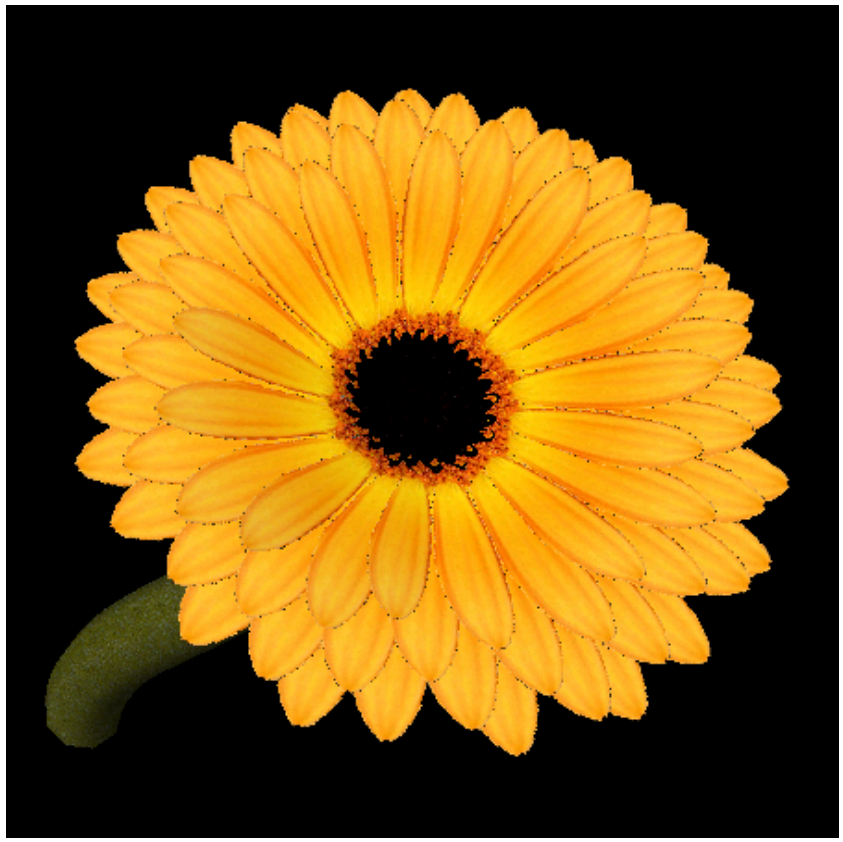


MULTIPY-edge

CHILD-edge

Example

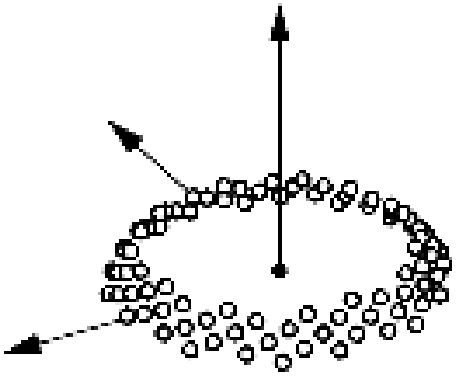
natural gerbera

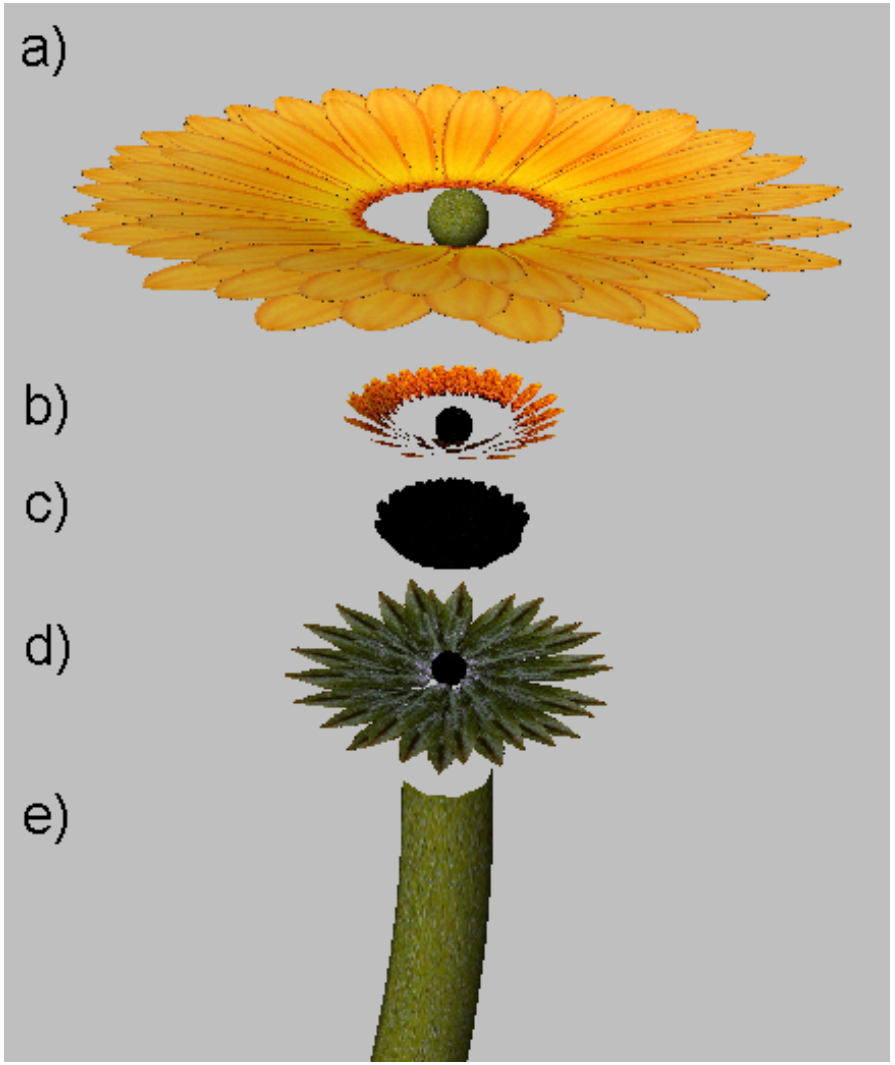


GroIMP-model

Example construction

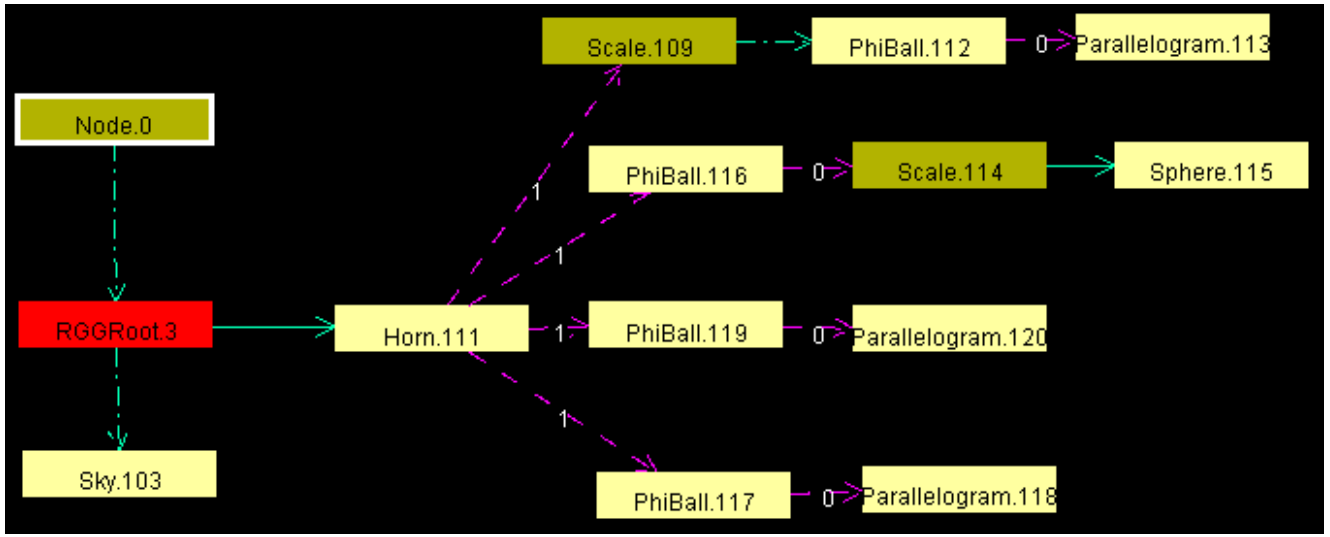
- construction:
  - horn block generates the shaft
  - every ring of petals is produced by a phiball block





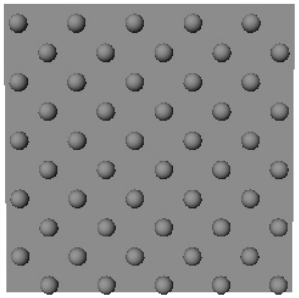
Example source code

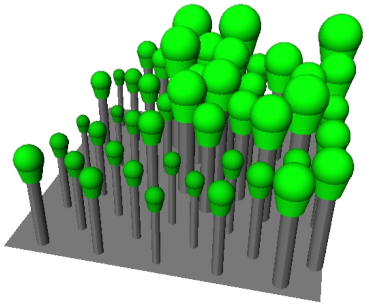
```
 1  const ShaderMat petalMat1 = shader("Lambert");
 2
 3  Parallelogram petal1 () {
 4      TMatrix4d m = new TMatrix4d();
 5      m.rotZ(Math.PI/2);
 6      return leaf(5f, 2f).(setMaterial(petalMat), setTransform(m));
 7  }
 8
 9  Ring1 ==> PhiBall(75).(setRadius(1.5, 1.5, 0.6), setFan(1.5, 1.35),
10          setScale1(0.8)) -MULTIPLY-> petal1;
11
12  shaft ==> Horn(15).(setMaterial(shaftMat), setLength(0.375), setRotZ1(0.05),
13          setRotX(-0.05, 0.05), setRange(1.4, 1.25), setScale1(0.06));
14
15  Axiom ==> shaft [-CHILD-> Scale(1.5) [Ring1]]
16                  [-CHILD-> Ring2]
17                  [-CHILD-> Ring3]
18                  [-CHILD-> Ring4];
```

