

Framsticks general information

Maciej Komosinski Szymon Ulatowski

www.framsticks.com

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Rendering styles

Summary

- https://youtu.be/CrWj_1-UrN4?t=60
- <https://youtu.be/r5RfTmx3S4g>

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- <https://youtu.be/r5RfTmx3S4g>

- developed since 1996
- authors and main developers: Maciej Komosinski and Szymon Ulatowski
- volunteers involved in development, experiments, and technical support

Main points of users' interest

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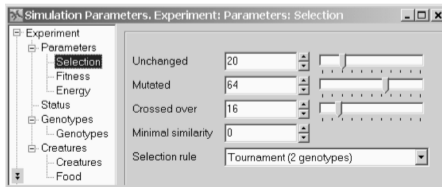
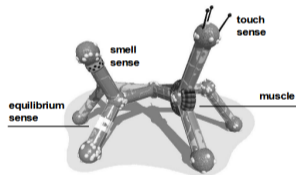
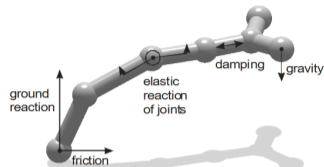
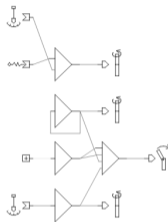
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- simulation
- biology, evolution
- robotics
- neuroscience
- cognitive science
- computer science
- visualization
- education and understanding
- simplicity / complexity
- entertainment
- versatility



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- regular users
- students
- teachers and researchers:
 - Virtual Life laboratory, Utrecht University, Netherlands
 - Bio-inspired Adaptive Machines Course at Autonomous Systems Lab, Lausanne, Switzerland
 - Cognitive Science Lab., Dept. of Philosophy, William Paterson University of New Jersey, USA
 - ...
- advanced users from all over the world

Users

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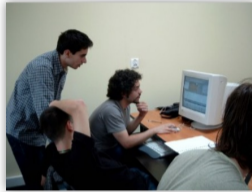
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- articles in paper and electronic magazines
- interviews for newspapers, magazines, radio, and TV
- lectures, seminars, presentations, and demonstrations at conferences, workshops, academic institutions and popular shows
- third-party demonstrations (artistic exhibitions, thematic presentations – history of technology, evolution, medicine, etc.)

Presentations invited by

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- LEGO Lab, University of Aarhus, DK
- TheoLab, Jena, DE. Friedrich Schiller University. Research Unit for Structure Dynamics and the Evolution of Systems
- University of Dortmund, DE. Chair of Systems Analysis, Department of Computer Science
- Max Planck Institute, Lipsk, DE
- Santa Fe Institute, USA
- European Summer School, PL
- Princeton Institute for Advanced Study, USA. Summer School in Computation and Biology
- University of North Carolina at Charlotte, USA
- Academy of Sciences, PL
- Paris 8 University, FR

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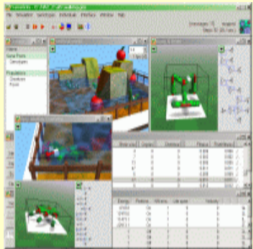
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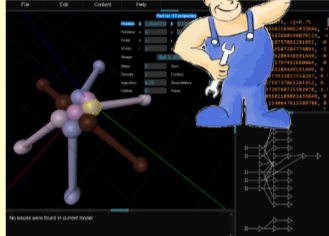
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Simulator GUI



Visual editor



Simulator command-line and network server

frams.exe

Framsticks command line interface
Homepage: <http://www.framsticks.com/>

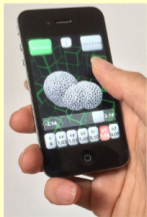
```
VMNeuronManager::autoload [INFO] S
UserScripts::autoload [INFO] S
Simulator::load [INFO] S
```

Framsticks Command Line

Framsticks command line interface
Homepage: <http://www.framsticks.com/>

```
VMNeuronManager::autoload [INFO] S
test Delay Thr ChSel_Test
UserScripts::autoload [INFO] S
Simulator::load [INFO] S
[newshell activated - cURL
```

Artificial Life (mobile app)



Native library with C++ and Python bindings

```
class FramsticksLib:
```

```
    def getSimplest(genetic_format) → str
```

```
    def evaluate(genotype_list: list[str]) → list[dict]
```

```
    def mutate(genotype_list: list[str]) → list[str]
```

```
    def crossOver(geno_parent1: str, geno_parent2: str) → str
```

```
    def dissimilarity(genotype_list: list[str]) → np.ndarray
```

```
    def isValid(genotype_list: list[str]) → list[bool]
```

