

Dr. Dirk Kähler

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## Add-In 'GoalSeeker' advanced parameter optimization in single and combined models



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advanced parameter optimization in single and combined models

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## Agenda

- Overview Add-In GoalSeeker
- basic Examples
  - Sweep with optimization
  - serial optimization of two parameters
  - nested optimization of two parameters
  - sweep without optimization
- Examples with two model files
  - successive calculations in two model files
  - parameter optimization in two independent models
  - parameter optimization in two combined models

# Add-in ‚GoalSeeker’ parameter sweep and advanced optimization

- compatible with all types of studies / physics
- operates on Windows, Linux and in client-server configurations
- low memory consumption – sweep results stored as table
- easy change between stored settings
- parameter sweep
- segregated or nested multi parameter optimization
- search for **target value** or **minimum value**
- automated data and mesh import and export

## advanced possibilities

- additional steps for initialization and analysis
- combined steps with multiple studies and method calls
- simultaneous use of two interacting model files

The screenshot displays the GoalSeeker software interface. At the top, there is a 'Compute' button and a dropdown menu set to 'Sweep L solve Current and Tmax'. Below this, the 'Outer Parameter Sweep' section is active, showing a table with columns for 'Parameter', 'Values', 'Unit', and 'Modify'. The table contains one entry: 'L' with a value of '6 7' and a unit of 'cm'. There are also checkboxes for 'Sweep', 'append', and 'final Sweep', and a button for 'all combinations'.

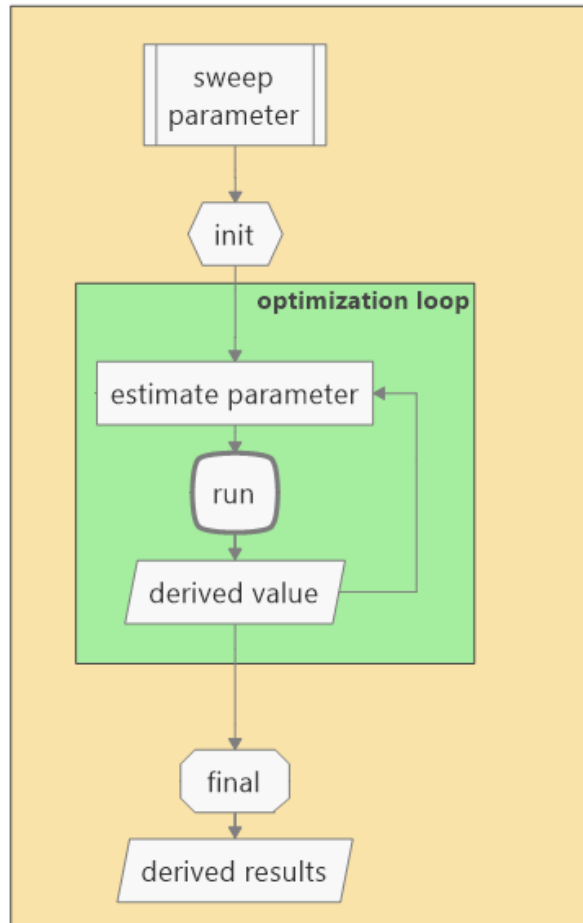
The 'Goal Seek' section is also visible, featuring 'Swap Level' buttons (1 <-> 2, 2 <-> 3, 1 <-> 3) and radio buttons for '1st level', '2nd level', and '3rd level'. The 'varied parameter' is set to 'wbb'. The 'parameter range' is from '3[cm]' to '8[cm]', and the 'step size' is '0.01[cm]'. Other settings include 'rel. step size' of '-1%', 'damping' of '1', 'Result Group' of 'physical values - Study 1', 'Derived Result' of 'Boundary Probe 1', 'Target Value' of '250[A] ± 0.1[A]', and 'max. iterations' of '20'. There are also checkboxes for 'accept local extrema' and 'disable aux sweep', and radio buttons for 'positive slope', 'negative slope', and 'unknown slope'. The 'Repeat on Error' is set to '3'.

At the bottom, the 'additional Results' section shows a table with columns for 'Tag', 'Label', 'Description', and 'modify'. The table contains one entry: 'pev...' with 'Domain Probe 1' as the label and 'current density' as the description.

