OSLANDIA

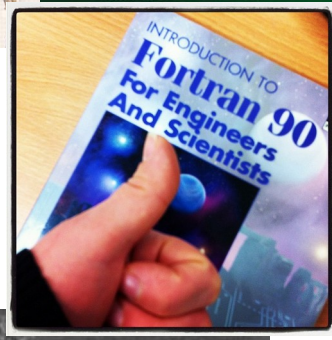
Simulation & QGIS

On simulation and GIS,
coupling and hydrology

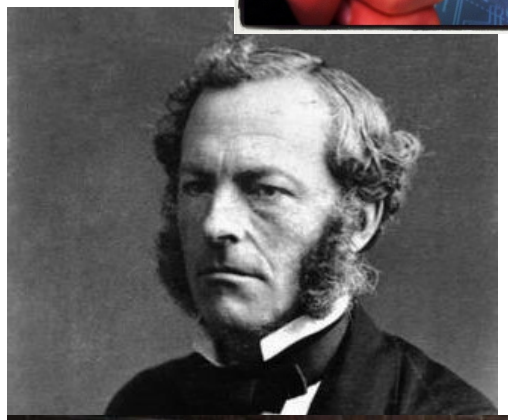
Vincent Picavet / Vincent Mora

Simulation

Different worlds



- Who runs simulations ?
- Simulation scientists can be hard to understand
- Technology gap