Network software

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Portable clients

The screenshot shows the 'tree7.py' application window. On the left, a tree view displays 'FramServer objects' including Genotypes, Populations, and a selected 'Creatures' group. The 'Creatures' group contains sub-items like 'Arumud Ezy', 'Model Parts', 'Model Joints', 'Neuron Definitions', 'Simulated Parts', 'Simulated Joints', 'Live Neurons', 'Uxana Sely', and 'Food'. The right panel shows configuration options for the 'Creatures' group, such as 'Number of creatures', 'Energy calculation', 'Death', and 'Neural net simulation'. A 'Frame Client: 30' window is overlaid, showing a 3D visualization of a neural network structure with nodes and connections. A status bar at the bottom indicates 'Connected to FramServer@127.0.0.1:9009'.

Command-line server

```
frams.exe
Framsticks command line int
Homepage: http://www.framsticks.org

VMNeuronManager::auto
UserScripts::autoload
Simulator::load [INFO]
>

Framsticks Command Lin
Framsticks command line
Homepage: http://www.framsticks.org

VMNeuronManager::auto
test Delay Thr ChSel_Tes
UserScripts::autoload [I
Simulator::load [INFO] S
[newshell] activated - cu
>
```

Experimentation Center



Visual editor

The screenshot shows a 'Visual editor' window. On the left, a 3D model of a neural network is displayed with nodes of various colors (blue, purple, yellow, brown) and connecting lines. On the right, a panel lists parameters for 'Framsticks Experimentation Center' with values for 'Number of neurons', 'Number of synapses', 'Number of connections', 'Number of synapses', 'Number of connections', 'Number of synapses', and 'Number of connections'. A status bar at the bottom indicates 'No issues were found in current model'.

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- Sources: C++, lex, bison, m4, awk
- Third-party libraries: PLIB, GLPNG
- Sources available in SVN repository – [SDK](#)
- Additional apps and modules: Python, JavaScript

Technical information – source size (C++ only)

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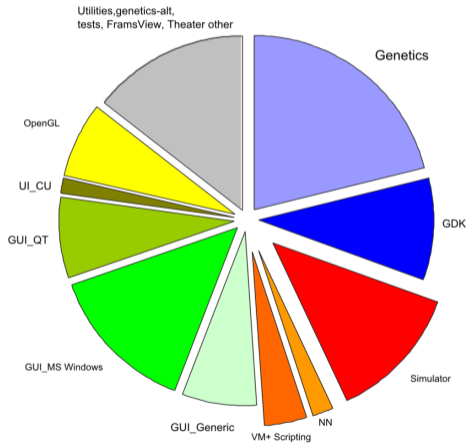
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2003: 78 KLOC, 2 MB



Technical information – source size (C++ only)

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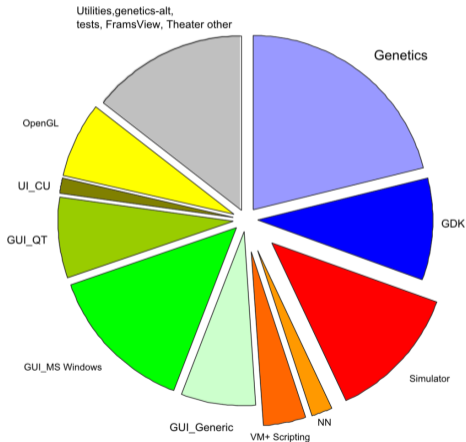
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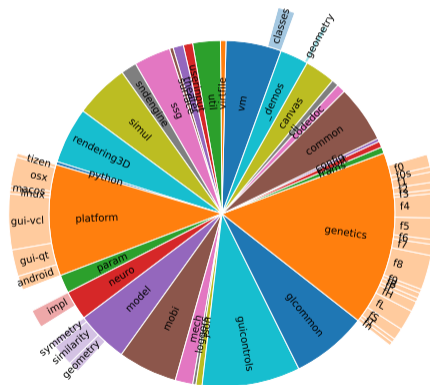
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2003: 78 KLOC, 2 MB



2024: 264 KLOC, 7.7 MB



Sample uses and experiments

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- synthesizing (building) agents
- studying agents' behaviors
- optimizing agents
- designing genetic representations
- studying evolutionary dynamics, coevolution, migration, etc.
- evolving neural and fuzzy controllers
- understanding evolved brains
- evolving communication and cooperation
- designing custom user experiments

- publications available from the [web site](#)

