Introductory Course: Using LS-OPT® on the TRACC Cluster

1.4a - Introduction to LS-OPT GUI

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What is LS-OPT?

LS-OPT UI

- Preprocessor
- Postprocessor

LS-DYNA Manager

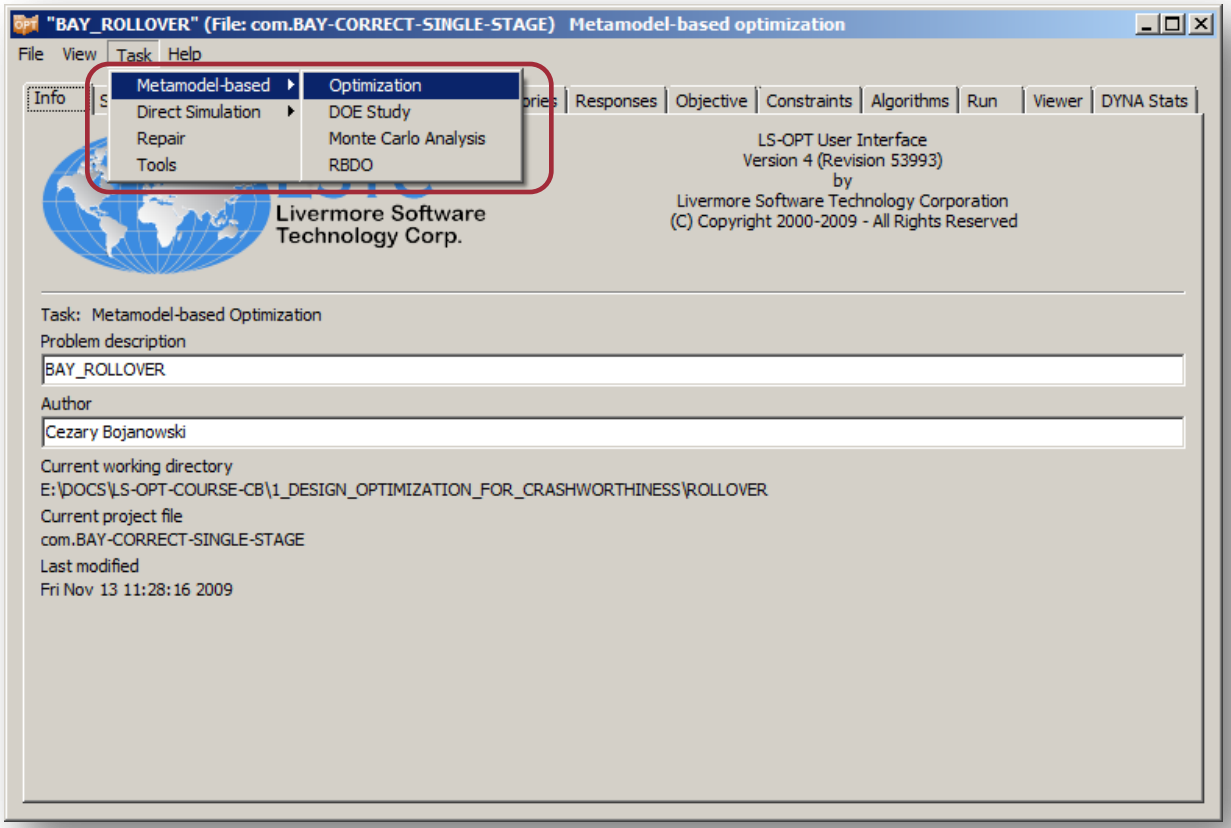
- Variable Input
- Job Scheduling
- Job Monitoring
- Result Retrieval

Technologies for Design Improvement

- Experimental Design
- Approximation
- Variable Screening
- Probabilistic Analysis
- Optimization