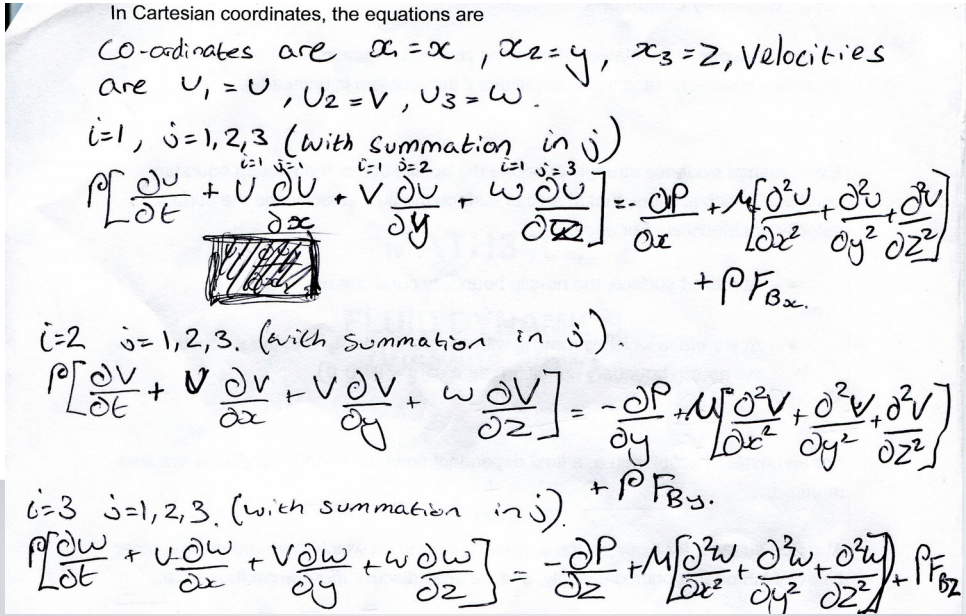


- ⇒ Bridge the gap
  - ⇒ enable simulation visualisation

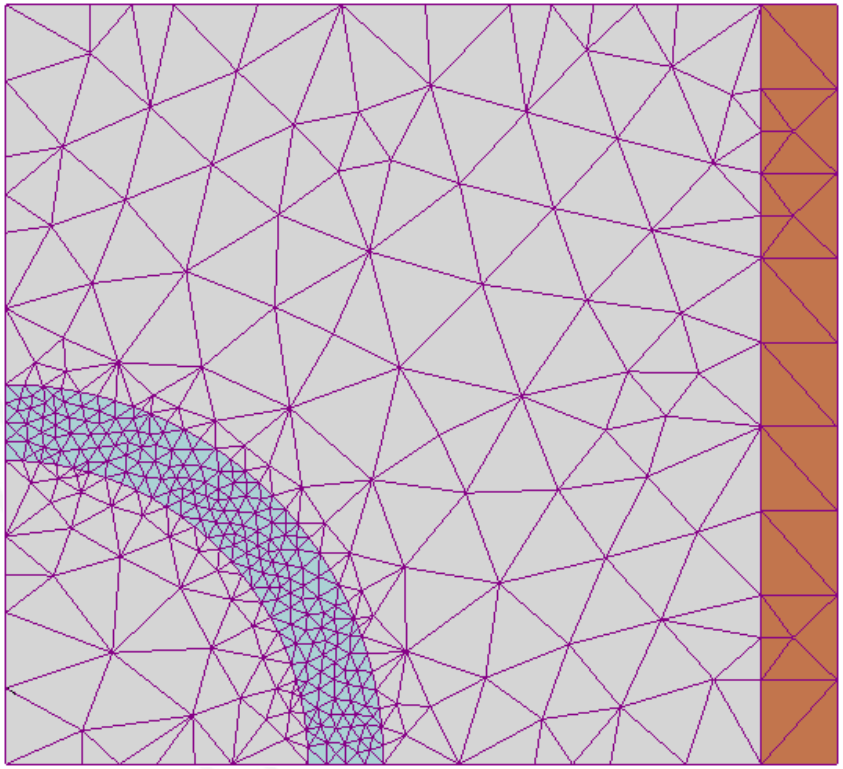
(Disclaimer : I was into simulation before GIS)

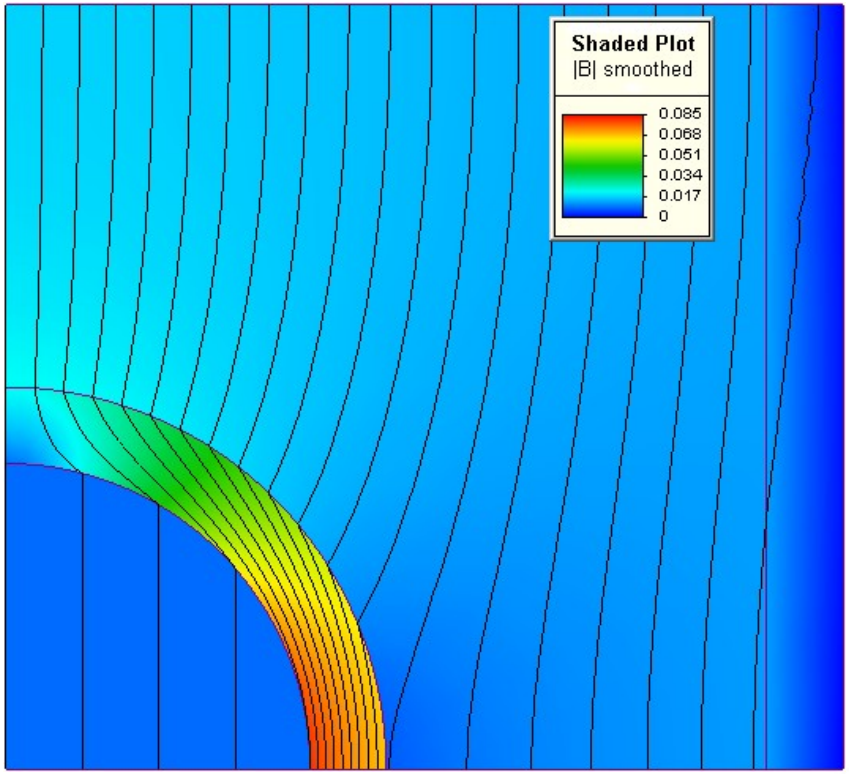
Simulation 101

- You have some « dynamic » model of a physical law
  - Usually modeled by differential equations
  - And depending on time
- You want to « solve » it on a particular domain
  - Analytical solutions cannot be used (do not exist or too hard)
- Cut down the problem into smaller problems
  - Into smaller subdomains
  - **=> Finite elements**