Synthesizing agents

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Genotype data. Genotype

Genotype

- Notes
- Body
- Performance
- Fitness
- Conversions

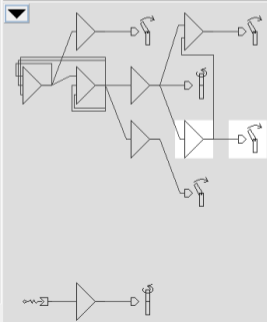
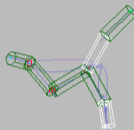
Name: Speedy

Genotype: `bGgLLLLffffMMMMM(, LLcffffMMMMQ(, lX[0:2.420, 1:-0.626, 1:-1, fo:0.04, fo:0.04] [-1:1, 0:1, 0:-1, s:0.577] [@-1:1.283, fo:0.041] Mq(RMMMMFX[-1:1.537, 1:2.088] lqX[-2:-1.094, s:0], RmmDDXfMMMMFmMFX[@T:0.128]), RRiffMX[-6:-0.703, si:2] IFFFFFX[-6:-0.696]))`

Mutate

g6

OK Cancel Apply



Synthesizing agents

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The screenshot displays a software interface for synthesizing agents, titled "Genotype data. Genotype". The interface is divided into several sections:

- Left Panel:** A navigation menu with options: Genotype, Notes, Body, Performance, Fitness, and Conversions.
- Top Section:** A form for editing the agent's name and genotype.
 - Name: Speedy
 - Genotype: `bGgLLLLffffMMMMM(, LLcffffMMMMQ(, lX[0:2.420, 1:-0.626, 1:-1,fo:0.04,fo:0.04] [-1:1, 0:1, 0:-1,s:0.577] [@-1:1.283,fo:0.041] Mq(RMMMMFX[-1:1.537, 1:2.088] lqX[-2:-1.094,s:0], RmmDDXfMMMMfMmFX[@T:0 RRiffMX[-6:-0.703,si:2]IFFFFFFX`
- Right Panel:** A 3D rendering of a robot arm with green and purple segments.
- Bottom Section:** A "Mutate" button and a field containing "# g6".

Overlaid on the bottom right is a "Part no. 12 properties" dialog box with the following data:

Property	Value
Position	x: 0.0668216, y: 0.176124, z: 0
Rotation	x: 0, y: 0, z: 0
Scale	x: 1, y: 1, z: 1
Vector	r: 1, g: 0.675, b: 1
Shape	Ball & Stick
Mass	2
Density	1
Ingestion	0.25
Halfway	0
Size	1
Friction	0.4
Assimilation	0.25
Veloc	0.2

Below the dialog box, a neural network diagram is visible, showing a series of nodes and connections. The text "No issues were found in current model" is displayed at the bottom of the dialog box.

Studying agents' behavior

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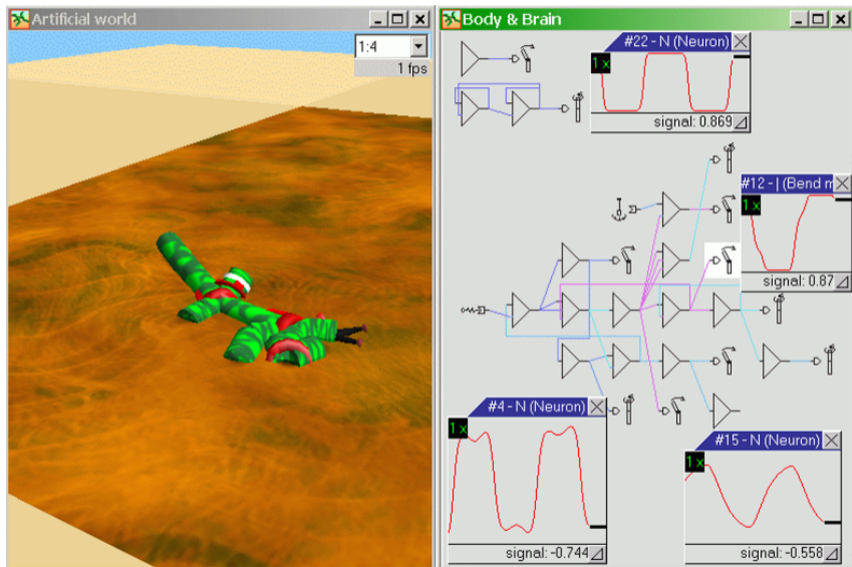
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Investigating evolution (tree, exogenous fitness)