# Parameter optimization – an everyday task

## example ‚busbar‘

### sweep with optimization



### Example: The ‚busbar‘ model

- introductory model from the application library
- Joule heating

#### Simulation task

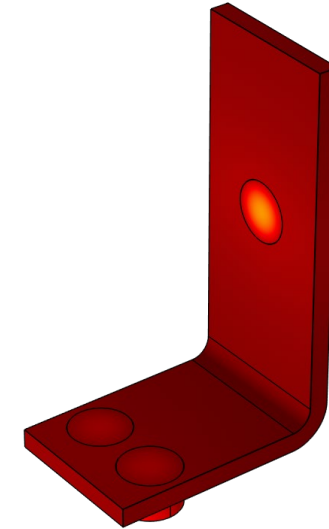
- max. operating current for different “products”  
→ diagram: **current** versus **width**

#### boundary condition

- maximum temperature:  $T_{max} = 80^{\circ}\text{C}$

#### variable parameter:

- applied voltage  
(current → requires AC/DC module)



### challenges

- simulation result  $T_{max}$  used as boundary condition

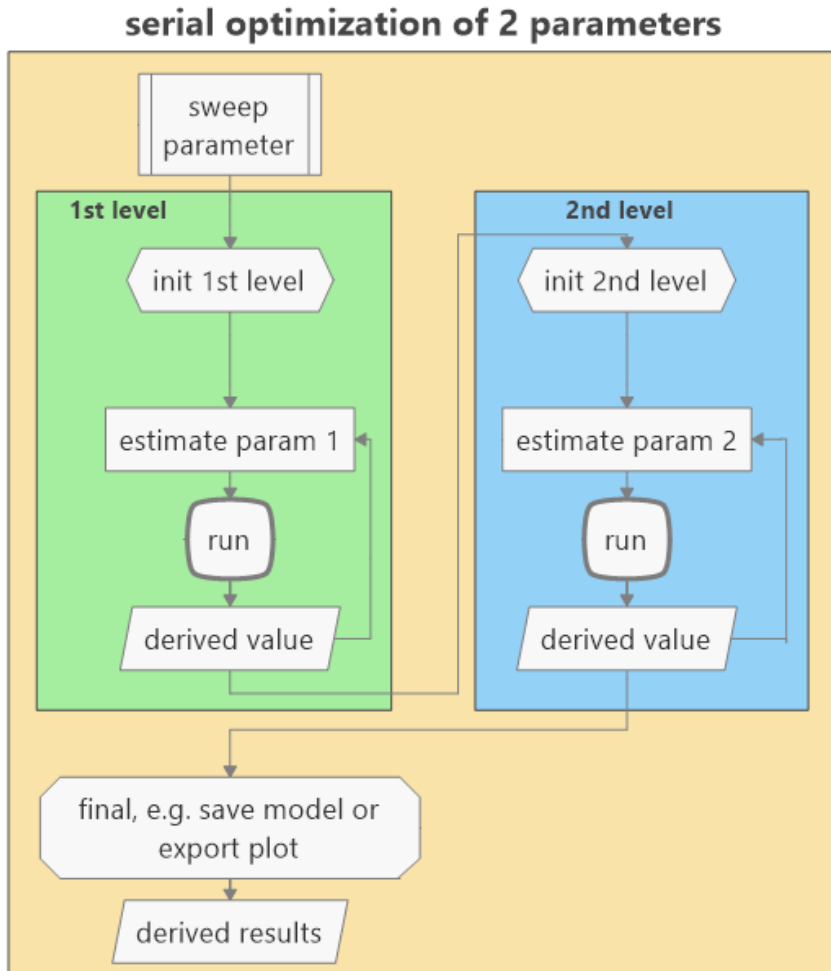
high

complexity

low

# sweep with 2 *independent* boundary conditions and final analysis

example: mechanical deformed ,busbar‘



simplified example: Joule heating and mechanical deformation

Simulation task

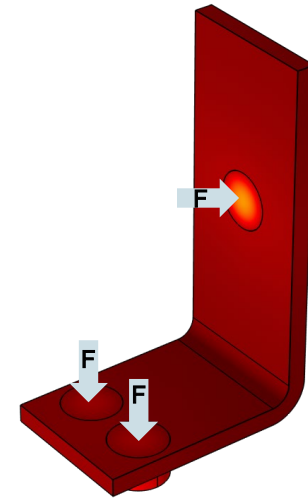
- plot diagram: **force** versus **length**