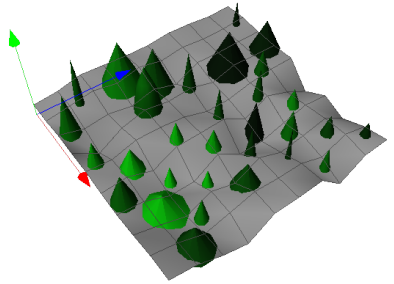


Arrange block

- arrange great amount of instances on a terrain
- distribution classes:
  - geometric arrangement
  - probability arrangement
  - halftoning
  - additional operations
- user defined location parameter field

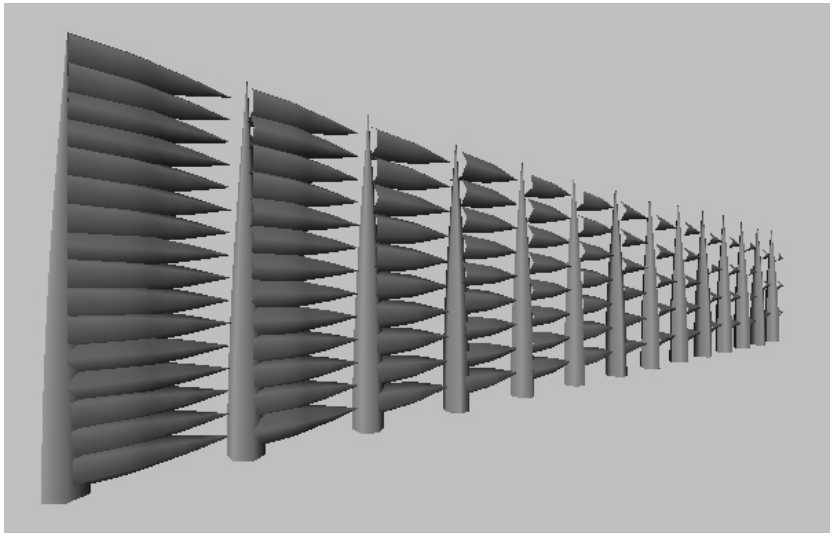




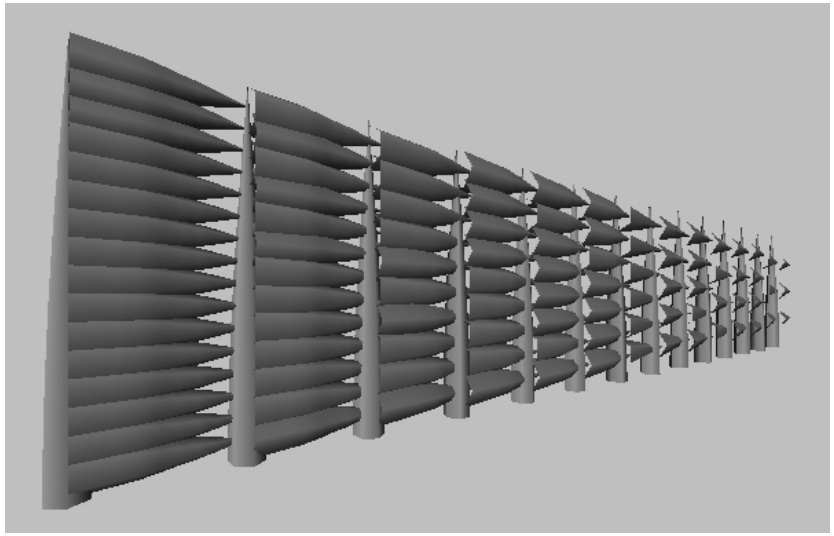


Level of detail

- dependence on the distance of the object to the camera the model is represented in different resolutions
- technique based on Lintermann "Drop and Resize"



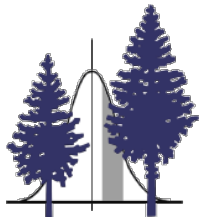
scale factor = zero



scale factor = maximal

Conclusion

+ intuitive modelling way, which fast produce handsome results
+ easy method to control geometrical and structural complexity
+ great diversity of objects can be modelled
  - biological not funded; appearance depends only on the modeller
  - dates taken from nature are heavily too transmit
  - limited for simulation of growing processes
  - performance problems with bigger models



Literature

- Home page of the interactive modelling platform GroIMP; BTU Cottbus: Ole Kniemeyer and Winfried Kurth, www.grogra.de
- O. Deussen; Computergenerierte Pflanzen, Technik und Design digitaler Pflanzenwelten; Springer, Berlin, 2003
- M. Henke; Entwurf und Implementation eines Baukastens zur 3D-Pflanzenmodellierung in GroIMP; Diploma thesis, BTU Cottbus, 2007