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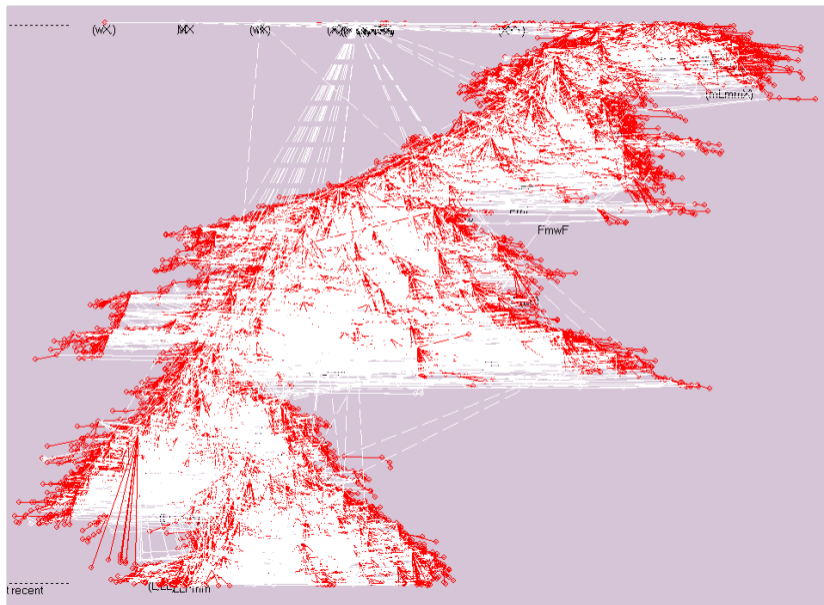
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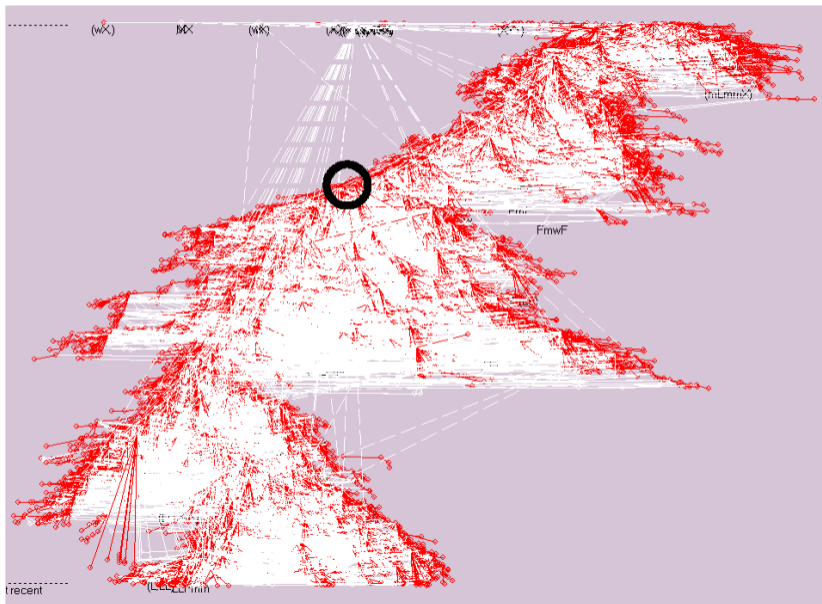
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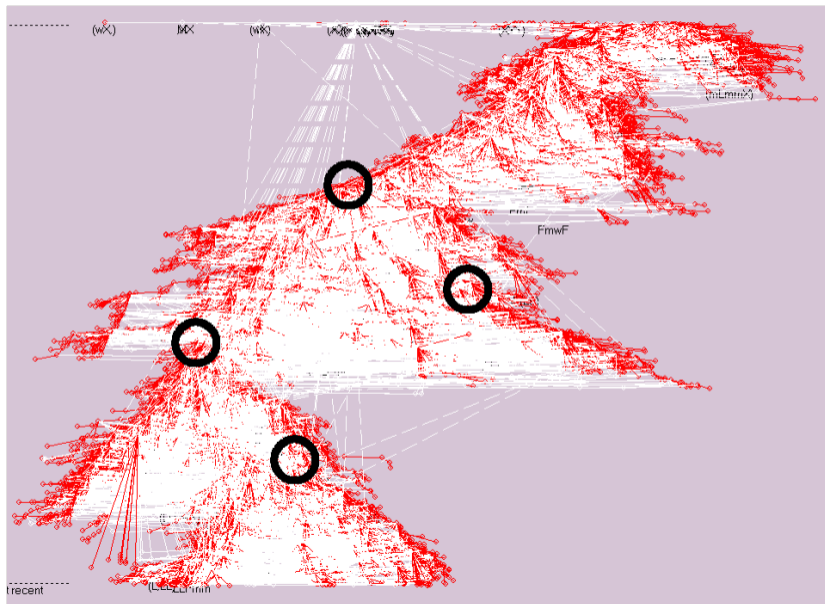
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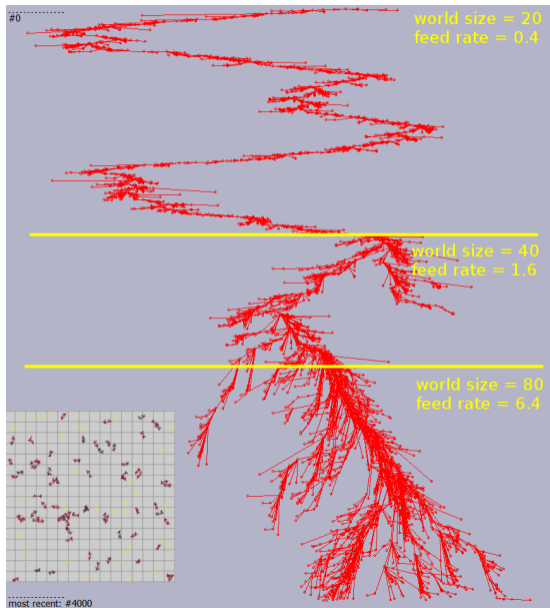
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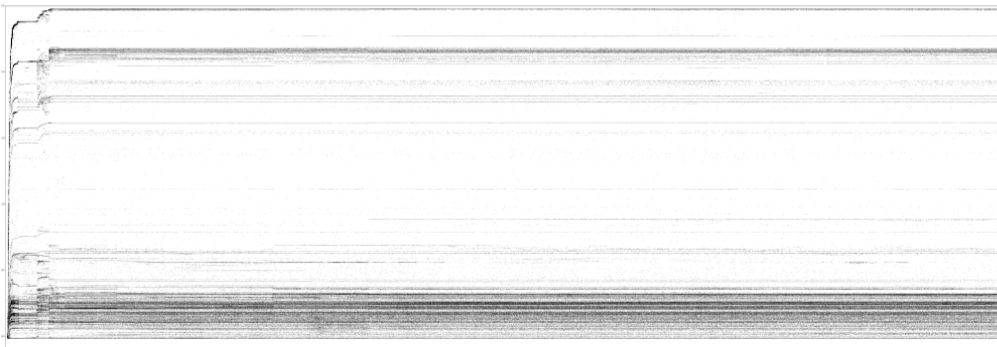
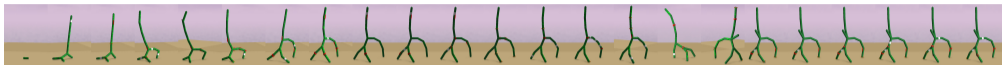
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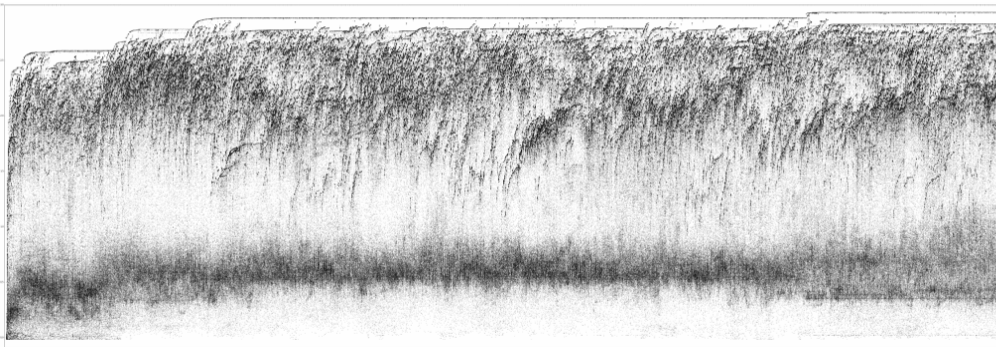
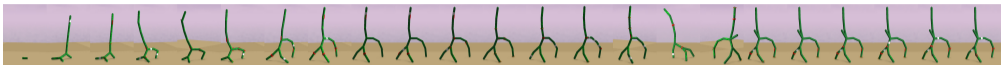
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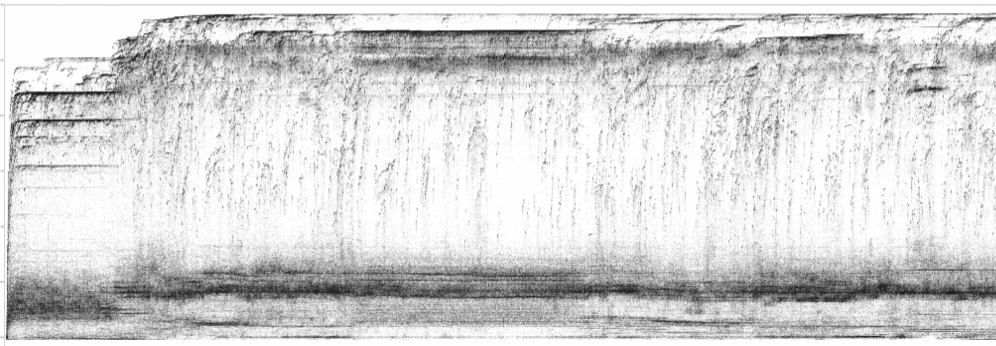
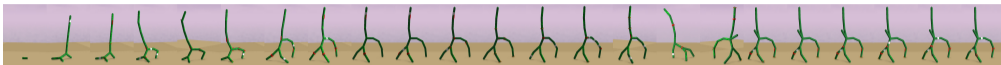
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Investigating evolution (individuals)