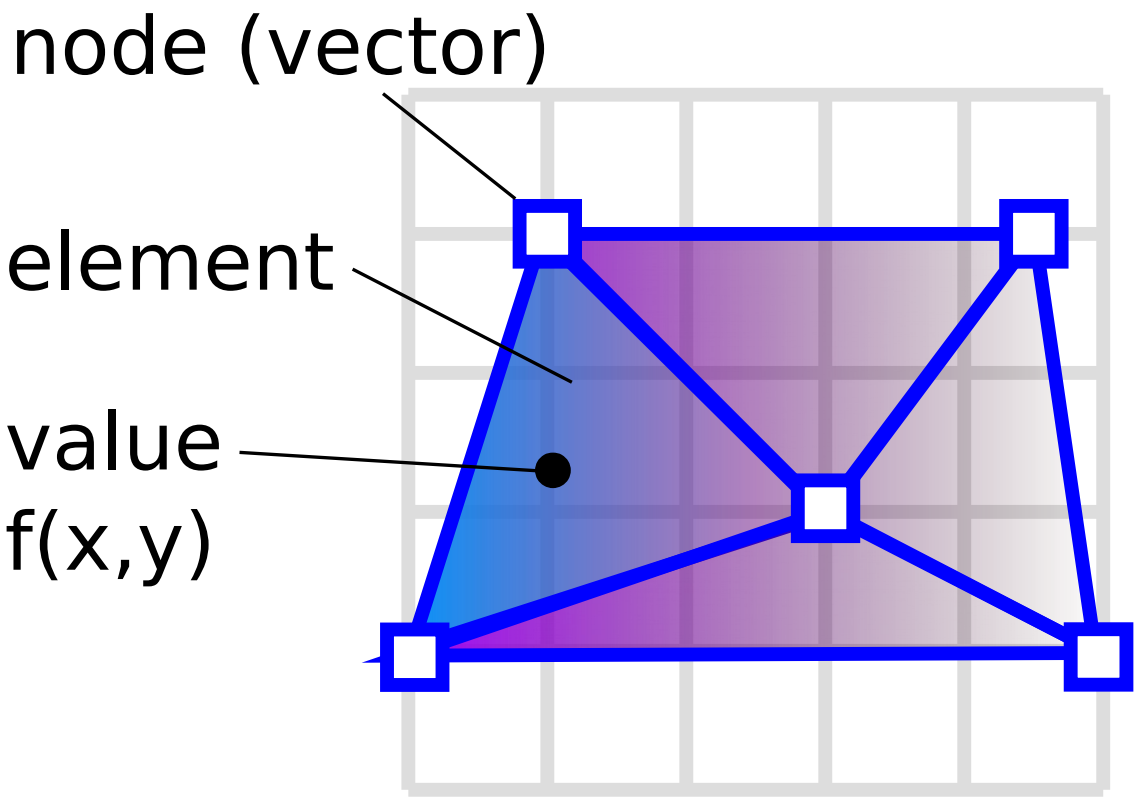


- Example : magnetic field problem





Vector field



Open source simulation

- Lots engines, models and formats !
  - MM5 (weather forecast)
  - Polyphemus (air quality)
  - SWMM (stormwater)
  - EPANET (drinking water)
  - WASP (wind speed)
  - MESO-NH (air quality)
  - OpenSees (earthquake)
  - open TELEMAC-MASCARET (tidal flow)
  - ...

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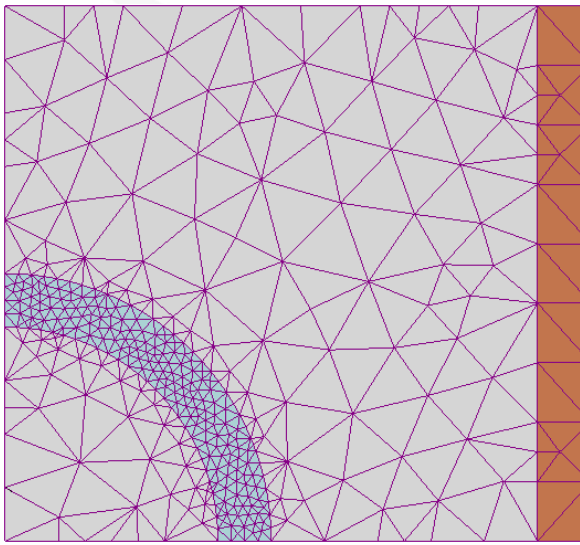
All can be geo-referenced

First try : use features



- Mesh cell = feature
- Value = attribute
- PostGIS / Spatialite classic geometry table
  - ⊗ Spaghetti model problem !
  - ⊗ Repeat features for temporal data
  - ⊗ Huge volumes ⇒ not efficient

- Mesh is a really different type of data….

A new friend for Vector, PointCloud and Rasta ?

