

modeFRONTIER初级培训教程

实例1: 基本操作

IDAJ-China 技术部

2019 年 5 月

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问题描述

■ 工字梁多目标优化问题

输入变量数据

变量 $a = [1, 10] \text{ mm}$

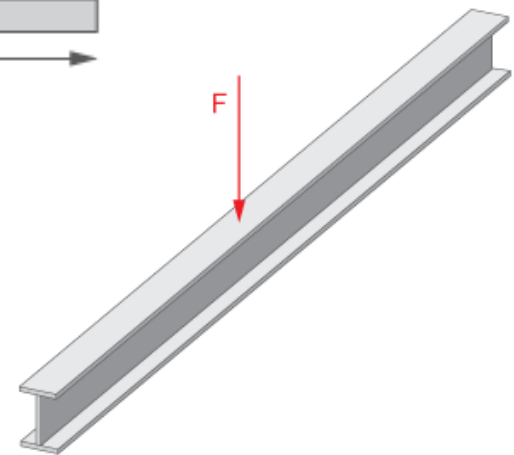
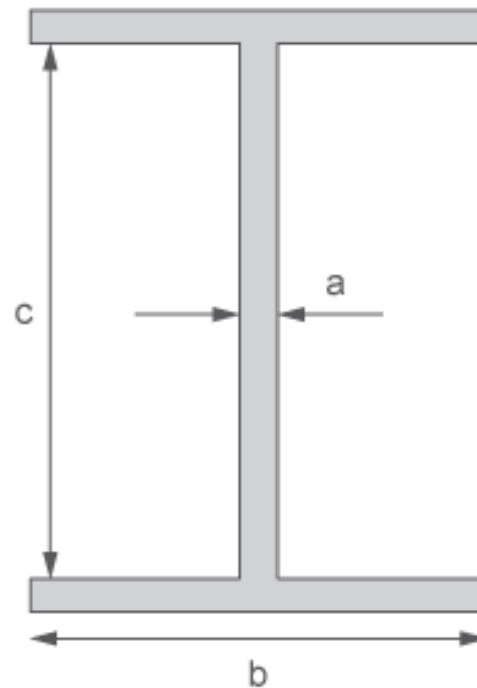
变量 $b = [50, 150] \text{ mm}$

变量 $c = [50, 250] \text{ mm}$

常量弹性模量 $2E11 \text{ Pa}$

常量密度 $8,000 \text{ kg/m}^3$

载荷 2000 N



问题描述

- 工字梁多目标优化问题

- 两个优化目标

- 梁重量W最小

- 梁最大挠度d最小

- 两个约束条件

- 最大应力 σ 小于100MPa

- 最大重量小于20Kg

$$I = \frac{ac^3}{12} + 2 \left[\frac{ba^3}{12} + ab \left(\frac{a}{2} + \frac{c}{2} \right)^2 \right]$$

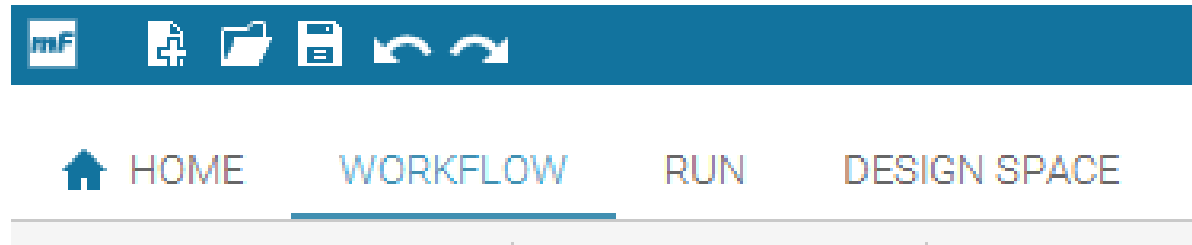
$$\sigma = \frac{FL}{4I} \left(a + \frac{c}{2} \right)$$

$$d = \frac{FL^3}{48EI}$$

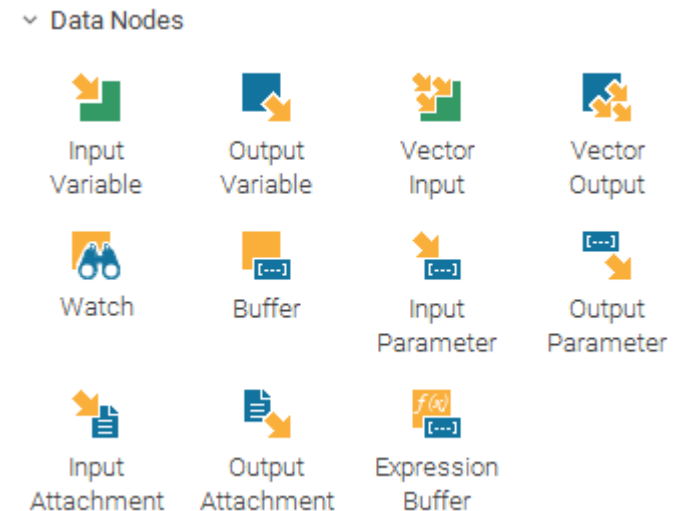
$$W = (2ab + ca)L\rho$$

启动modeFRONTIER

- 进入Workflow环境

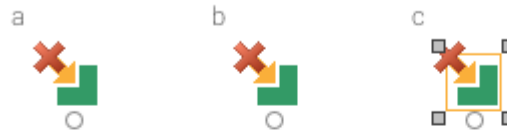


- 选择及插入节点来建立工作流程



创建输入变量

1. 选择输入变量节点图标
2. 拖动图标到流程面板，重命节点名为a、b、c
3. 按照下表修改变量属性参数

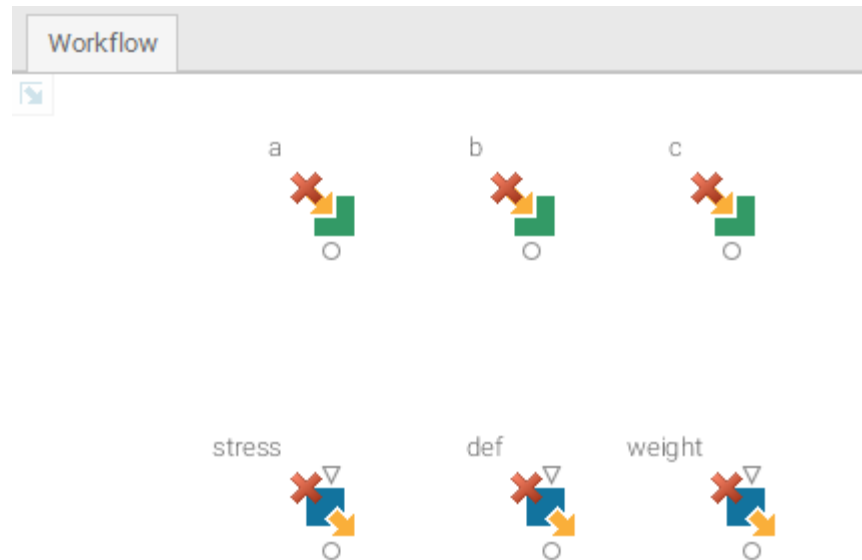


Input Variable	Lower bound	Upper bound
a	0.001	0.01
b	0.05	0.15
c	0.05	0.25

 Input Variable  Output Variable  Design Objective  Design Constraint						
	Name	Type	Default Value	Expression	Lower Bound	Upper Bound
1	a	Variable	0.0		0.001	0.01
2	b	Variable	0.0		0.05	0.15
3	c	Variable	0.0		0.05	0.25

创建输出变量

1. 选择输出变量节点图标
2. 拖动图标到流程面板，重命名节点为stress、def、weight



定义设计目标

1. 选择目标节点图标
2. 拖动两个节点到流程面板，重命名为 **min_def**、**min_weight**，并连接至对应节点
3. 修改目标属性

Workflow

stress

def

weight

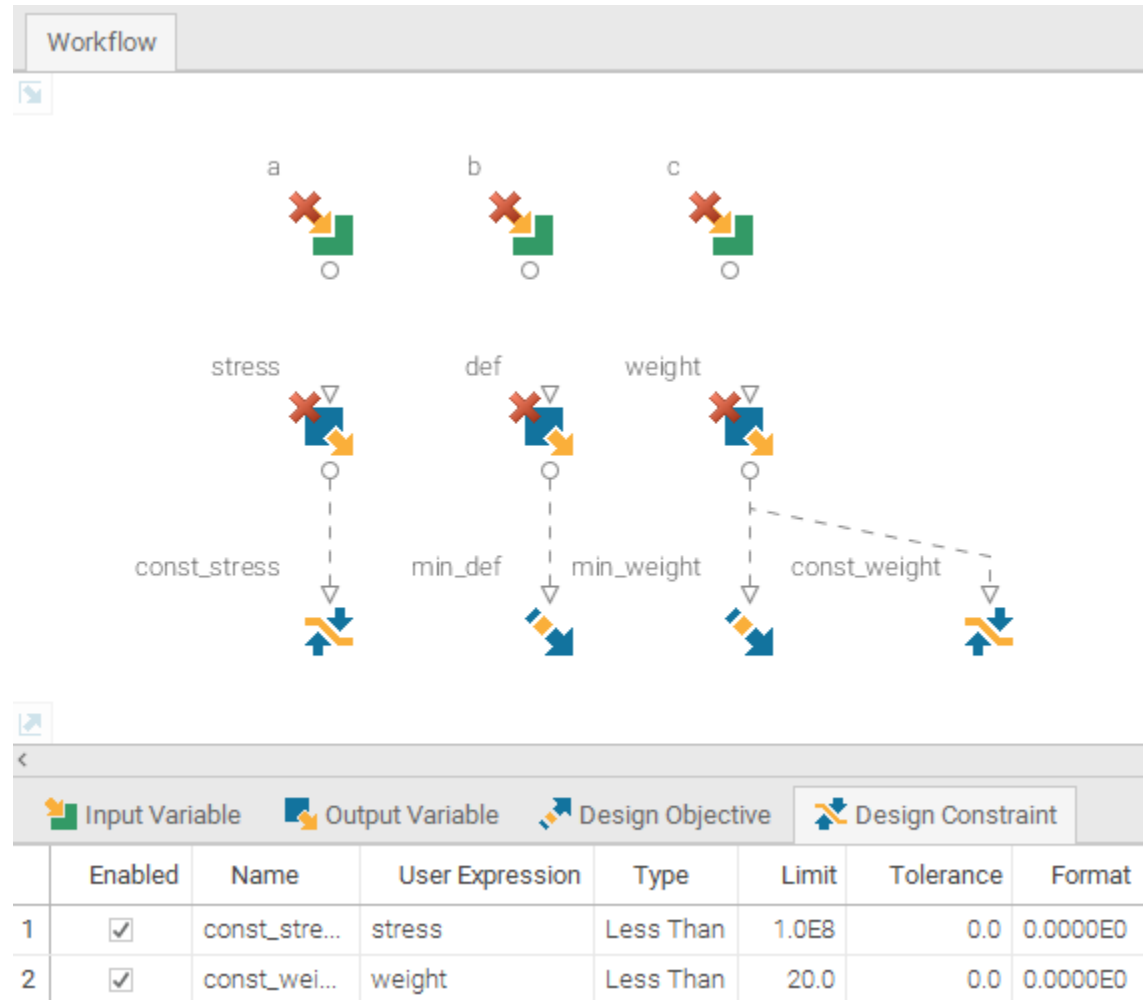
min_def

min_weight

	Enabled	Name	User Expression	Type	Format
1	☒	min_def	def	Minimize	0.0000E0
2	☒	min_weight	weight	Minimize	0.0000E0