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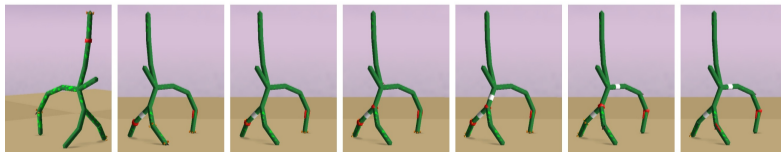
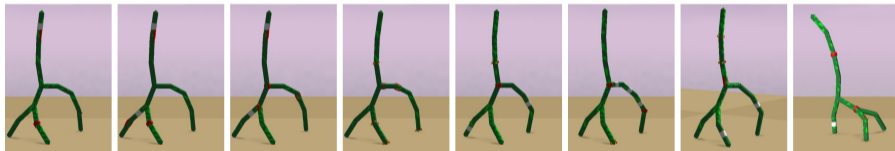
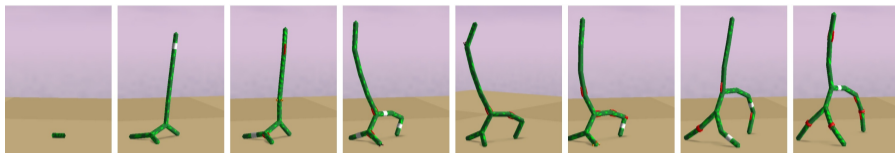
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<https://youtu.be/ZRIe0YpTS04>