independent boundary conditions

- maximum temperature:  $T_{max} = 80^{\circ}\text{C}$
- max. deformation or max. stress

variable parameters

- applied voltage
- force

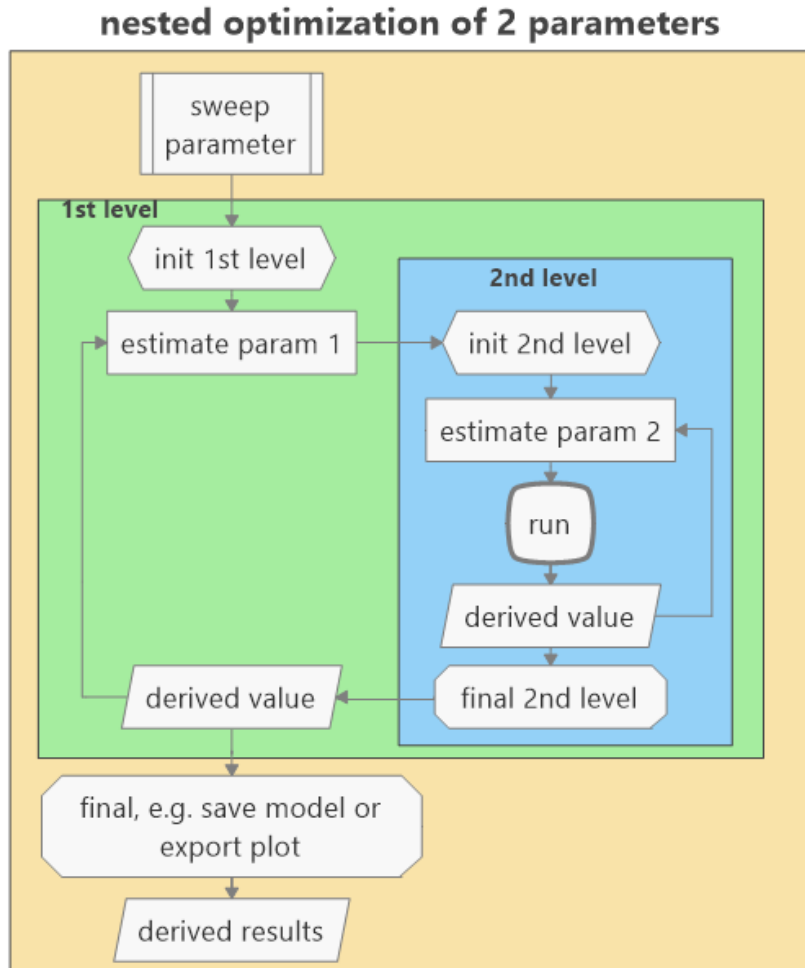


high

complexity

low

# sweep with 2 *coupled* boundary conditions example ,busbar‘



## Optimizing the ,busbar‘

### Simulation task

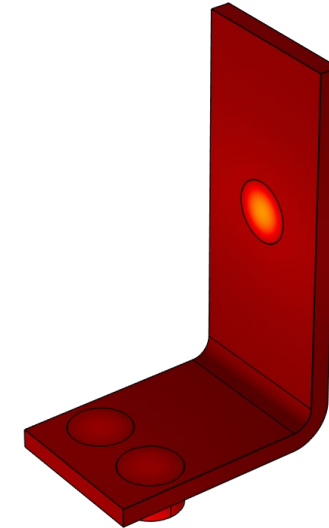
- “product” optimization
  - diagram: **current** versus **width**
  - diagram: **thickness** versus **width**