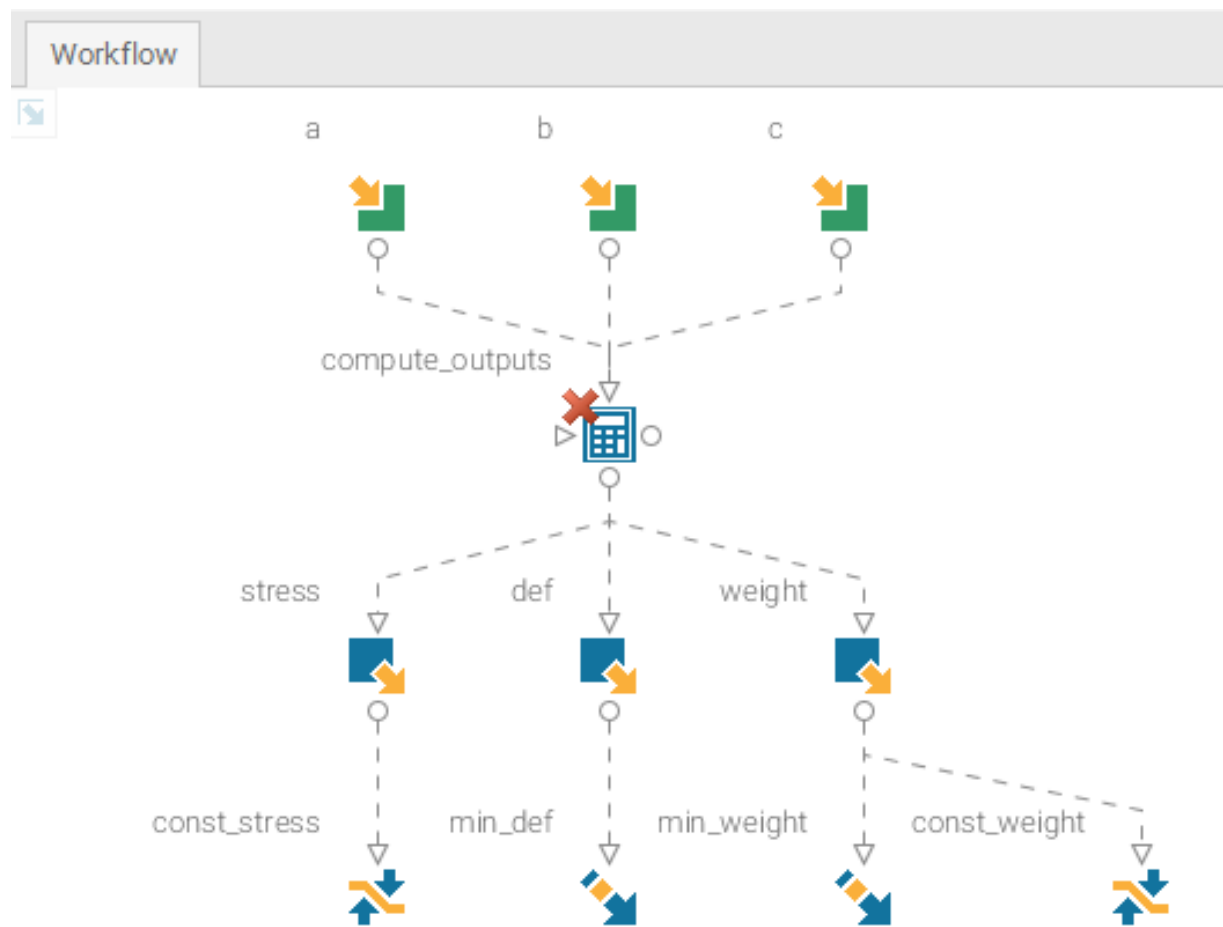
定义设计约束

1. 选择约束节点图标
2. 拖动两个节点到流程面板，重命名为 **const_stress**、**const_weight**,
3. 链接至输出变量 stress 及 weight
4. 修改 const_stress 的属性为小于 **1e8**
5. 修改 const_weight 的属性为小于 **20**



定义计算节点

1. 选择计算器节点图标
2. 拖动到流程面板,
3. 链接至输入和输出节点



在计算节点中定义数学公式

1. 在文本区输入公式

$Young=2E11$

$L=3$

$F=2000$

$dens=8000$

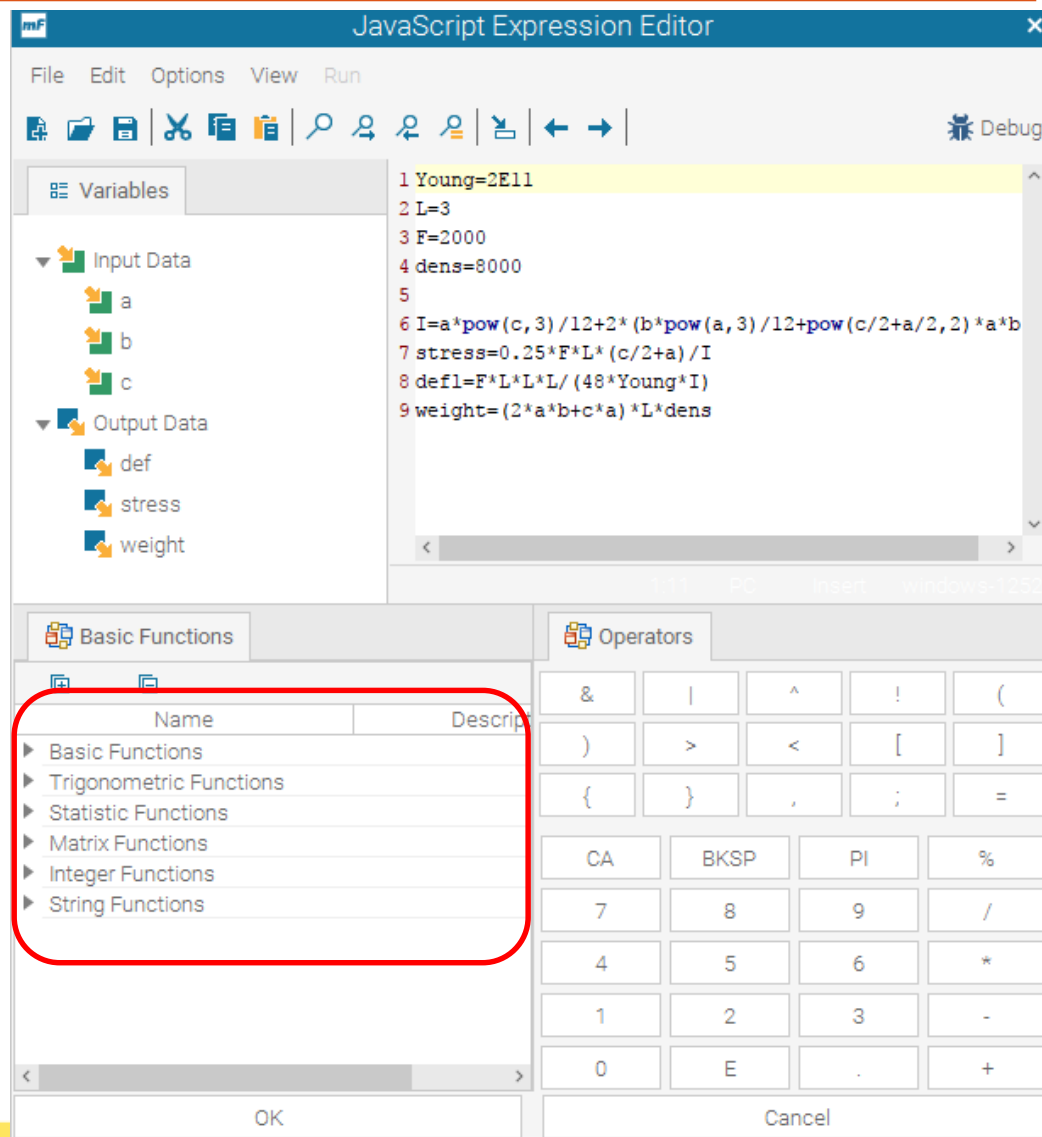
$I=a*pow(c,3)/12+2*(b*pow(a,3)/12+pow(c/2+a/2,2)*a*b)$