Potential evolved behaviors

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- walking/swimming/jumping/rolling/...
- memory
- predation, prey
- symbiosis, cooperation
- mutual identification and location
- preferences, group/social behaviors
- communication
- feelings, consciousness, ...?

- ... they discover, learn, and exploit simulator imperfections!

Framsticks as an open system

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- custom fitness functions
- experiment definition scripts for custom definition of system framework; user-defined neuron types
- support for various [genetic representations](#)
 - conversion to the basic format
 - genetic operators
- network submission of experiment proposals and interesting genotypes; Experimentation Center
- discussion forums for users and developers
- custom definitions of visualization rules (POV-Ray, [OpenGL](#))
- open-source projects

Style: Classic

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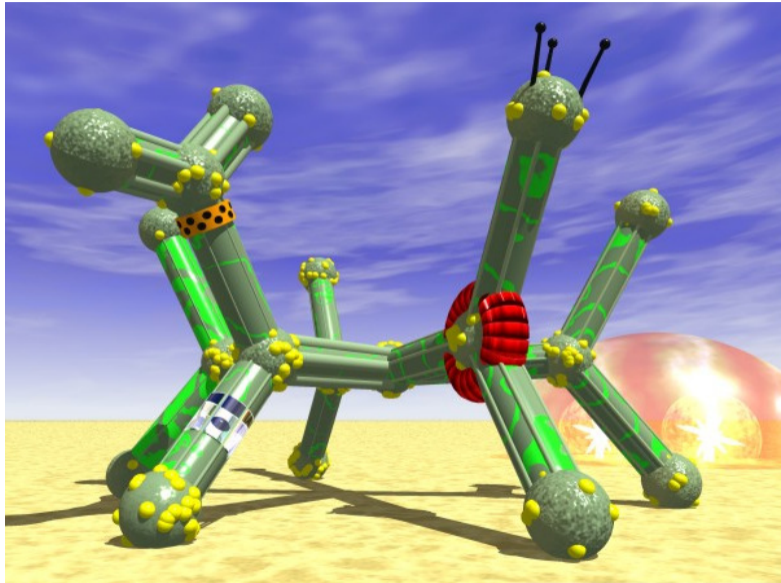
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Style: Planet