Meet «Mesh»

SIM & GIS

Our focus

- GIS Data
  - Meshes with georeferences
- Representation: suitable for both simulation and GIS
  - Arbitrary values on nodes
  - 1D, 2D or 3D
  - Topological constraints (!= polygon soup)
  - Interpolation functions
  - Simple and efficient format
  - Seen as GIS layers when needed (spatial analysis)
  - Seen as a simulation mesh when needed

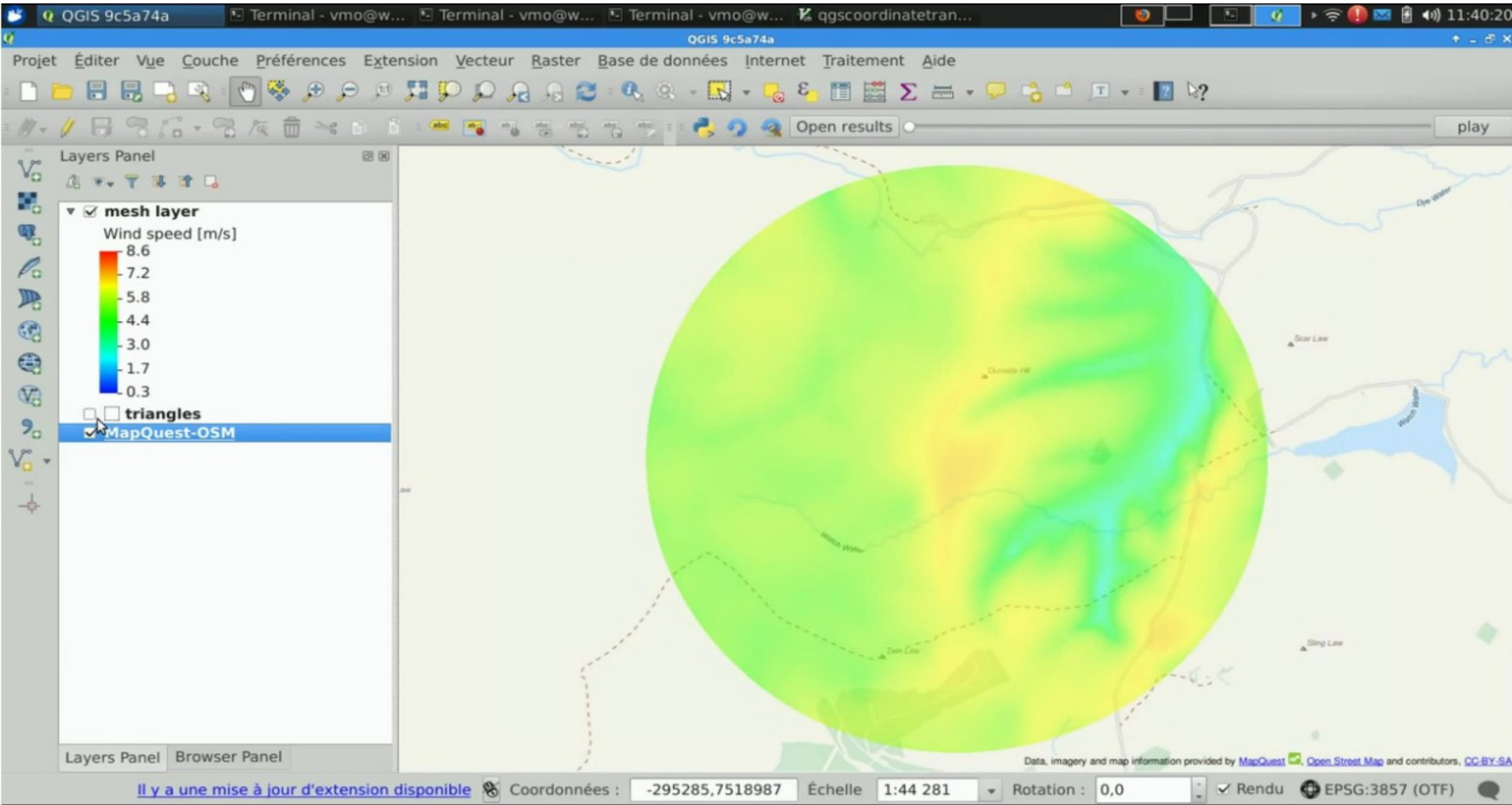
Data model

- Generic
  - A layer of « nodes »
    - A POINT layer with arbitrary attributes
  - A layer of connectivity
    - 3 or 4 columns (node Ids) for triangles or quads + attributes
  - A layer of results for each node
    - Node_id, Time, Value