$stress=0.25*F*L*(c/2+a)/I$

$defl=F*L*L*L/(48*Young*I)$

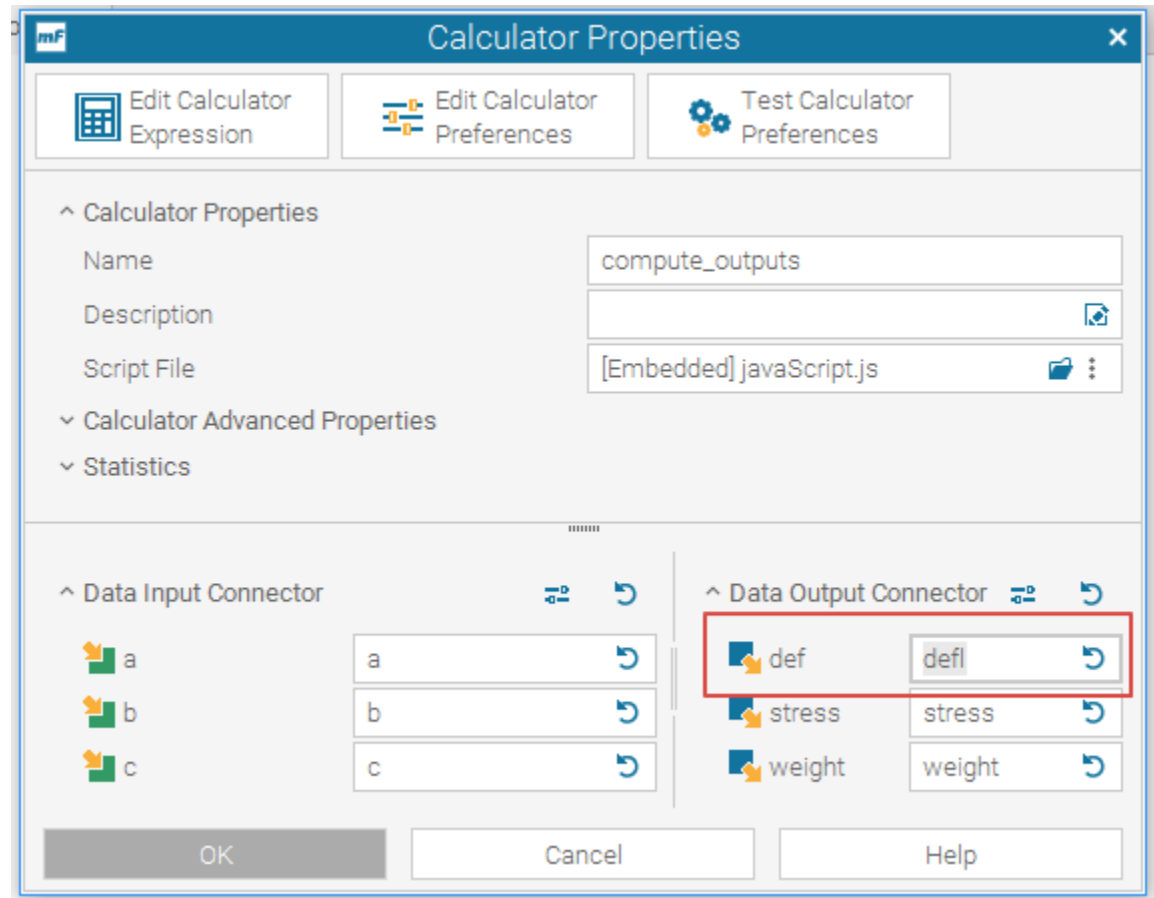
$weight=(2*a*b+c*a)*L*dens$

2. 可在函数命令区选择需要的函数



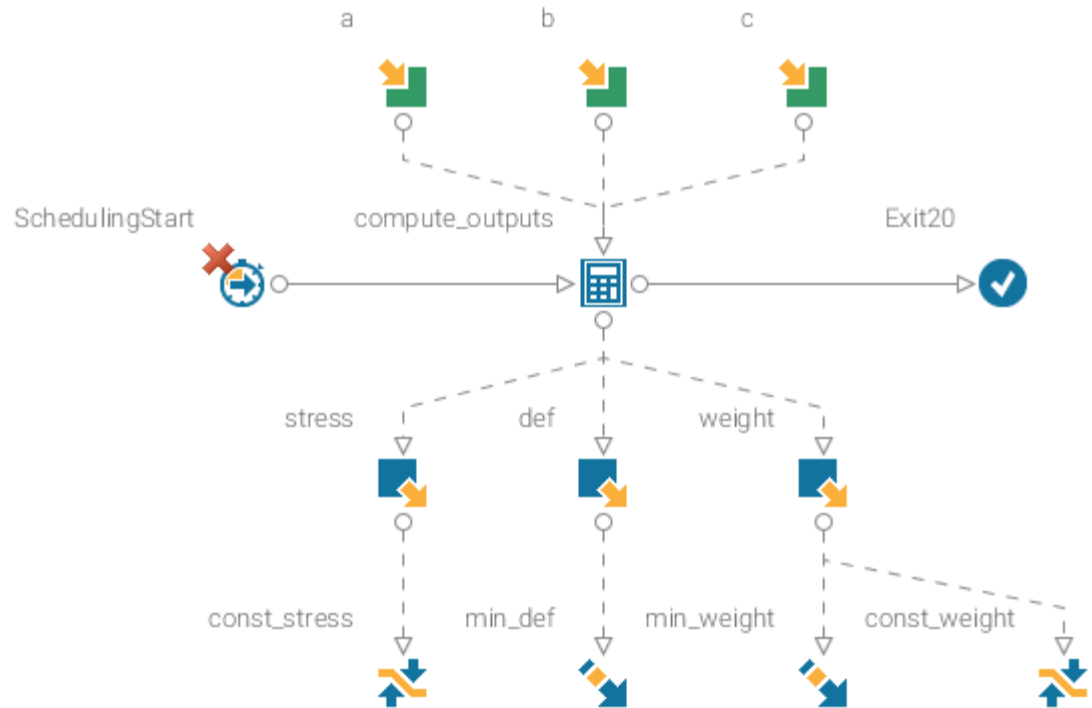
修改Calculator节点中的连接参数名称

1. 修改输出参数def的对应值为defl



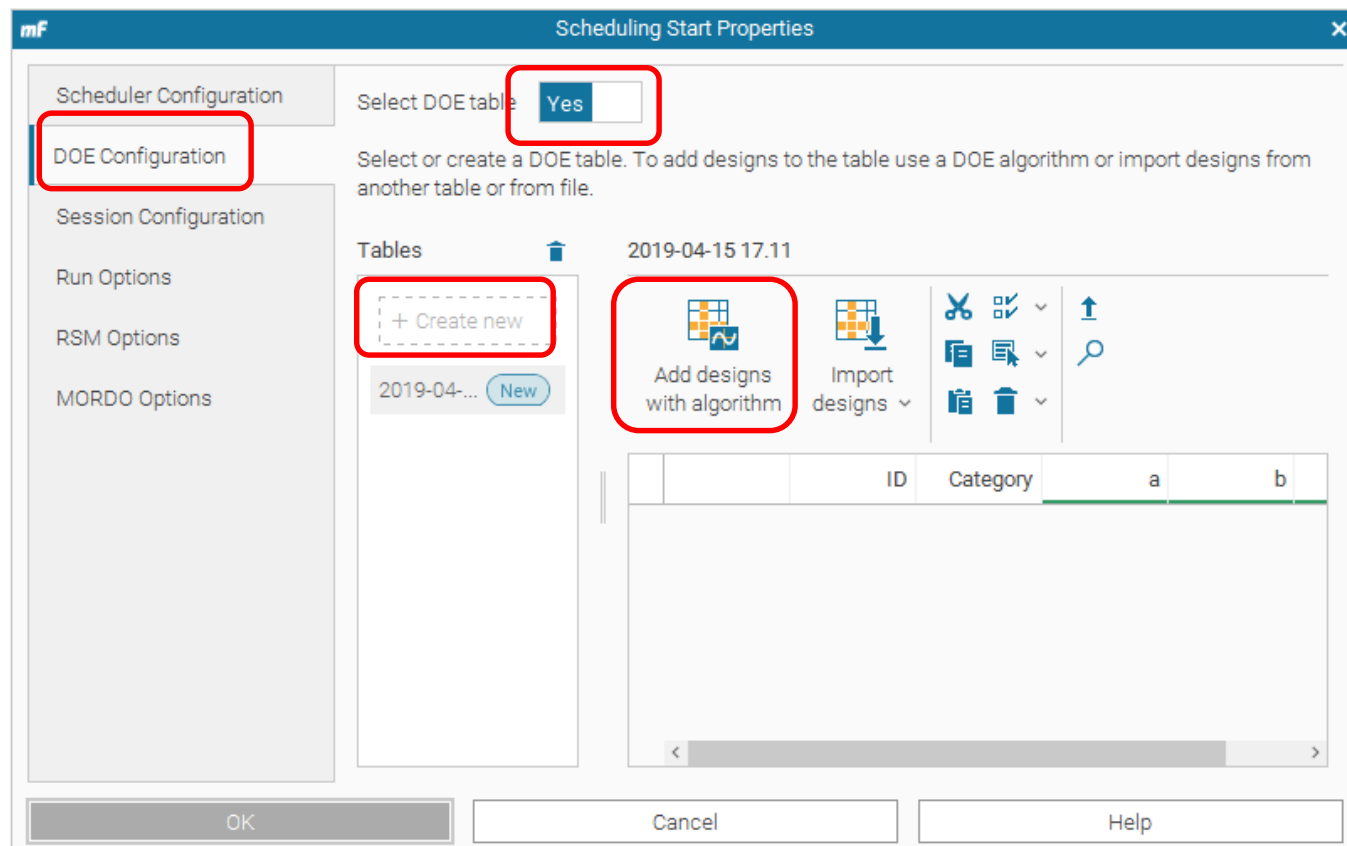
设置计算流程

1. 选择开始任务节点图标
2. 拖动到流程面板，并链接至计算器节点
3. 选择结束节点图标
4. 拖动到流程面板，并链接至计算器节点



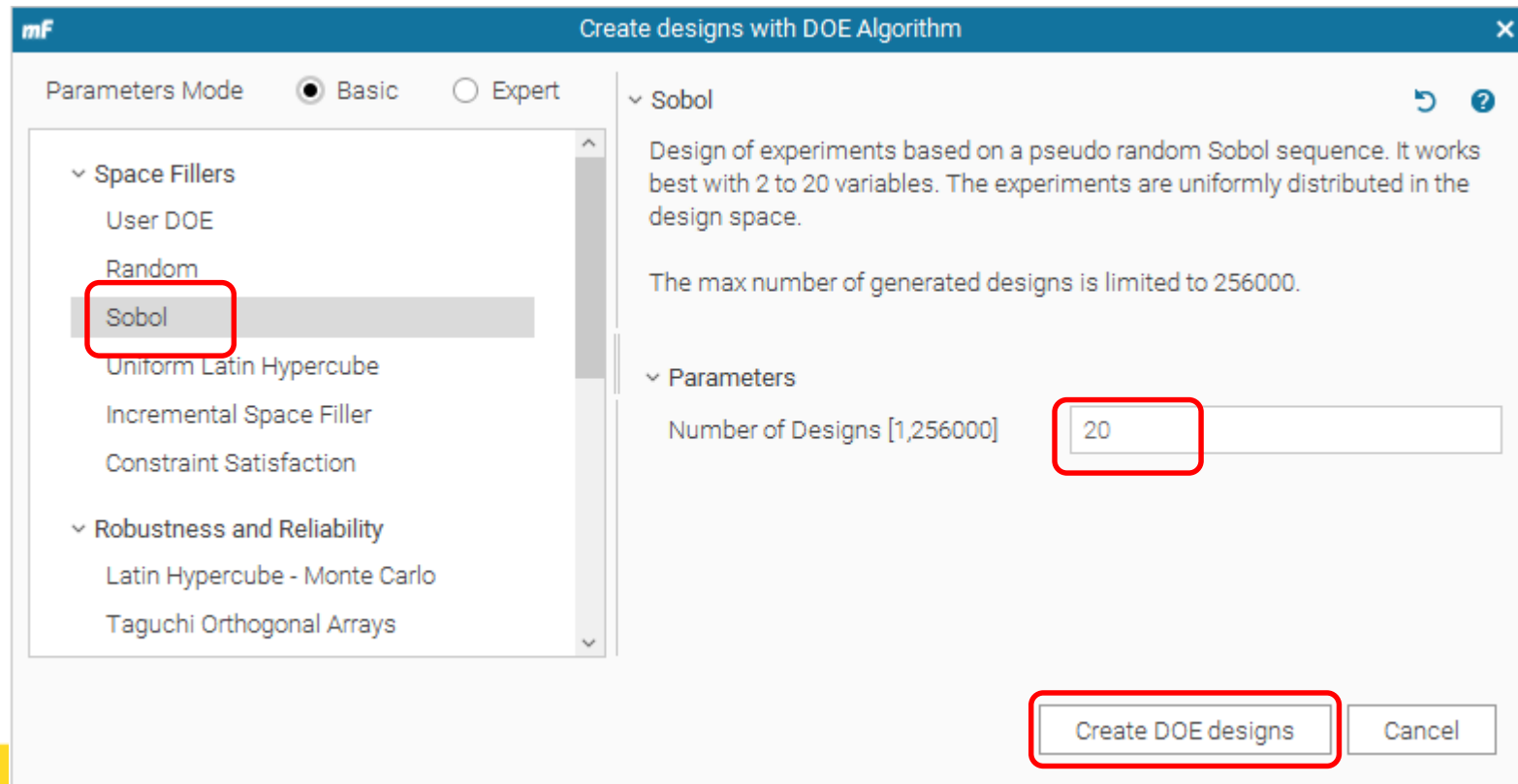
DOE算法设置

1. 双击进入
Scheduling Start
节点
2. 切换至DOE
configuration
3. 切换select DOE
table为yes
4. 在Tables下点击
Create new
5. 点击add designs
with algorithm