### boundary condition

- maximum temperature:  $T_{max} = 80^{\circ}\text{C}$
- maximum current density

### variable parameter:

- applied voltage
- thickness



## challenges

- coupled boundary conditions

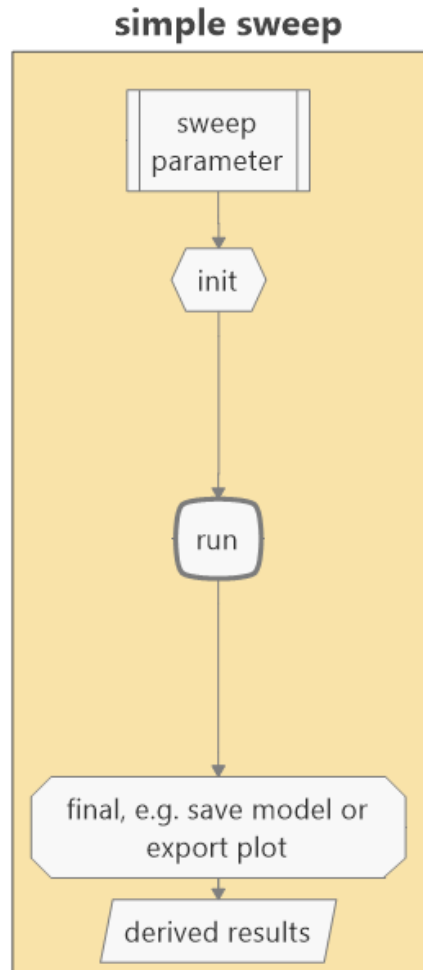
high

complexity

low

# parameter sweep

## sweep without optimization – basic features



### Advantages

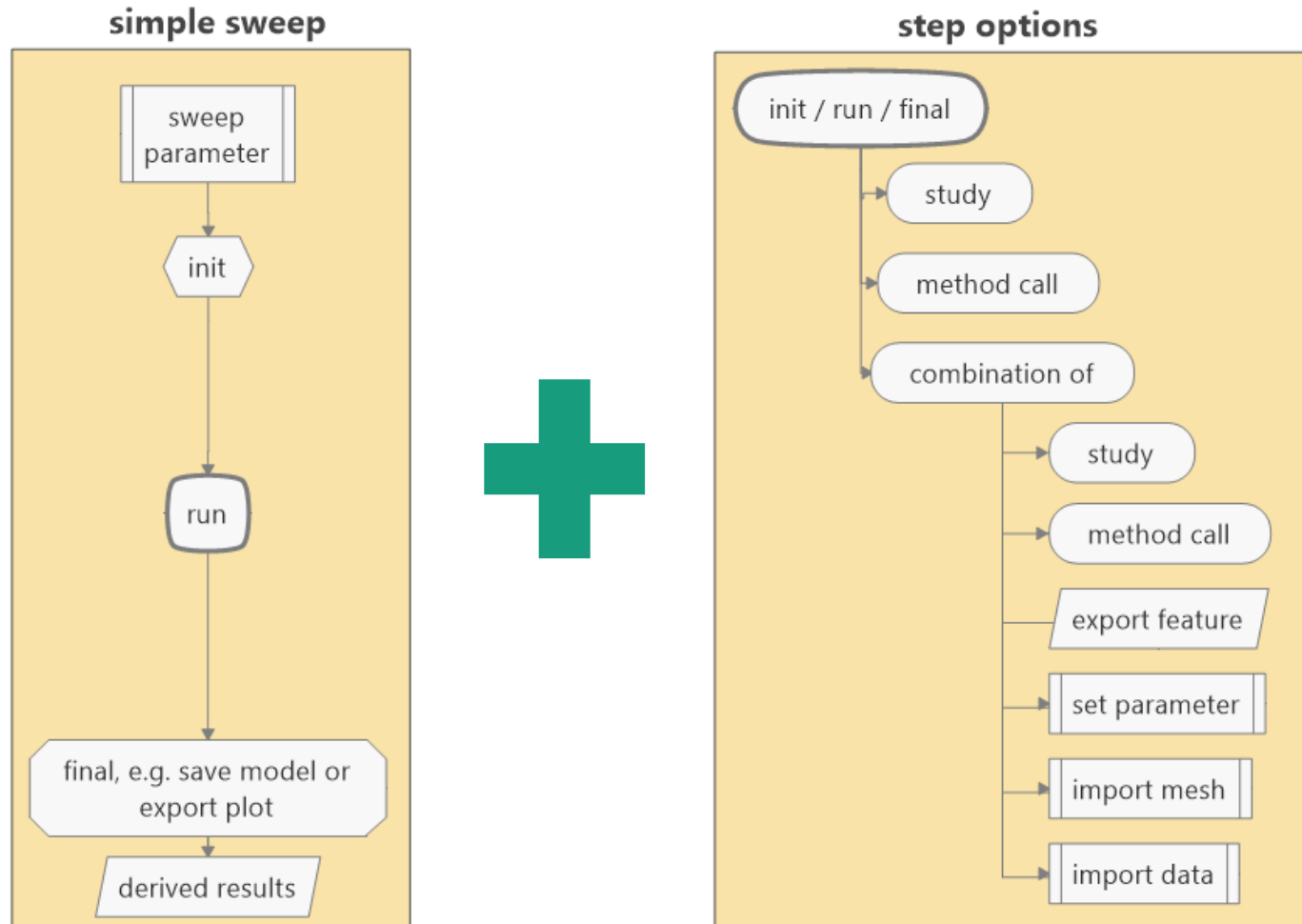
- parameter combinations: **all** or **specified**
- memory conserving
  - memory consumption independent of parameter list
- well-arranged result table
  - with parameters and multiple derived values
  - optionally saved after each calculation
- four step calculation
  - init: opt. initialization
  - run: **update study** , **run study** or **parameter optimization**
  - final: opt. final calculations
  - calculation of derived values → result table