Demo

- Geo-hydrological demo for Nuclear pollutant dissemination
  - « please do not show this »
- Wind data simulation
  - Simple ASCII file format
  - Temporal data
- A PluginLayer that draws the result
- A control GUI

https://vimeo.com/139449072



QGIS Mesh implementation

- Custom color scale support
- Min/max & log scale support
- OTF reprojection & map rotation support
- Performances
  - Rendering 70k triangles < 8ms
  - Data fetching can be bottleneck

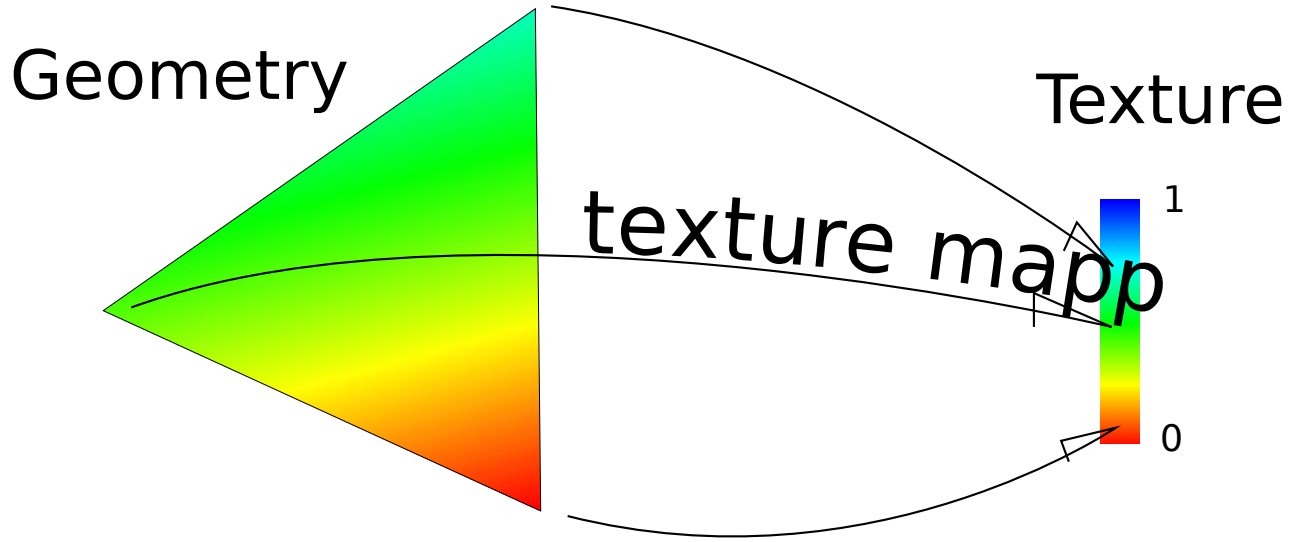
    → load data in memory in provider
- Not yet in QGIS master

QGIS Mesh implementation

- QgsPluginLayer - **MeshLayer** - **MeshDataProvider**
- Specific Registry for MeshDataProvider
- Various MeshDataProvider
  - Simple ASCII sample
  - SpatiaLite-based provider
  - … to be extended ...
- GlMesh class for colored mesh rendering