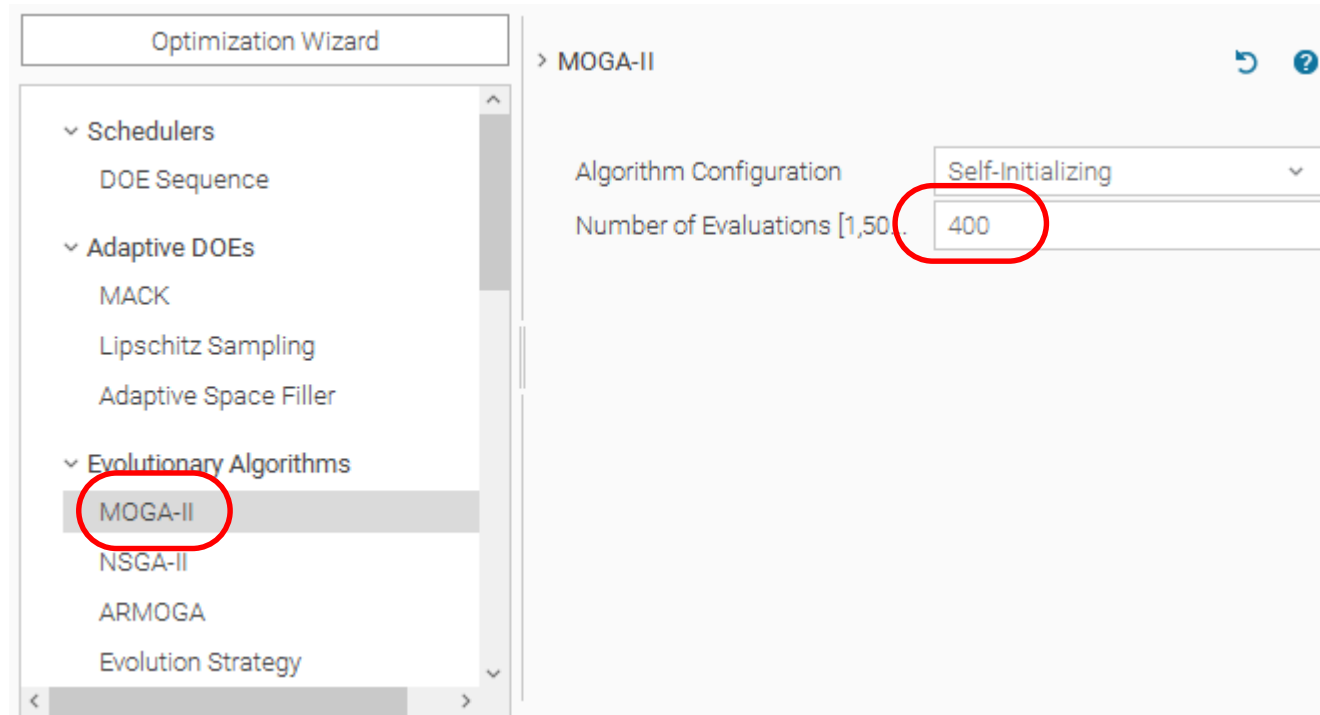
DOE算法设置

1. 从Space Filter中选择Sobol算法
2. 设定数目为20
3. 点击create DOE Designs添加DOE设计点
4. 观察生成的设计点，点击OK关闭界面



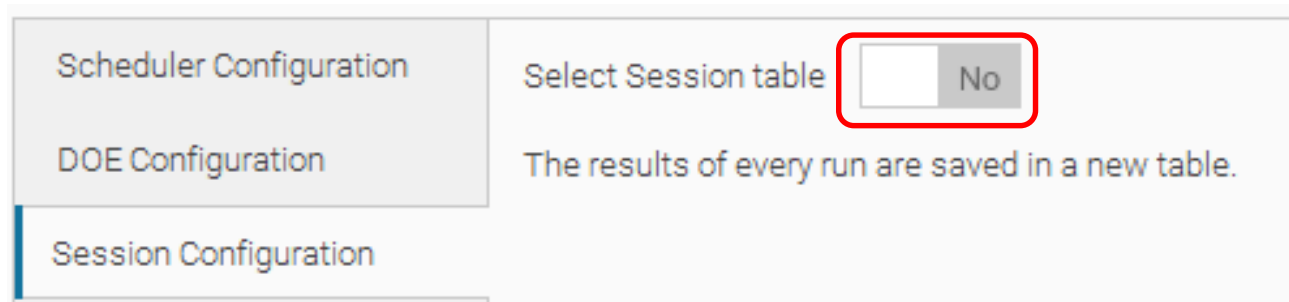
优化算法设置

1. 点击scheduler configuration
2. 双击进入优化节点选择**MOGA-II**算法
3. 设定数目为**400**，点击OK推出界面



数据保存位置设置

1. 点击session configuration
2. 选择Select Session table为No



The screenshot displays the IDAJ configuration window. On the left, a sidebar contains three tabs: 'Scheduler Configuration', 'DOE Configuration', and 'Session Configuration'. The 'Session Configuration' tab is selected and highlighted with a blue bar. The main area of the window shows the 'Select Session table' dropdown menu, which is currently set to 'No'. This dropdown is highlighted with a red rectangular box. Below the dropdown, a text label reads: 'The results of every run are saved in a new table.'

运行算例

- 点击运行案例，保存算例并求解
- 可通过监控状态了解求解状态

HOME WORKFLOW RUN DESIGN SPACE

Customize Interface Create New Layout Project Help

Interface Dashboard

Gadget Library

All Gadgets Favorites

Find gadget

Expand All View Collapse All

Charts

Multi-Hist... Bubble Pie

Broken Constraints

File Viewer

Design Files Project Files

Logs

Project Info Scheduler Designs

Robust Designs

Run Monitor

Project Info

Navigation Bar

Project Info

Project Name: tut01.prj

modeFRONTIER Version: modeFRONTIER 2018R3 - Dev

modeFRONTIER Version number: 6.2.9-SNAPSHOT b20181003

modeFRONTIER Home: C:\Users\mengel\IdeaProjects\fr

Date: Wed Oct 03 12:07:21 CEST 2018

Project PWD: C:\Users\mengel\Documents\mode

Host Info

Host Name: wolverine

Host IP Address: 10.10.10.44

Operating System: Windows 10 10.0 amd64

Java (SDK/JRE) Version: 1.8.0_181

Java Home: C:\Program Files\Java\jdk1.8.0_181\jre

User Name: mengel

User Home: C:\Users\mengel

Working Directory: C:\Users\mengel\Documents\modefrontier

Java VM Arguments: -Xmx512m

Run Info

Log Level: FINE

Num. Concurrent Des.: 1

Clear Des. Dir on Exit: never

Eval Repeated Designs: false

Save Repeated Designs: true

Save Error Designs: true

Eval Unfeasible Designs: true

Force Error Designs to NaN: true

RSM Percentage: 0%

Design Files

Design ID: 31

Synchronize: Yes

Name	Size	Last Modified
00031 [proc]		03/10/2018 12:0...
compute_outputs_00000		03/10/2018 12:0...
00031 [log]		03/10/2018 12:0...
compute_outputs_00000		03/10/2018 12:0...
designdata.html	3.9 KB	03/10/2018 12:0...
designlog.html	4.5 KB	03/10/2018 12:0...

Engine Table

Id	Start Time	Elapsed Time
FrontierEngine	Wed, Oct 03 2018...	0h:0m:7.0s
MOGA-II	Wed, Oct 03 2018...	0h:0m:6.95s

Filter Designs Statistics

Evaluated designs: 334 / ~400

Real designs: 334 (100%)

Virtual designs: 0 (0%)

Feasible designs: 267 (79.94%)

Unfeasible designs: 67 (20.06%)

Error designs: 0 (0%)

Design List

0	1	2	3	4	5	6	7
8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39

Ready Grid status: not available Mode: MONITOR v6.2.9-SNAPSHOT b20181003

后处理：数据表格

		ID	RID	Category	a	b	c	dens	defl	stress	weight	min_def	min_weight	const_stress	const_weight
9	☐	8		□ SOBO	2.6875E-3	8.1250E-2	2.3750E-1	8.0000E3	6.0490E-4	1.9589E7	2.5800E1	6.0490E-4	2.5800E1	1.9589E7	2.5800E1
10	☐	9		□ DOE_A...	4.9375E-3	1.0625E-1	8.7500E-2	8.0000E3	2.2329E-3	2.8991E7	3.5550E1	2.2329E-3	3.5550E1	2.8991E7	3.5550E1
11	☐	10		□ SOBO	9.4375E-3	5.6250E-2	1.8750E-1	8.0000E3	3.6322E-4	9.9945E6	6.7950E1	3.6322E-4	6.7950E1	9.9945E6	6.7950E1
12	☐	11		□ SOBO	8.3125E-3	1.1875E-1	2.1250E-1	8.0000E3	1.8309E-4	5.5933E6	8.9775E1	1.8309E-4	8.9775E1	5.5933E6	8.9775E1
13	☐	12		□ DOE_A...	3.8125E-3	6.8750E-2	1.1250E-1	8.0000E3	2.5270E-3	4.0474E7	2.2875E1	2.5270E-3	2.2875E1	4.0474E7	2.2875E1
14	☐	13		□ SOBO	1.5625E-3	1.4375E-1	1.6250E-1	8.0000E3	1.5705E-3	3.4682E7	1.6875E1	1.5705E-3	1.6875E1	3.4682E7	1.6875E1
15	☐	14		□ DOE_A...	6.0625E-3	9.3750E-2	6.2500E-2	8.0000E3	3.8456E-3	3.8264E7	3.6375E1	3.8456E-3	3.6375E1	3.8264E7	3.6375E1
16	☐	15		□ DOE_A...	6.3438E-3	1.4688E-1	2.4375E-1	8.0000E3	1.5285E-4	5.2262E6	8.1834E1	1.5285E-4	8.1834E1	5.2262E6	8.1834E1
17	☐	16		□ DOE_A...	1.8438E-3	9.6875E-2	1.4375E-1	8.0000E3	2.3940E-3	4.7063E7	1.4934E1	2.3940E-3	1.4934E1	4.7063E7	1.4934E1
18	☐	17		□ DOE_A...	4.0938E-3	1.2187E-1	1.9375E-1	8.0000E3	4.5929E-4	1.2366E7	4.2984E1	4.5929E-4	4.2984E1	1.2366E7	4.2984E1
19	☐	18					750E-2	8.0000E3	1.4677E-3	2.1710E7	4.8984E1	1.4677E-3	4.8984E1	2.1710E7	4.8984E1
20	☐	19					375E-1	8.0000E3	5.5447E-4	1.0216E7	7.8722E1	5.5447E-4	7.8722E1	1.0216E7	7.8722E1
21	☐	20					750E-1	8.0000E3	6.0514E-4	1.9596E7	2.5790E1	6.0514E-4	2.5790E1	1.9596E7	2.5790E1
22	☐	21					997E-1	8.0000E3	5.2607E-4	1.4482E7	3.5417E1	5.2607E-4	3.5417E1	1.4482E7	3.5417E1
23	☐	22					300E-1	8.0000E3	1.2922E-3	2.2652E7	3.4413E1	1.2922E-3	3.4413E1	2.2652E7	3.4413E1
24	☐	23					300E-2	8.0000E3	1.2146E-3	1.5021E7	7.4693E1	1.2146E-3	7.4693E1	1.5021E7	7.4693E1

