

# Effective execution of System Dynamics models

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# Agenda

- Introduction in System Dynamics
- SdCloud Project
  - Motivation
  - Goals
  - Architecture
- PySD Library
- Optimization processes in System Dynamics
- ErlSD computation core

# System Dynamics

**System Dynamics** is a methodology and mathematical modeling technique to frame, understand, and investigate issues and problems of complex systems, such as:

- Causal relationship
- Loops feedbacks
- Delays reactions
- The impact of the environment

## Basic terms:

- Stocks - model accumulated values
- Flows - rate of stocks changing

## Basic model formats:

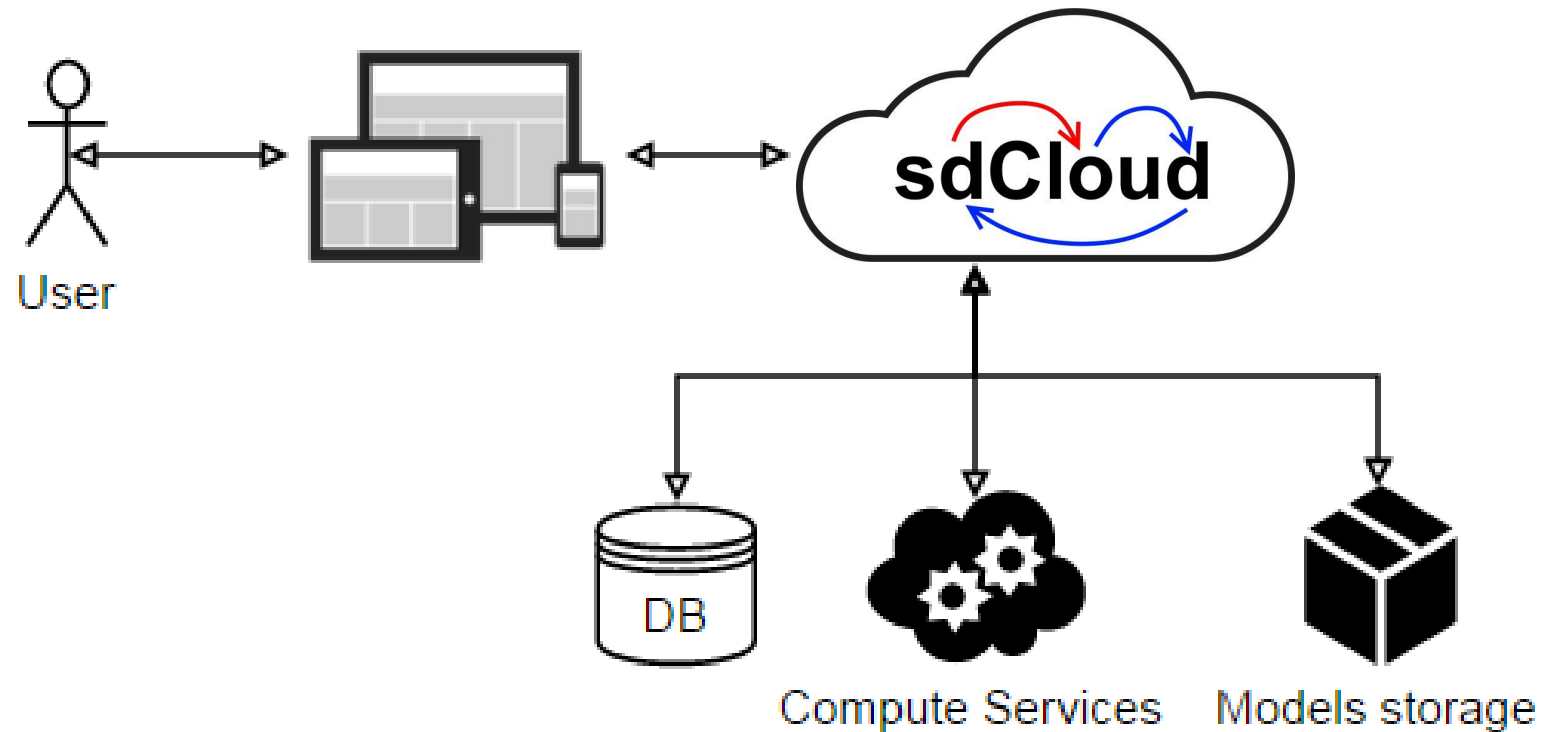
- XMILE
- Stella
- Vensim

# System Dynamics: model in XMILE format

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<xmile version="1.0" xmlns="http://docs.oasis-open.org/xmile/ns/XMILE/v1.0">
  <header>
    <name>Teacup cooling</name>
  </header>
  <sim_specs>
    <stop>50.0</stop>