Result visualization

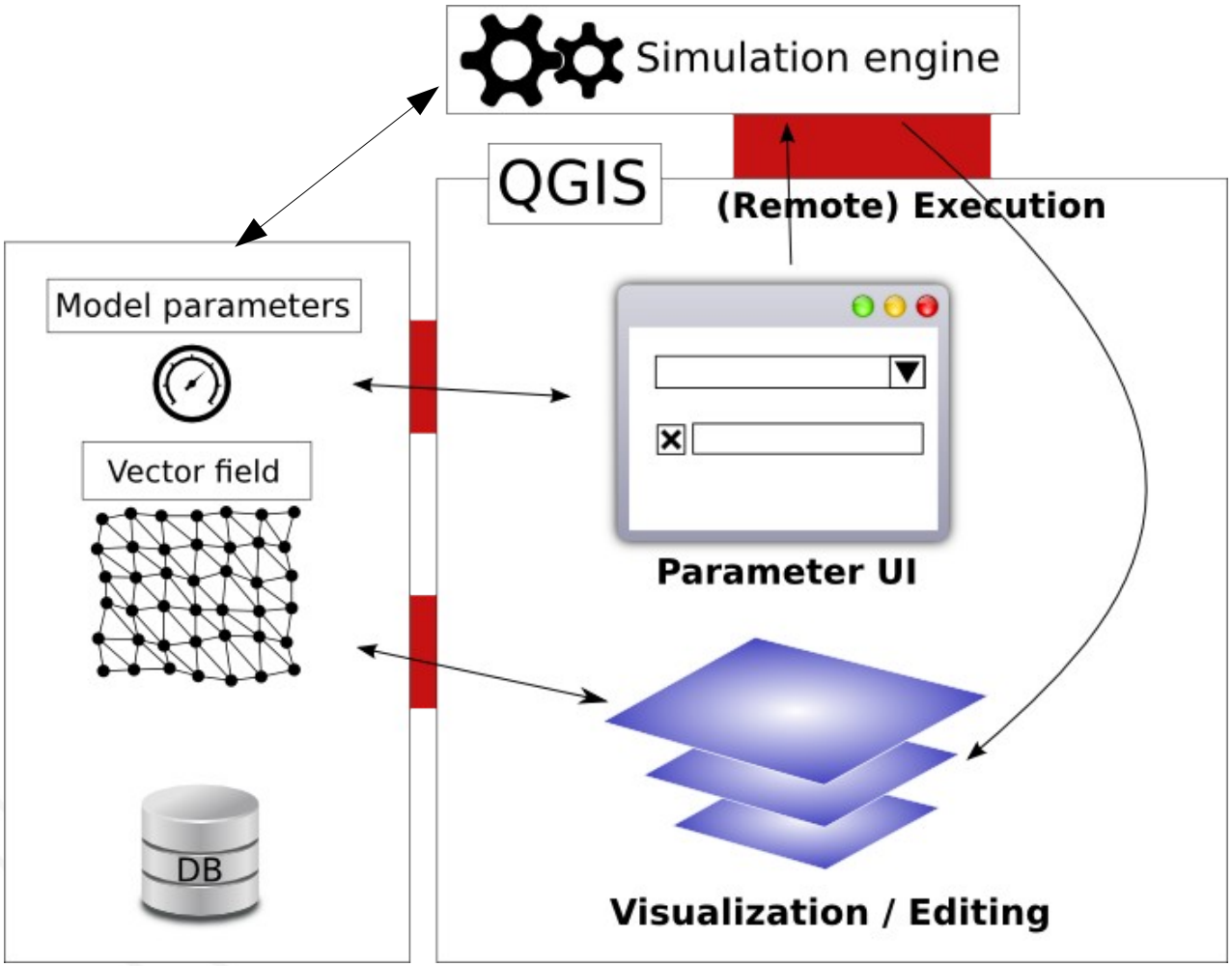
- We use OpenGL
  - Linear interpolation of values = natural with OpenGL
  - Great performances



QGIS as simulation platform

The global picture

- Towards a generic simulation platform



QGIS as simulation platform

- Separate simulation and GUI
  - Quick GUI generation for parameters with QGIS
- Use QGIS Processing as simulation wrapper
  - Integrate simulation into QGIS Processing workflows
- Get data and parameters from DB
  - PostGIS, SpatiaLite

Hydrology

Application : Hydrogeology

- Non-disclosed user
- We converted simulation data input to GIS data
  - Small changes to simulation code
  - Much better user interface & capabilities
- Output : temporal meshes
  - Opened directly as QGIS mesh layers
- Output : 1D dissemination columns (table)
  - Display with specific Matplotlib widget

Application : FREEWAT

- FREEWAT H2020 project (www.freewat.eu)
- QGIS as a Hydrology platform
  - Pre-processing
  - Post-processing
  - Simulation control
  - Data visualization
- MODFLOW simulation code interface
- Run to see Massimiliano's talk at 14:40 Room 12

FREEWAT
Free and Open Source Software Tools for Water Resource Management
EU HORIZON 2020 Project

Future

Future

- 3D
  - Finite elements ⇒ 3D representation
  - OpenGL in QGIS plugin
- Custom composer widget API
  - Your own object types in composer
  - e.g. : 2D slice of 3D data
  - or MatplotLib graph
- New formats support for Mesh Layers
  - HDF ? NetCDF ?
-

감사합니다
Merci
Thank you

Questions ?

vincent.picavet@oslandia.com

@vpicavet

www.oslandia.com

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