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Style: Planet

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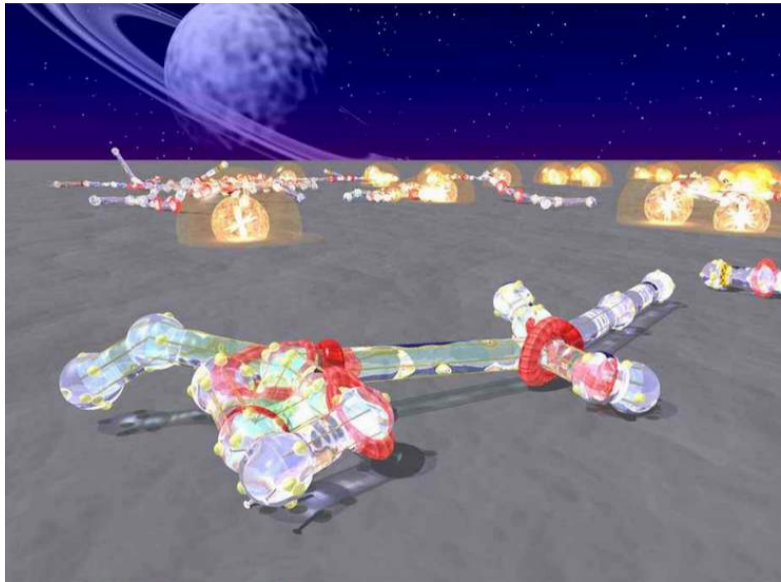
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Style: Blocks

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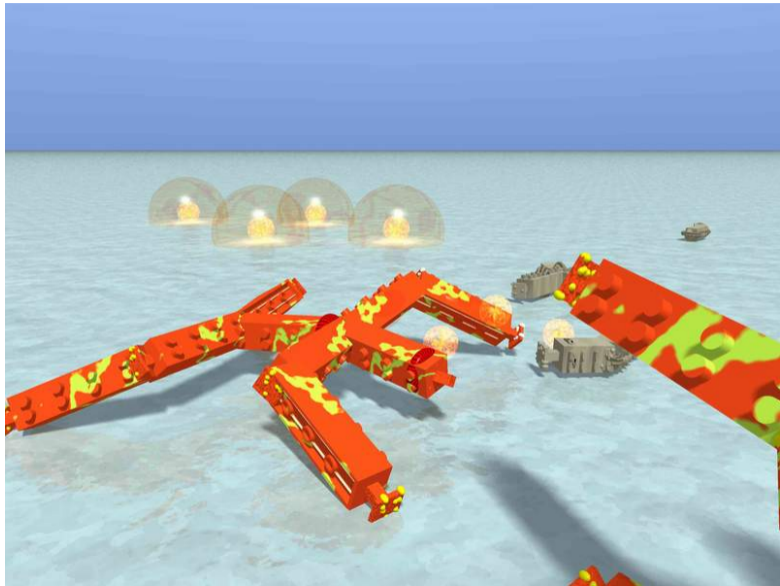
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Style: Blocks

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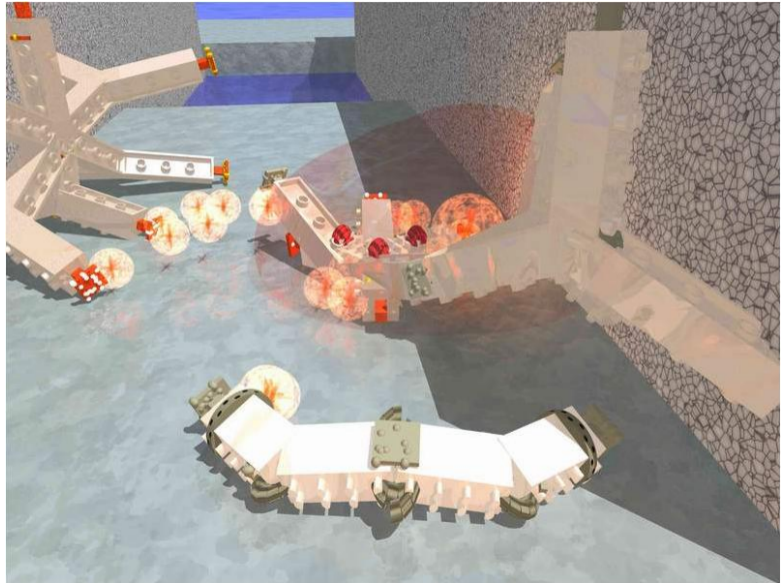
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Style: Ghost