    <start>0.0</start>
    <dt>0.25</dt>
  </sim_specs>
  <model>
    <variables>
      <flow name="TDIFF">
        <doc>Heat Loss</doc>
        <eqn>KFAC*(RMTMP-CUPTEMP)</eqn>
      </flow>
      <stock name="CUPTEMP">
        <doc>CURRENT TEMPERATURE</doc>
        <inflow>TDIFF</inflow>
        <eqn>170</eqn>
      </stock>
    </variables>
    <views>
      <view>
        <flow name="TDIFF" x="150.0" y="50.0">
          <pts>
            <pt x="125.0" y="50.0"/>
          </pts>
        </flow>
        <stock name="CUPTEMP" x="200.0" y="50.0"/>
      </view>
    </views>
  </model>
</xmile>
```

# SdCloud project

**SdCloud** is a new open-source project, designed as a cloud-based execution environment for System Dynamics models.



# SdCloud project: Motivation

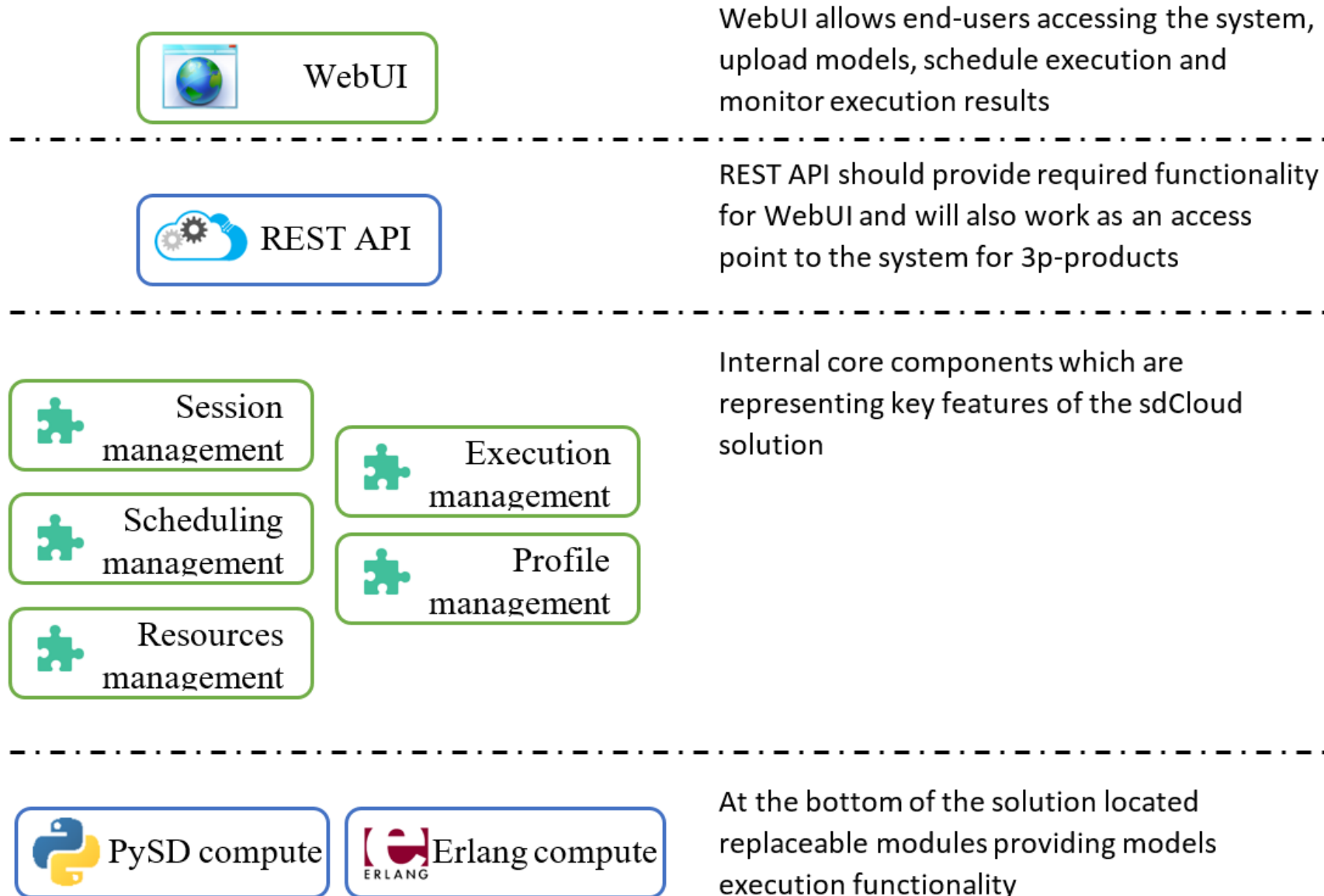
## Disadvantages of existing products

- Costliness of commercial projects
- Lack of separation between model creation and model execution
- Lack of model translation
- Complexity of the installation and configuration