high

complexity

low

# parameter sweep advanced step options



## examples

- run multiple studies
- use derived result as input parameter
- use deformed geometry as input
- export images or data

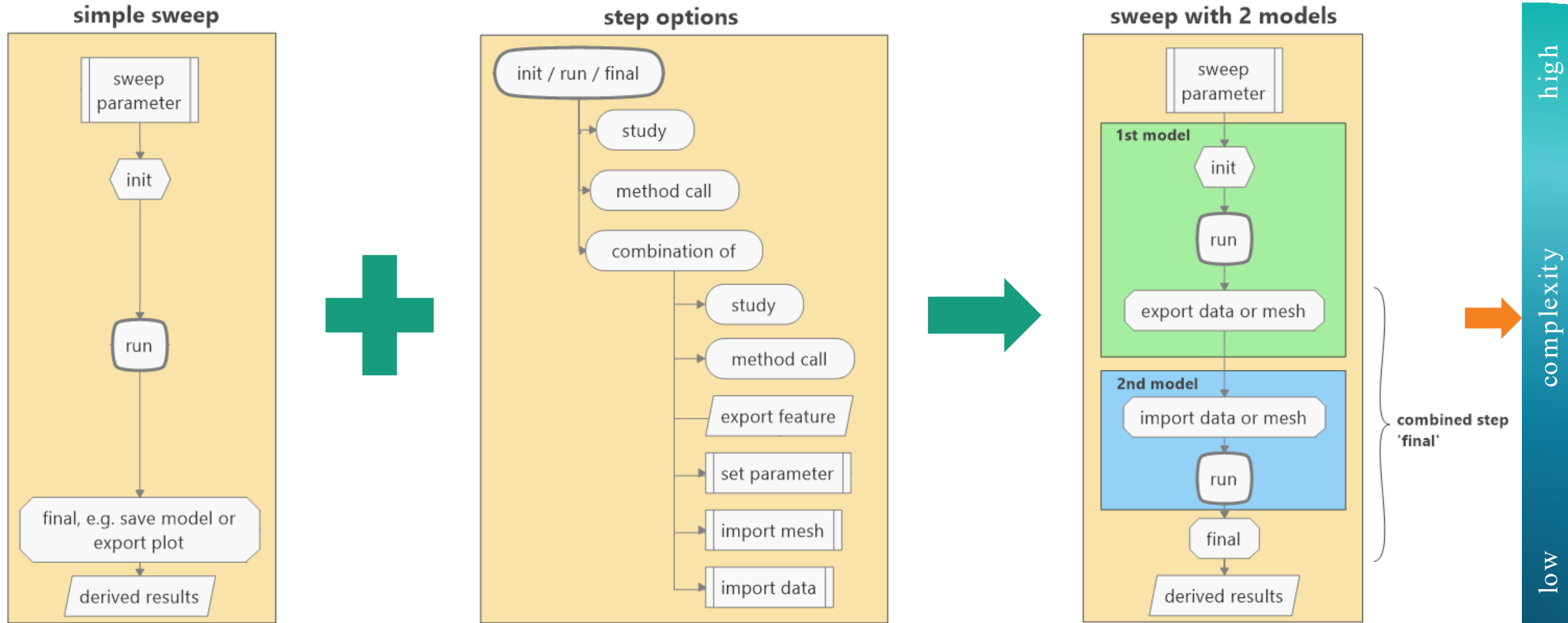


all step options may  
access a 2nd model «

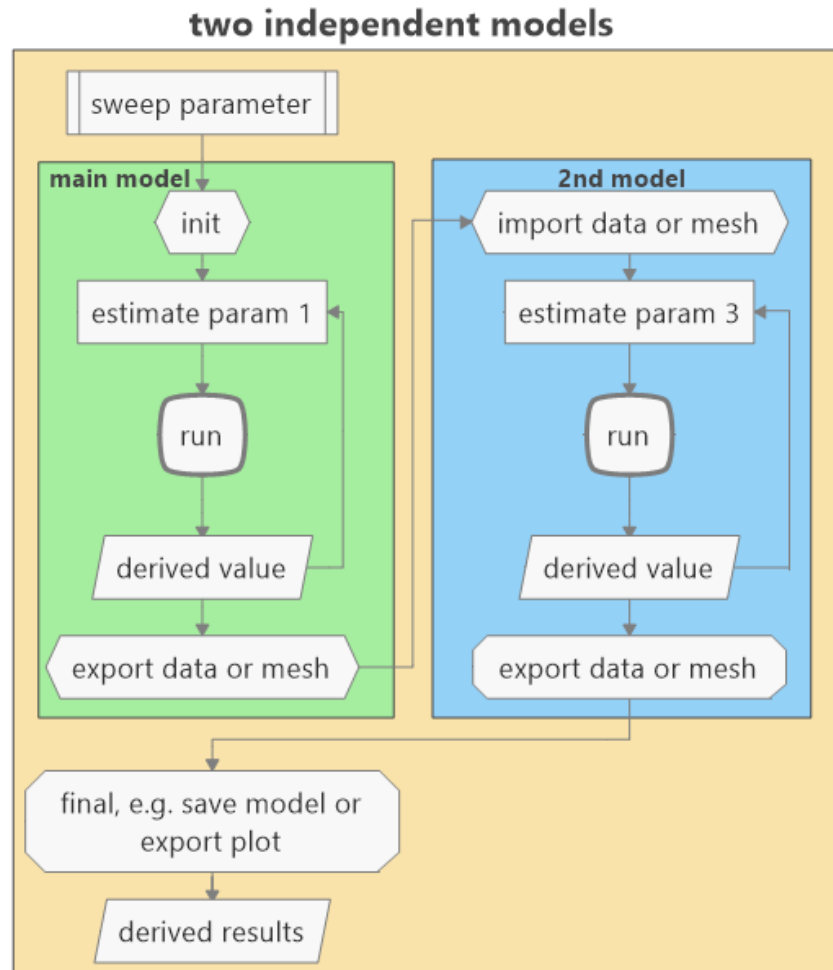


# step options and 2<sup>nd</sup> model

## successive calculations in two model files



# parameter optimization in two *independent* models combining production and application



## analyze device properties

model 1: fabrication process

- e.g. material extrusion, bending, heat treatment
- anything which has influence on the device

model 2: final application

- e.g. mechanical, electrical or optical properties
- anything which is influenced by the result of model 1