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Style: Chestnuts

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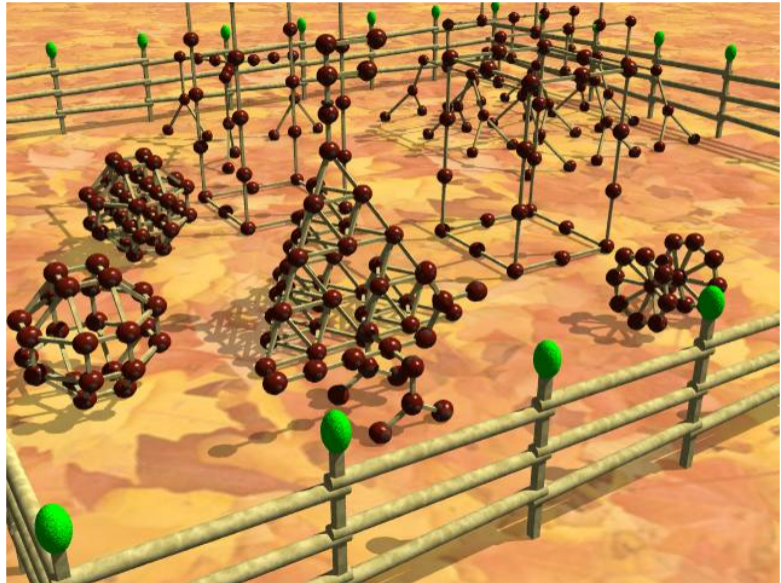
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Style: Wookiee

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Style: Wookiee

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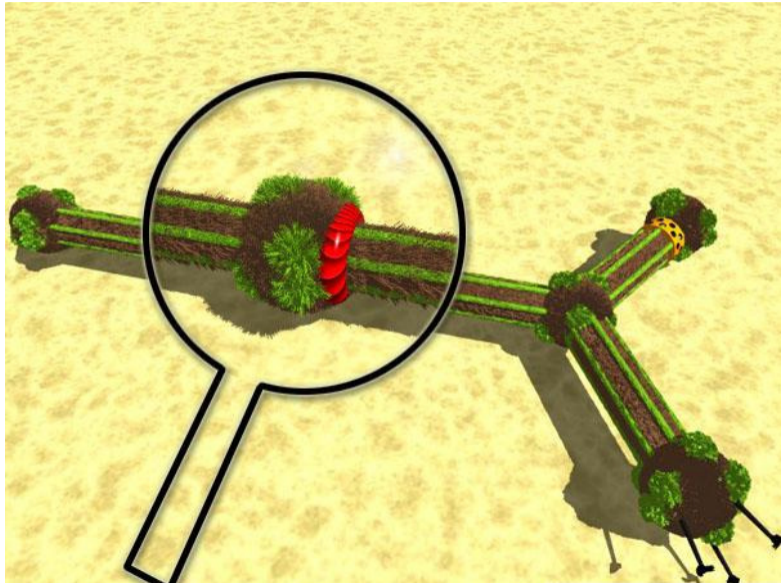
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- simulating bodies controlled by CAM Brain – PL/JP '98
- LEGO Lab – DK '99
- simulating bodies controlled by wet brains, real neural tissues – USA '00
- HP: Internet, entertainment – USA '00
- UWE, Intelligent Autonomous Systems Engineering Lab., evolving real robots – UK '00
- autonomous/NN agents: games/VR – UK '00
- Max Planck Institute/TheoLab: evolution, phylogeny and methodology – DE '00
- NASA: Space Station robot optimization – USA '04
- structural design – PL '18
- soft robotics, optimization of designs and control – PL '23

Further development and research

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- network programs, distributed and parallel evolution
- other genetic representations
- more complex tasks / environments
- tools for analysis of emerged behaviors
- open-ended and spontaneous evolution
- more sensors/effectors (e.g., communication), more fitness criteria
- evolution distributed via mobile apps and Experimentation Center

Inspiration for EC, AL, and KD/ML

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- decomposition of hard optimization problems
- hierarchical representation of solutions
- effective crossover operator and speciation
- measures of similarity of complex solutions; global convexity of the search space
- coevolution of solutions and constraints/fitness function
- properties of various solution encodings
- automatic analysis of evolution and agent behaviors
- active perception