“白色” 表示正确运行的设计

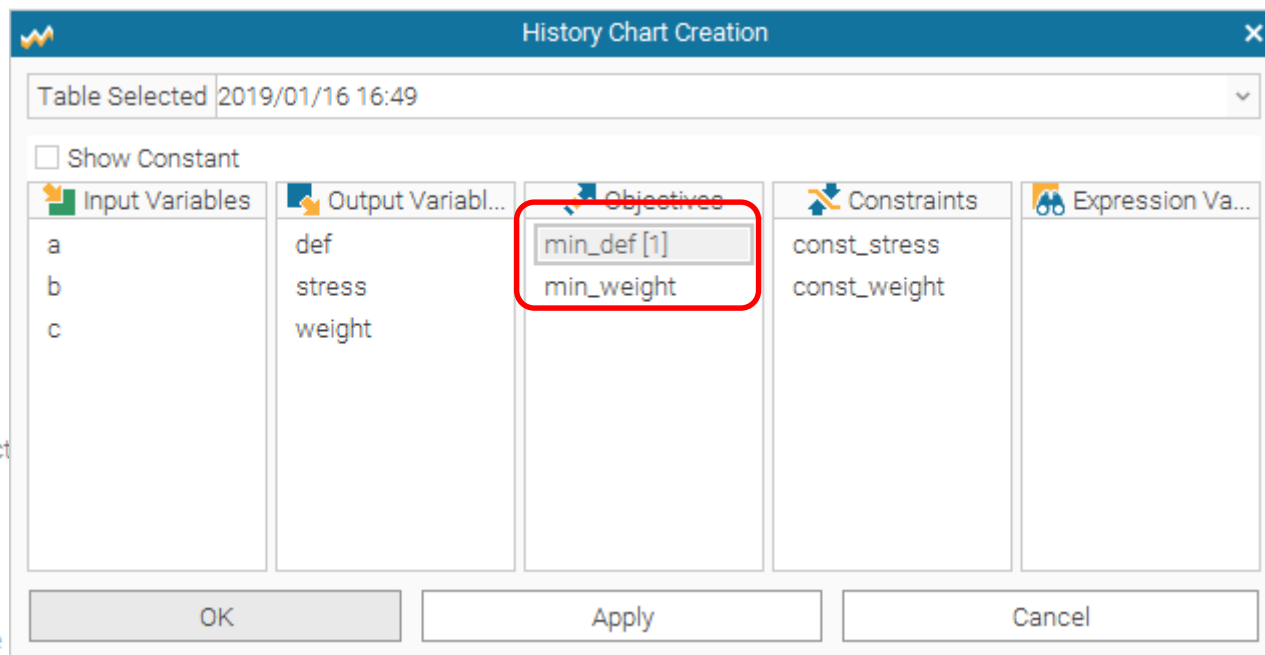
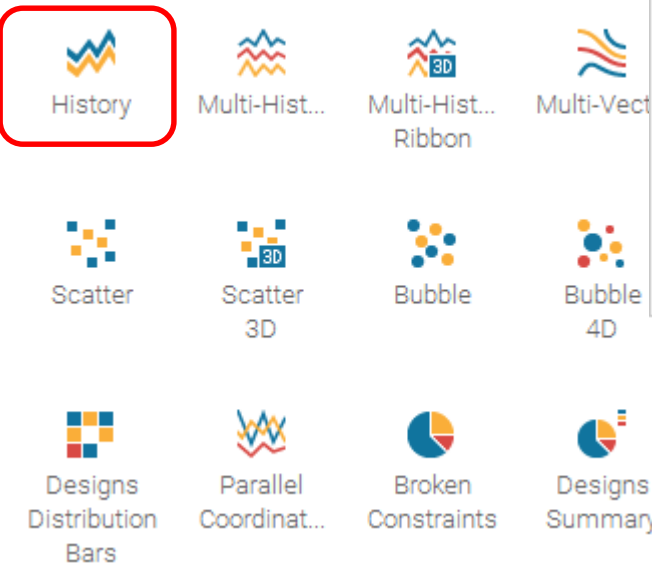
“黄色” 表示不满足约束的设计

“红色” 表示求解错误的设计

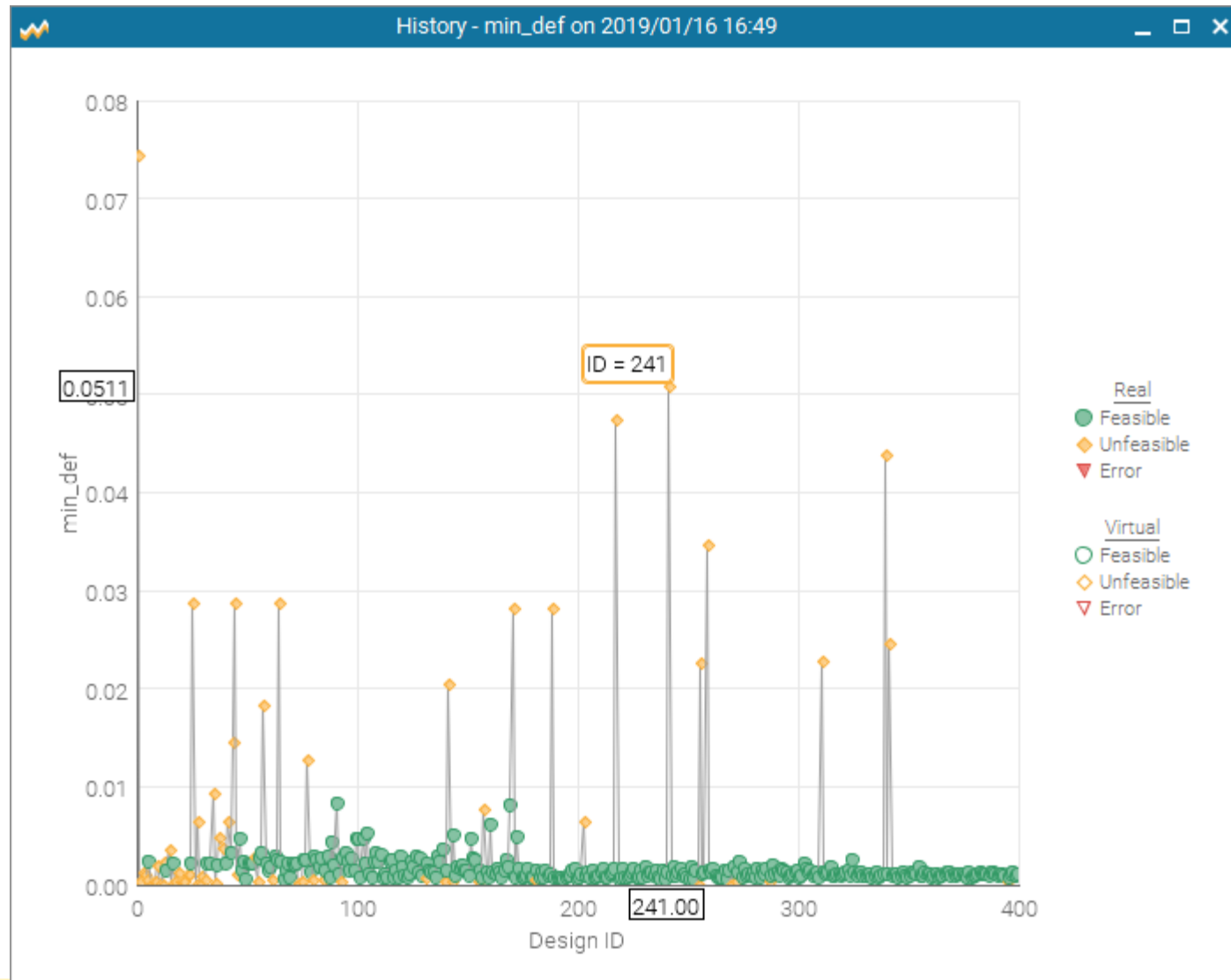
后处理：历史图History Chart

1. 点击历史图的图标
2. 选择表格及相应的参数

^ Designs Charts



后处理：历史图History Chart



后处理：散点图 Scatter Chart

1. 点击散点图的图标
2. 选择两个目标作为x和y轴

^ Designs Charts



History



Multi-Hist...



Multi-Hist...
Ribbon



Multi-Vect



Scatter



Scatter
3D



Bubble



Bubble
4D



Designs
Distribution
Bars



Parallel
Coordinat...