- Integration issues
- No cloud-based projects

# SdCloud project: Goals

- Cloud-based solution
- Features
  - Download models in any format
  - User-friendly interface to edit models
  - Schedule model execution
  - Execution progress tracking
  - Storing and sharing of models and its execution results
  - Rest API

# SdCloud project: Architecture



WebUI allows end-users accessing the system, upload models, schedule execution and monitor execution results

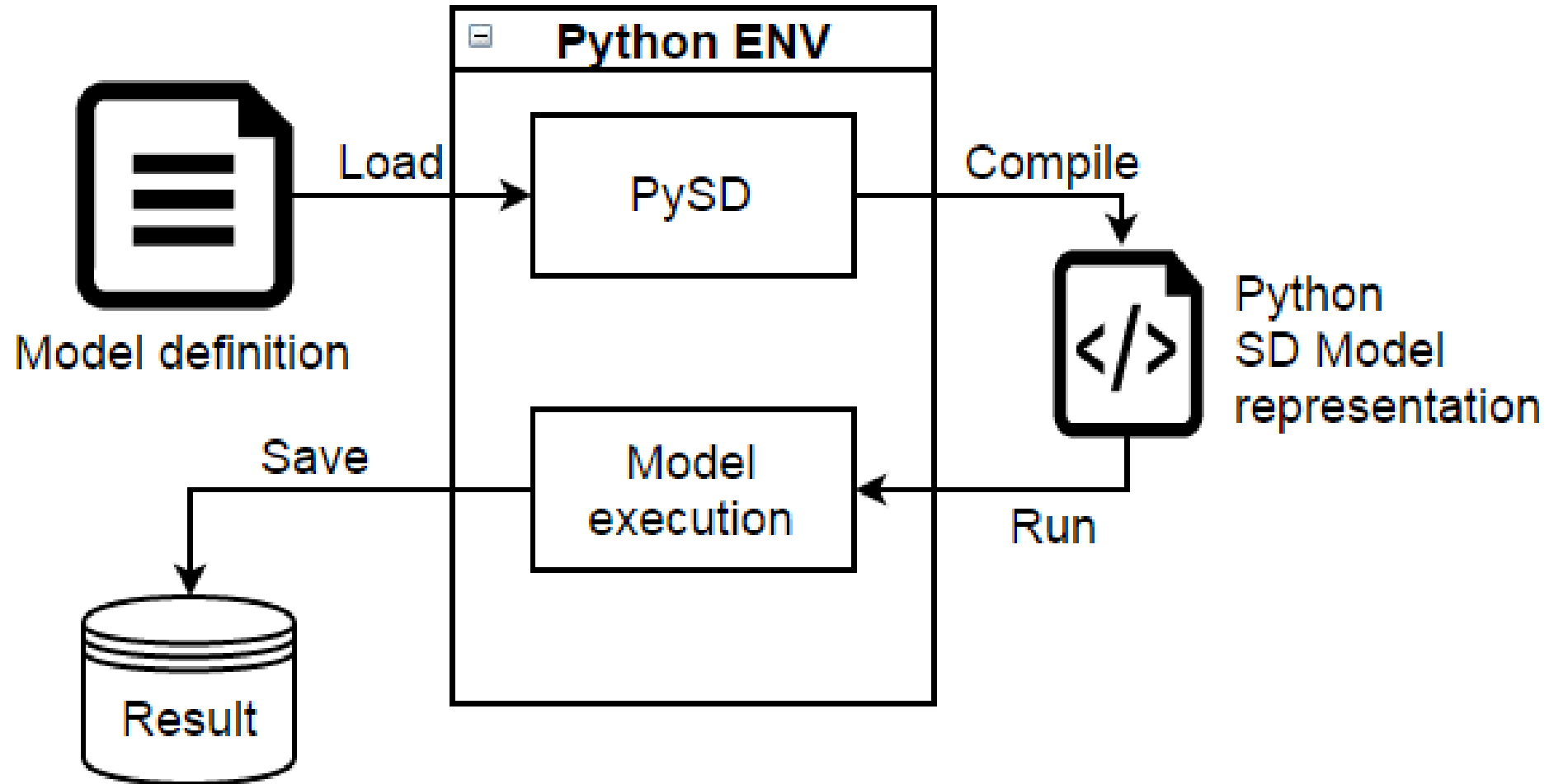
REST API should provide required functionality for WebUI and will also work as an access point to the system for 3p-products

Internal core components which are representing key features of the sdCloud solution

At the bottom of the solution located replaceable modules providing models execution functionality



# PySD computation core



# Optimization processes in System Dynamics

## **Instrumental approach**

- Optimization by changing development tools and technologies