## advantages

- reduced model complexity
- independent development by different people

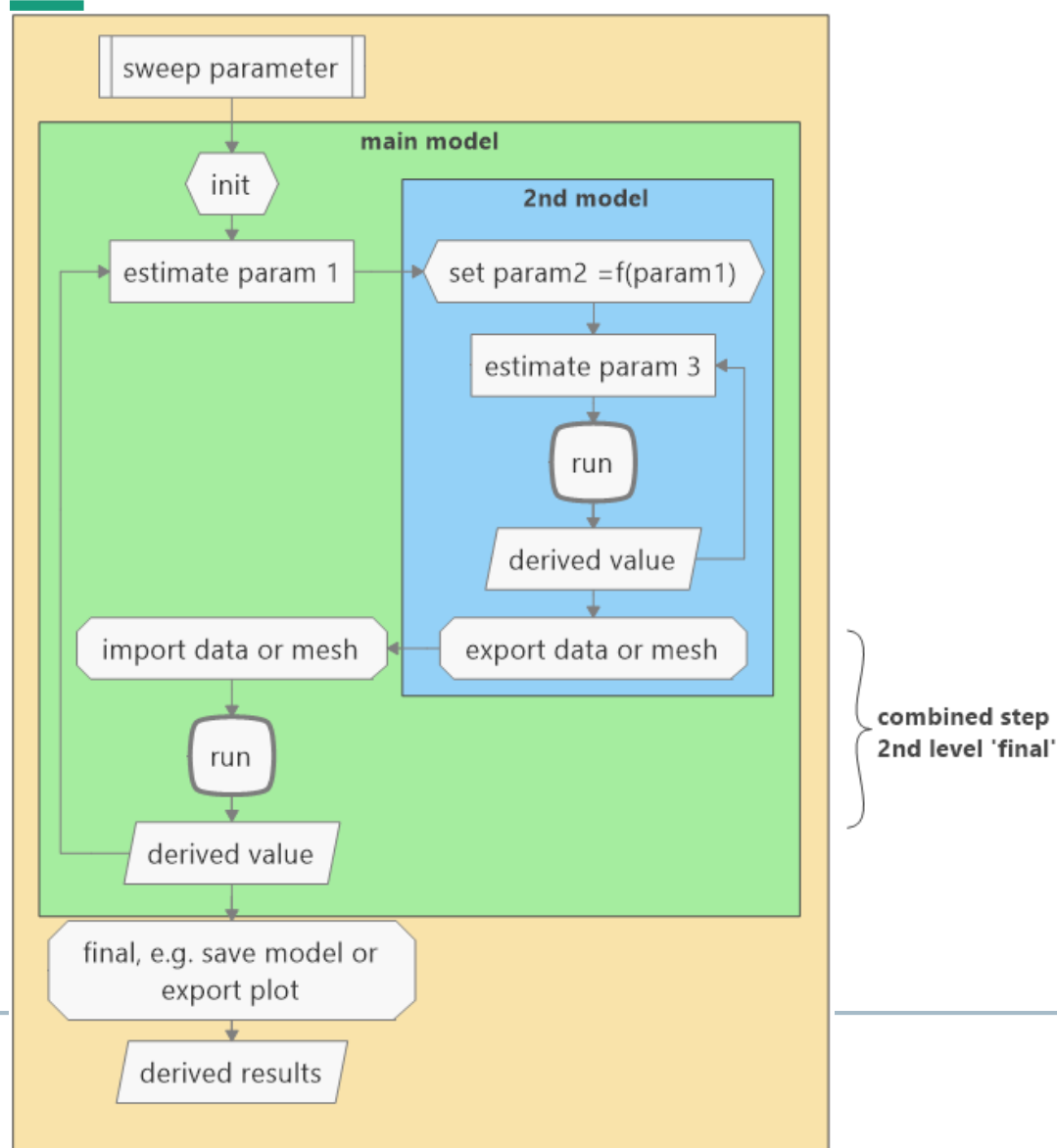
high

complexity

low

# parameter optimization in two *combined* models

## combining production and application



### optimize fabrication process

#### model 1: fabrication process

- e.g. material extrusion, bending, heat treatment
- anything which has influence on the device

#### model 2: final application

- e.g. mechanical, electrical or optical properties
- anything which is influenced by the result of model 1

### advantages

- reduced model complexity
- independent development by different people



high

complexity

low

# planned developments

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## combined steps

- modify 'parametric sweeps', i.e. use study results e.g. eigenmode values in a parametric sweep
- modify arbitrary solution parameter, e.g. tolerance settings, iterations, etc.

test  
planned

## general modifications

- implement complex parameter and results
- increase solution speed for nested goal seeks
- batch sweep

in progress  
starts soon  
planned



# Thank you for your attention!

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„GoalSeeker“ is available «