Broken
Constraints



Designs
Summary

Scatter Chart Creation

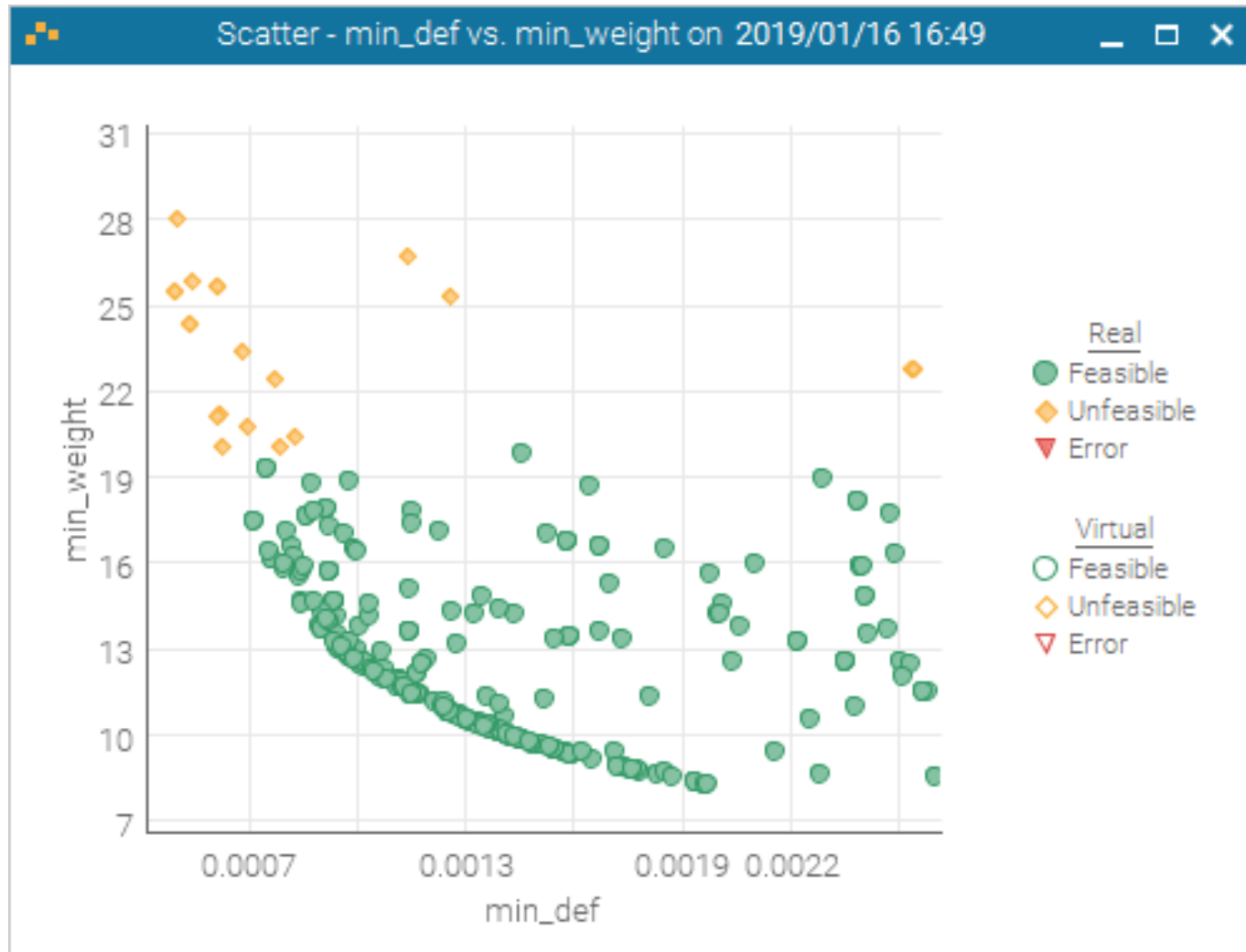
Table Selected 2019/01/16 16:49 .STDEV

☐ Show Constant

Input Variables	Output Variabl...	Objectives	Constraints	Expression Va...
a b c	def stress weight	min_def [X] min_weight [Y]	const_stress const_weight	

OK Apply Cancel

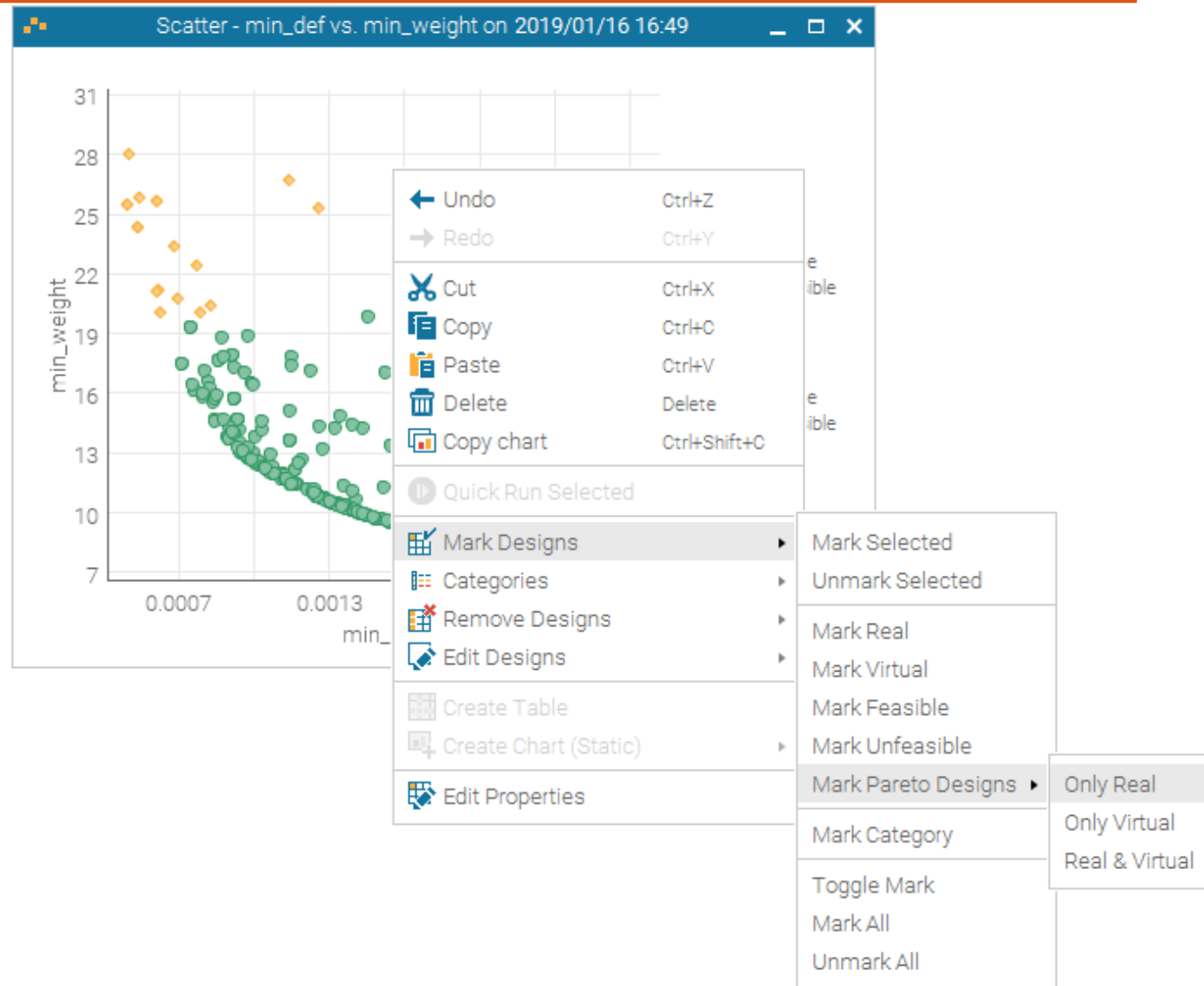
后处理：散点图 Scatter Chart



后处理：帕累托前沿

多目标优化当目标冲突时没有唯一最优解

在散点图中点击右键选择**Mark Pareto Designs**来标记帕累托设计点



后处理：帕累托前沿

标记好的设计可以在**Designs Table**中选择

	↓ ID	RID	Category	a	b	c	dens	defl	stress	weight	min_
188	☐	187	☐ MOGA2	1.2338E-3	1.4200E-1	2.0221E-1	8.0000E3	1.2568E-3	3.4297E7	1.4397E1	1.2568
189	☐	188	☐ MOGA2	1.0000E-3	1.4102E-1	5.0562E-2	8.0000E3	2.8372E-2	1.9884E8	7.9825E0	2.8372
190	☒	189	☐ MOGA2				.0000E3	9.3327E-4	3.1358E7	1.3200E1	9.3327
191	☐	190	☐ MOGA2				.0000E3	9.7717E-4	3.2640E7	1.2868E1	9.7717
192	☐	191	☐ MOGA2				.0000E3	9.3310E-4	3.0844E7	1.4227E1	9.3310
193	☒	192	☐ MOGA2				.0000E3	9.6555E-4	3.2443E7	1.2904E1	9.6555
194	☐	193	☐ MOGA2				.0000E3	7.9596E-4	2.6736E7	1.7201E1	7.9596
195	☐	194	☐ MOGA2				.0000E3	9.1252E-4	3.0807E7	1.5790E1	9.1252
196	☐	195	☐ MOGA2				.0000E3	1.1352E-3	3.7277E7	1.5182E1	1.1352
197	☐	196	☐ MOGA2				.0000E3	1.1347E-3	3.4376E7	1.3751E1	1.1347
198	☐	197	☐ MOGA2				.0000E3	1.5862E-3	5.2956E7	9.4637E0	1.5862
199	☒	198	☐ MOGA2				.0000E3	1.7299E-3	5.8124E7	8.9708E0	1.7299
200	☒	199	☐ MOGA2						50E7	1.7579E1	7.0775
201	☐	200	☐ MOGA2						36E7	1.3118E1	9.6200
202	☒	201	☐ MOGA2						31E7	1.0837E1	1.2676
203	☐	202	☐ MOGA2						12E8	7.6637E0	6.6509
204	☐	203	☐ MOGA2						99E7	1.4266E1	1.0266

后处理：帕累托设计

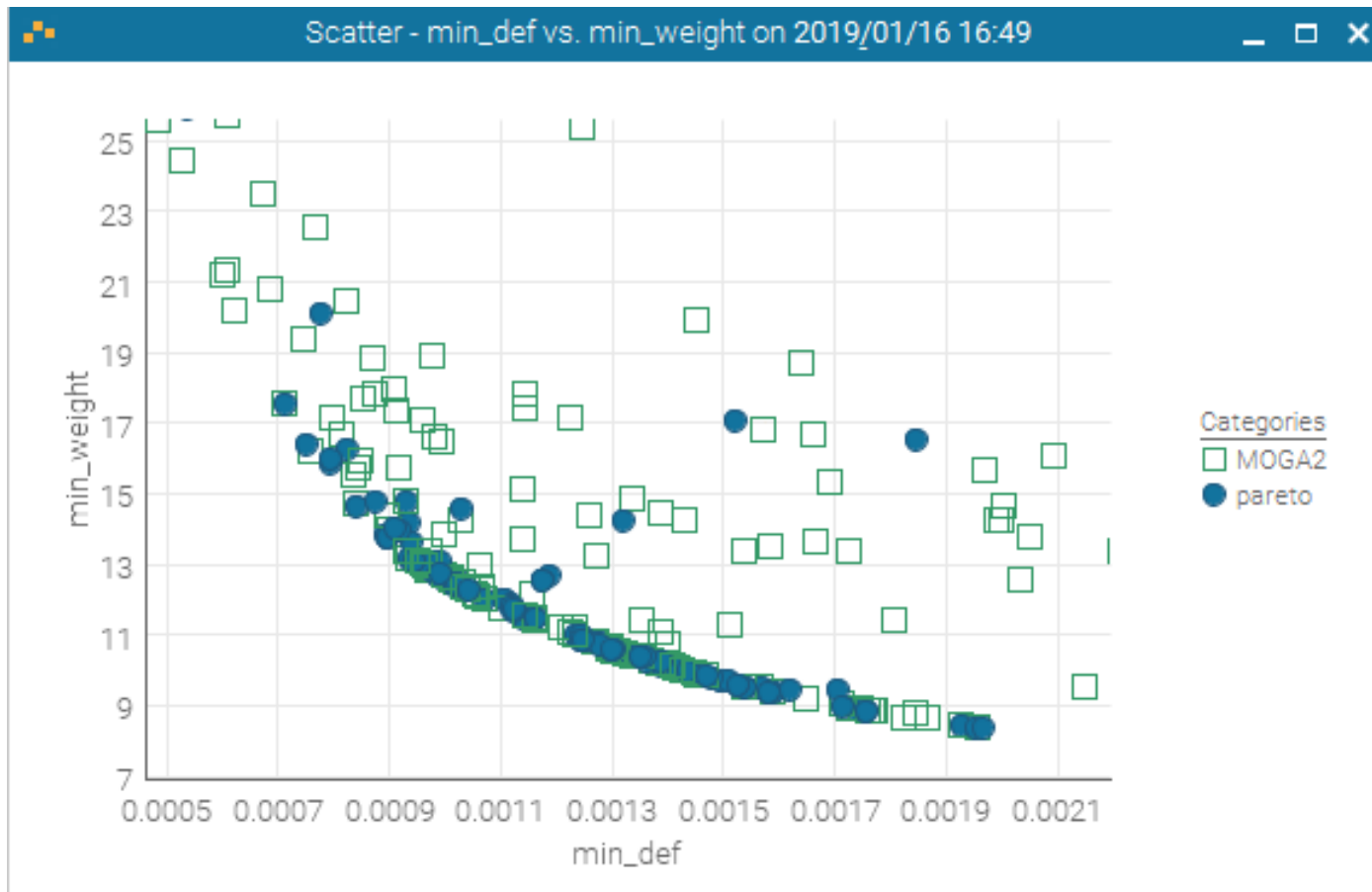
- 可以为帕累托前沿定义不同的图标来区别显示，右键选择的帕累托设计添加为新类别，并定义不同的颜色的图标。