- Translation of models into functional programming language
- Profit due to runtime

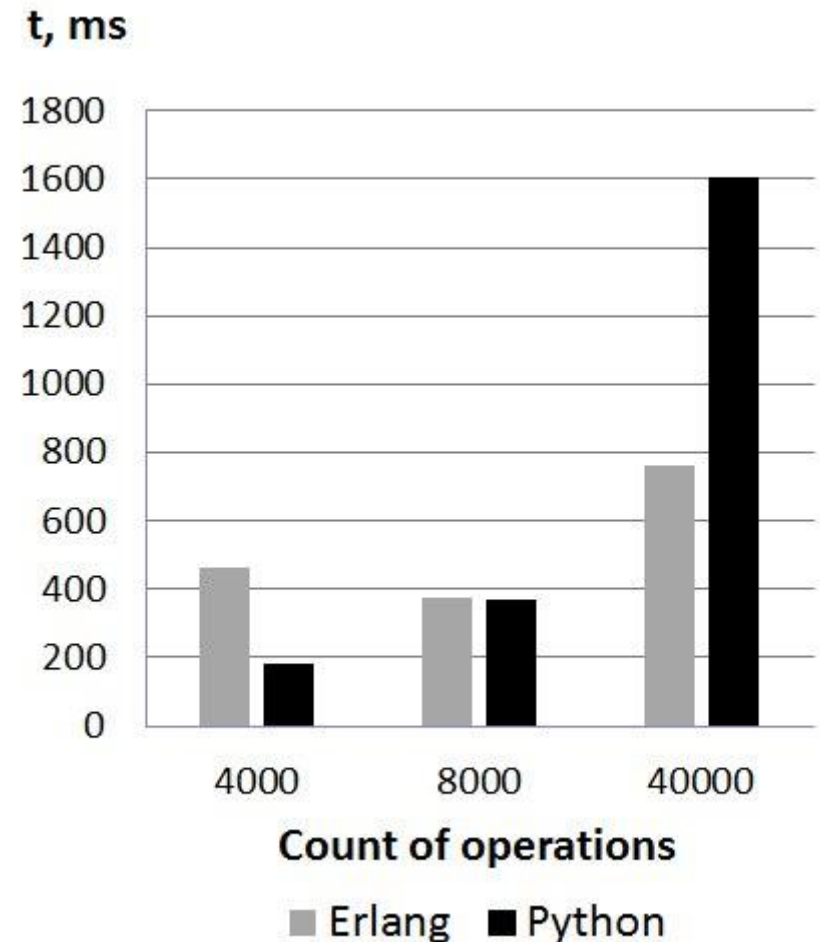
## **Disturbed algorithms approach**

- Development of specific disturbed algorithm
- Model is spitted into separated nodes
- Nodes are represented by linked graph
- Nodes without feedback loops executes in parallel

# ErISD computation core

**Erlang** execution environment provides following benefits:

- Not require for manual handling of system resource allocation
- All processes executes in virtual machine
- Erlang has integrated functionality for design distributed applications
- Hot code upgrade provide possibility of quickly changing model compiled representation

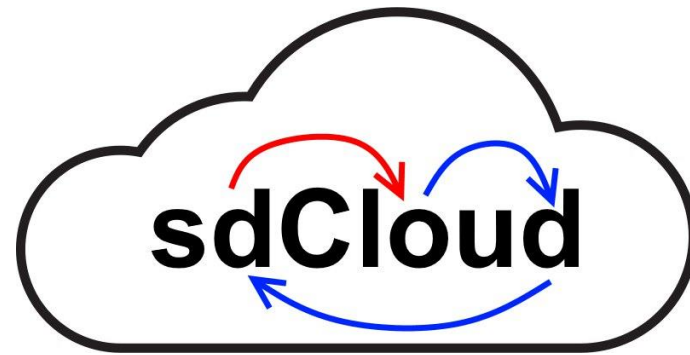


# Conclusion

SdCloud project is an answer to the big data processing and data access challenges facing by the System Dynamics community.

- ✓ Easy to start with
- ✓ Easy to use
- ✓ Easy to share
- ✓ Easy to integrate

# Thanks for attention!



<https://sdcloud.ifmo.ru/>