The screenshot displays the IDA software interface. In the foreground, the 'Add to Category' dialog box is open, showing the 'Edit Selected Category' section. The 'Name' field is set to 'pareto', the 'Symbol' is a blue circle, and the 'Visible' checkbox is checked. The 'Clustering' section shows a list of categories: MOGA2, SOBOL, DOE_APPROX, and pareto (selected). The background shows a data table with columns: ID, RID, Category, a, b, c, dens, defl, and stress. A context menu is open over the table, showing options like Cut, Copy, Paste, Delete, Show/Hide Columns, Select In Columns, Order Columns, Format Columns, Create Robust Design, Quick Run Selected, Select, Mark Designs, Categories, Edit Designs, Create Table, Create Chart (Static), Find, and Edit Table Properties. The 'Categories' option is highlighted, and a sub-menu is visible showing 'Add to Category', 'Remove from Category', 'Add Marked to Category', and 'Edit Categories'.

	↓ ID	RID	Category	a	b	c	dens	defl	stress
188	187		MOGA2	1.2338E-3	1.4200E-1	2.0221E-1	8.0000E3	1.2568E-3	3.4297E7
189	188		MO				8.0000E3	2.8372E-2	1.9884E8
190	189		MO				8.0000E3	9.3327E-4	3.1358E7
191			MO				8.0000E3	9.7717E-4	3.2640E7
192			MO				8.0000E3	9.3310E-4	3.0844E7
193			MO				8.0000E3	9.6555E-4	3.2443E7
194			MO				8.0000E3	7.9596E-4	2.6736E7
195			MO				8.0000E3	9.1252E-4	3.0807E7
196			MO				8.0000E3	1.1352E-3	3.7277E7
197			MO				8.0000E3	1.1347E-3	3.4376E7
198			MO				8.0000E3	1.5862E-3	5.2956E7
199			MO				8.0000E3	1.7299E-3	5.8124E7
200			MO				8.0000E3		2.3850E7
201			MO				8.0000E3		3.1886E7
202			MO				8.0000E3		4.2381E7
203			MO				8.0000E3		1.0612E8
							8.0000E3	1.0266E-3	3.4599E7

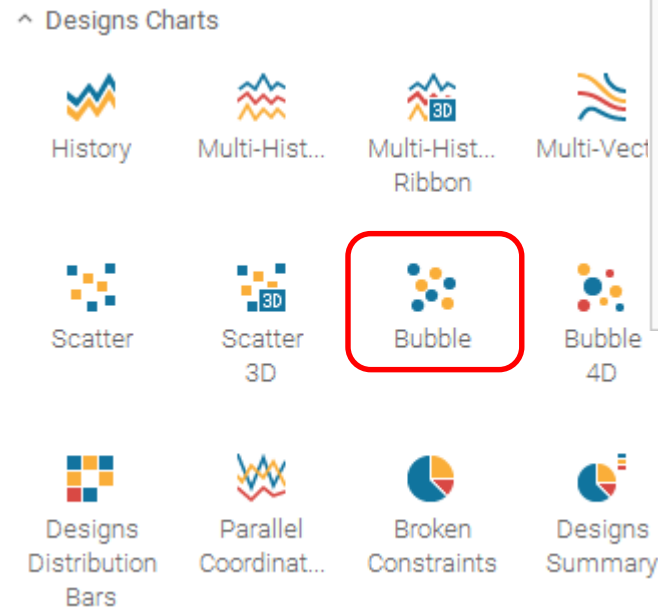
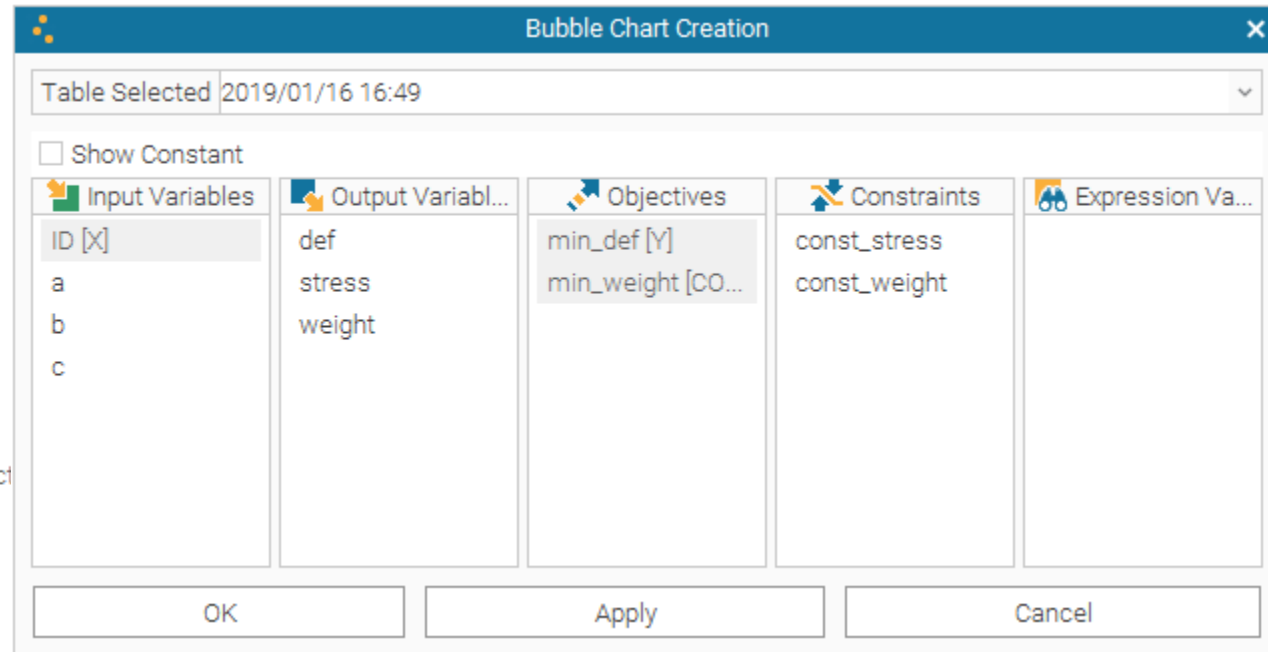
后处理：帕累托设计

- 勾选Paint Categories选项，蓝色的点为区别后的帕累托解

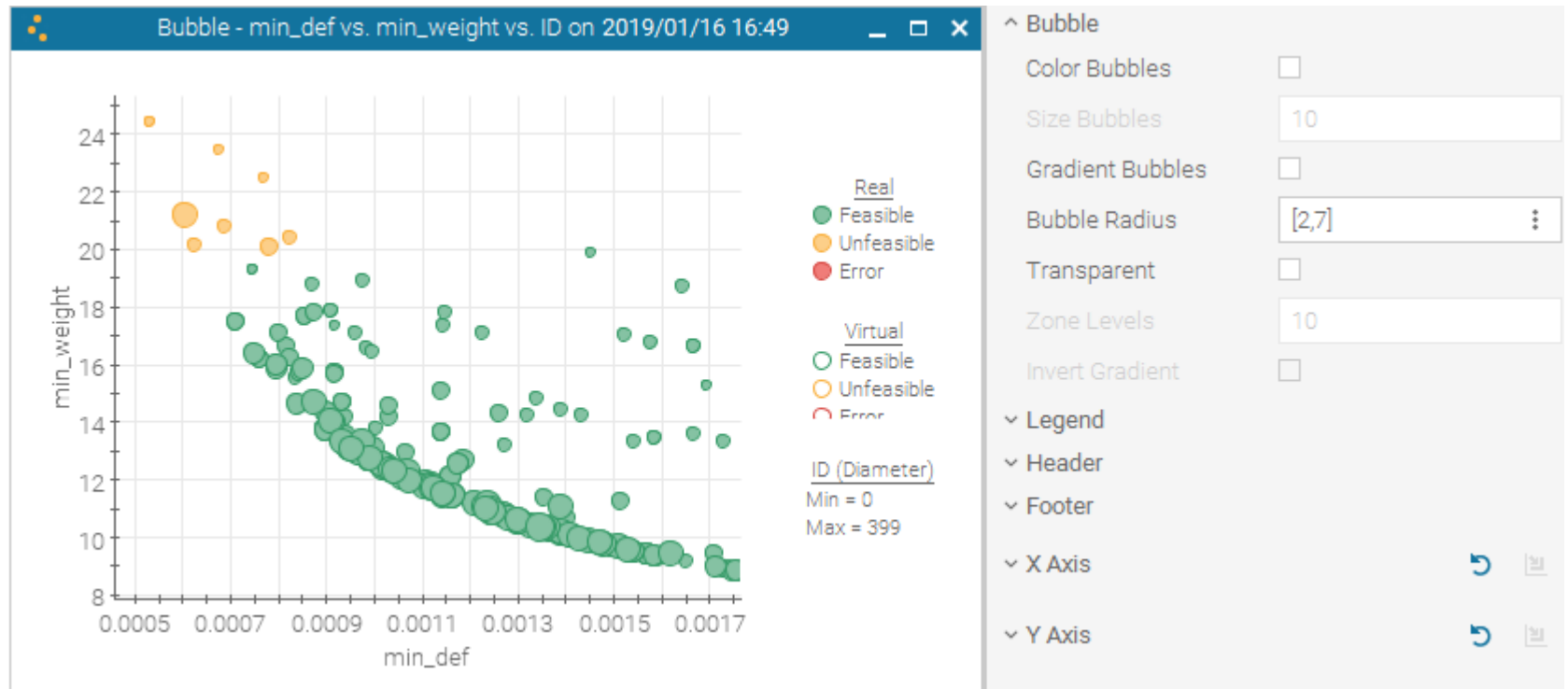


后处理：气泡图 Bubble Chart

1. 点击散点图的图标
2. 选择ID和min_def作为x和y轴，选择min_weight以颜色显示

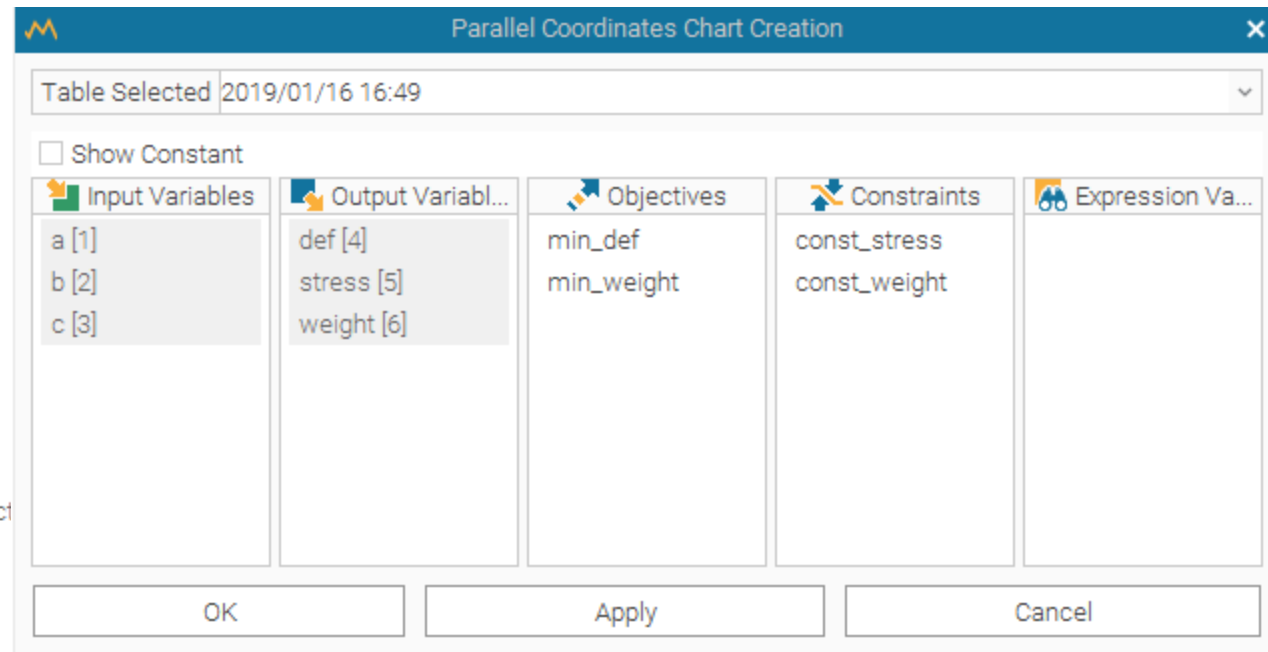


后处理：气泡图 Bubble Chart



后处理：平行坐标图 Parallel Coordinates Chart

1. 点击平行坐标图的图标
2. 选择输出和输出参数



^ Designs Charts



History



Multi-Hist...



Multi-Hist...
Ribbon



Multi-Vect...



Scatter



Scatter
3D



Bubble



Bubble
4D



Designs
Distribution
Bars



Parallel
Coordinat...

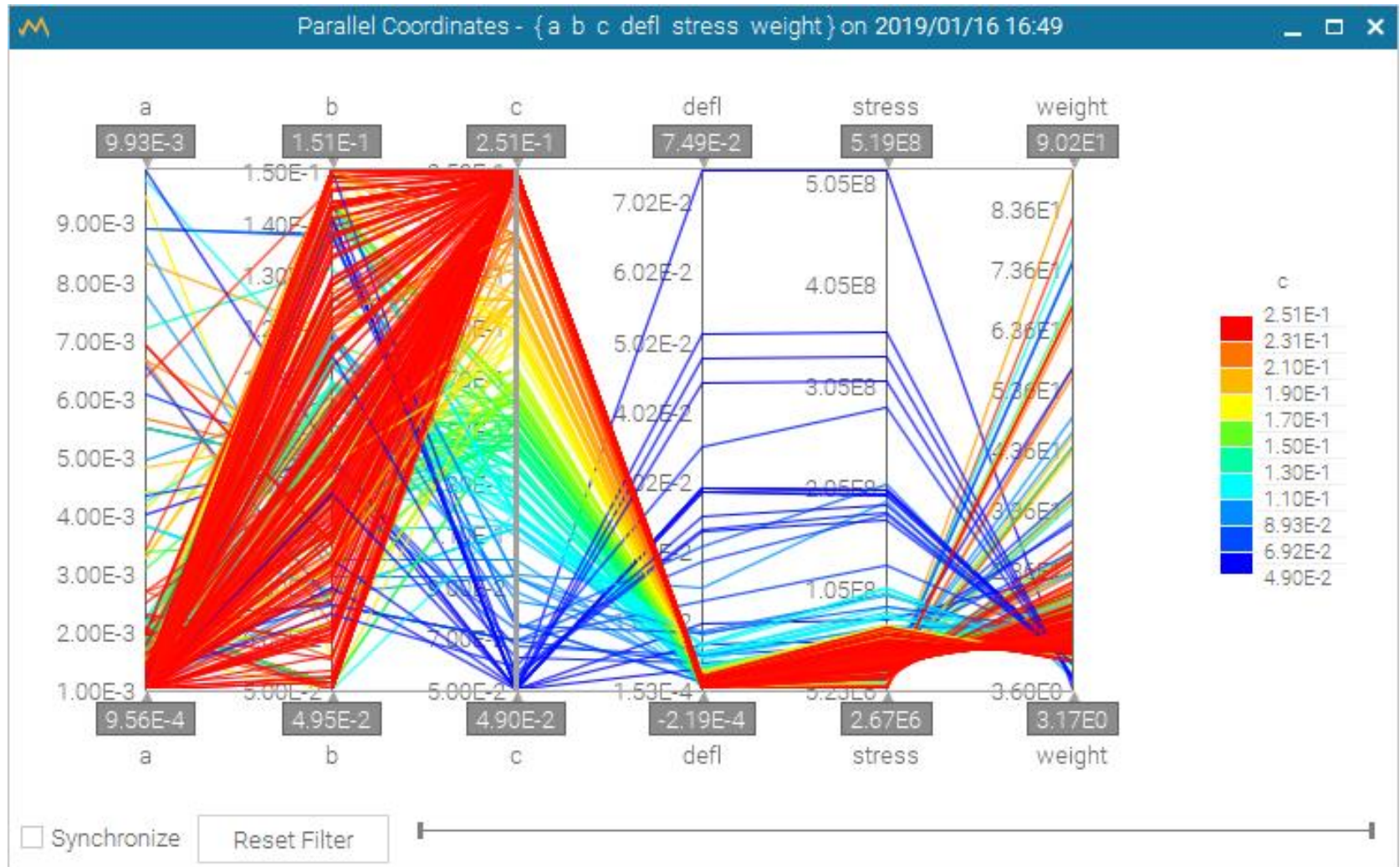


Broken
Constraints



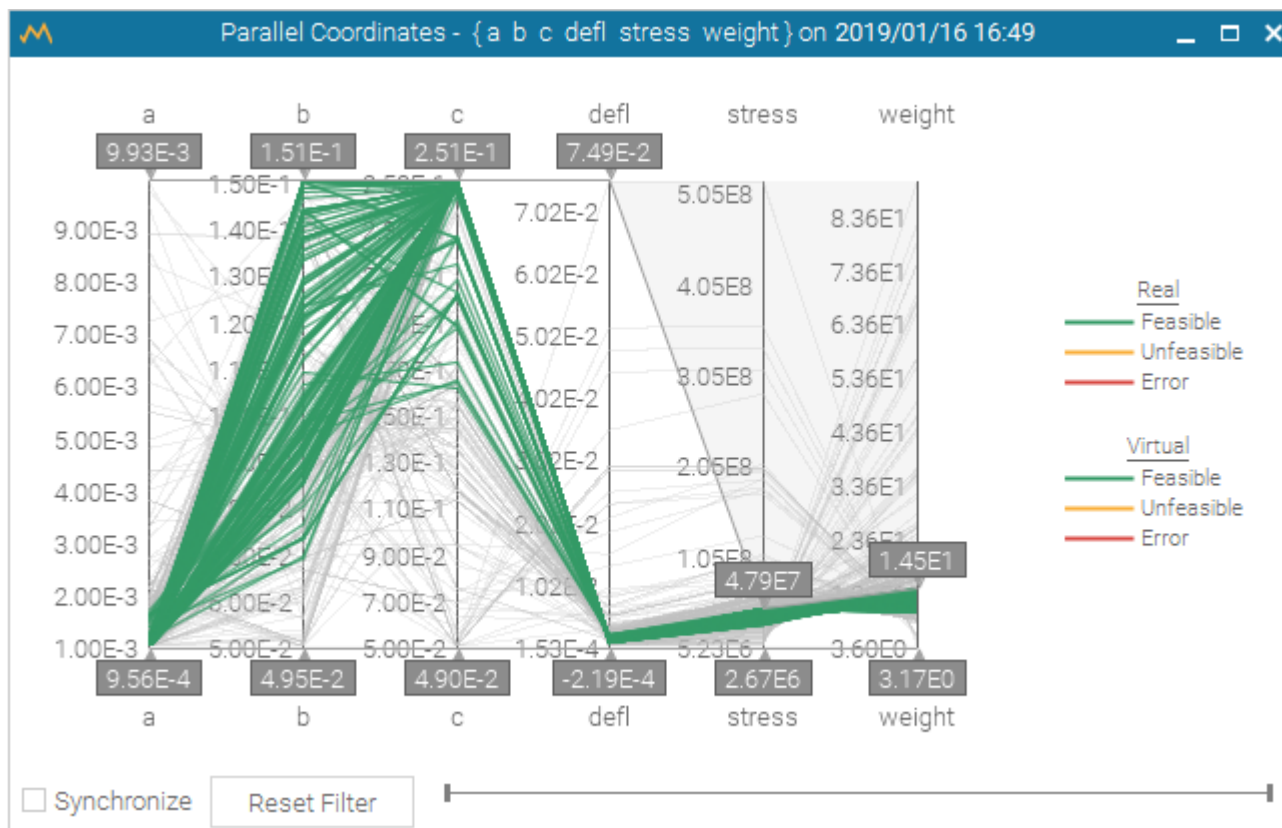
Designs
Summary

后处理：平行坐标图 Parallel Coordinates Chart



平行坐标图参数过滤

- 选择stress及weight向下拖动，可以过滤掉对应的设计，从而可以观察期望设计对应的输入参数的情况





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