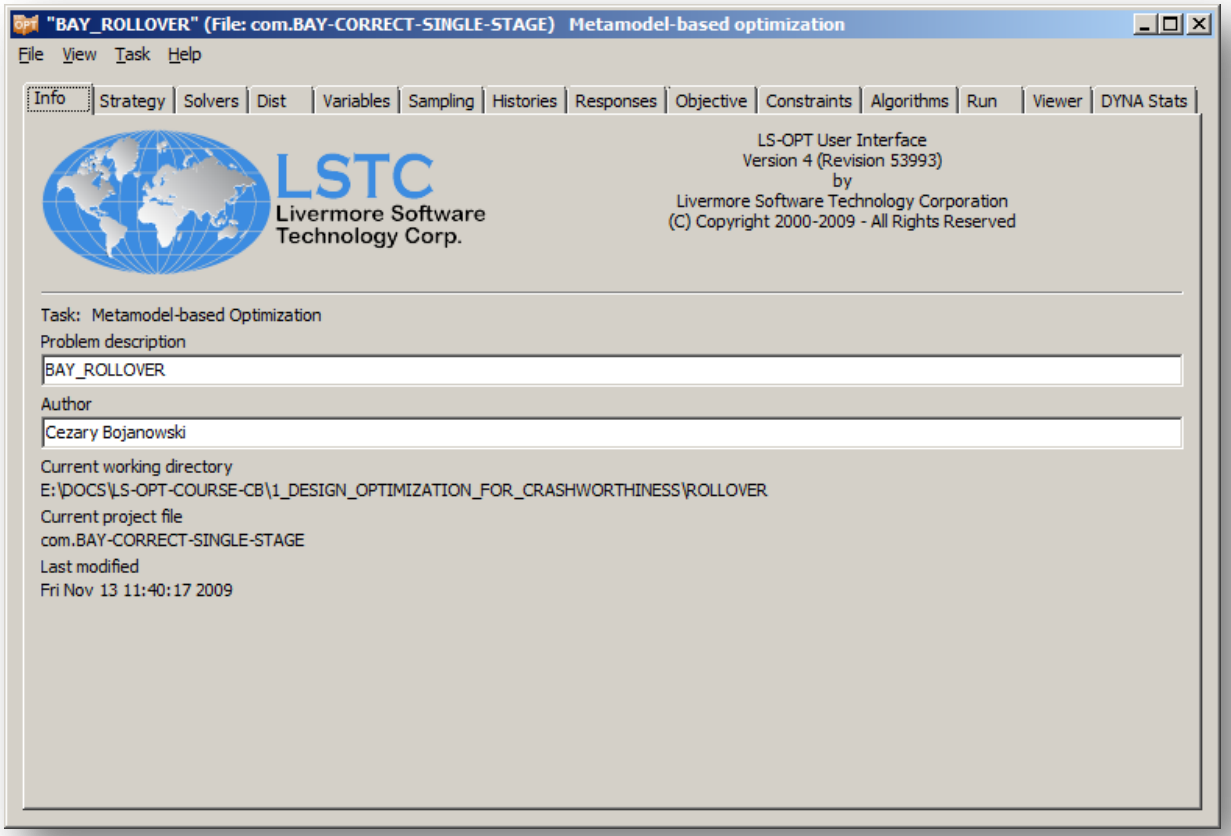
Task Selection

- Choose type of analysis:
  - Metamodel based
  - Direct Simulations
  - Repair tasks



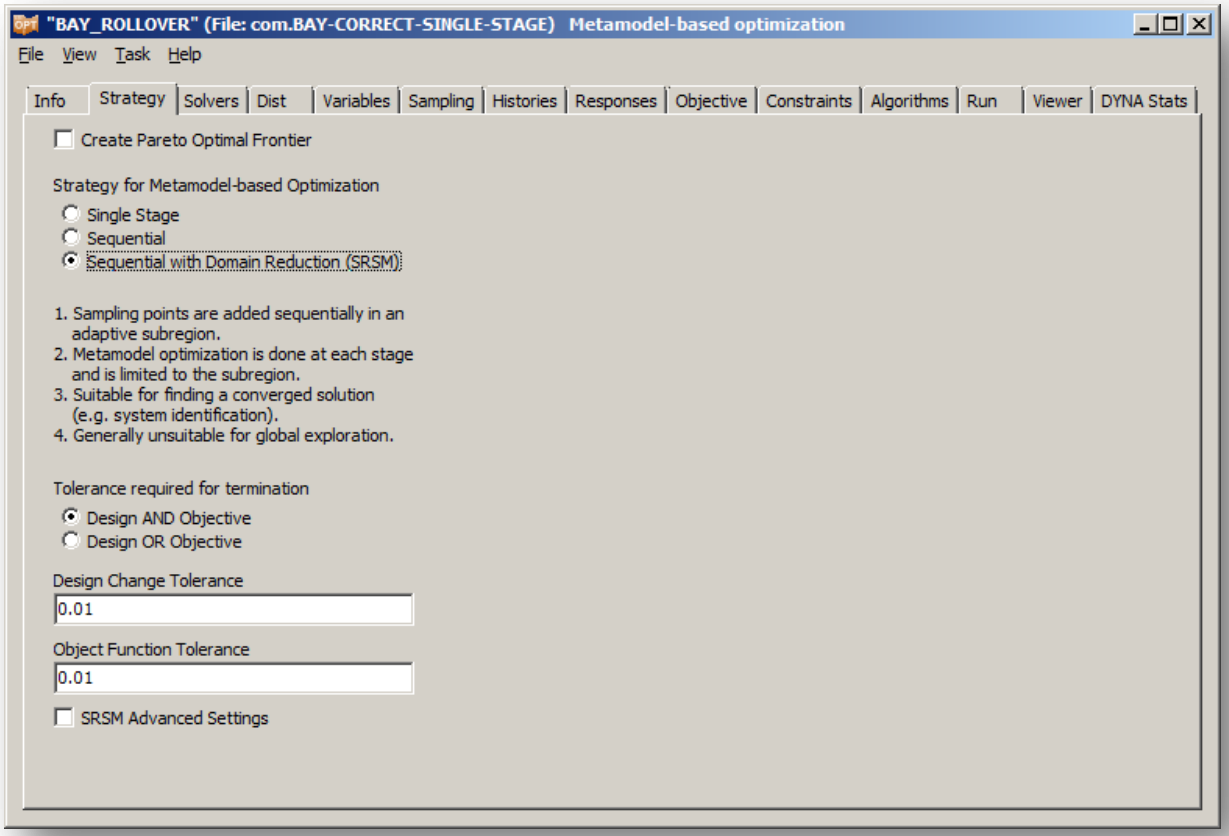
Info Tab

- Problem description
- Author information



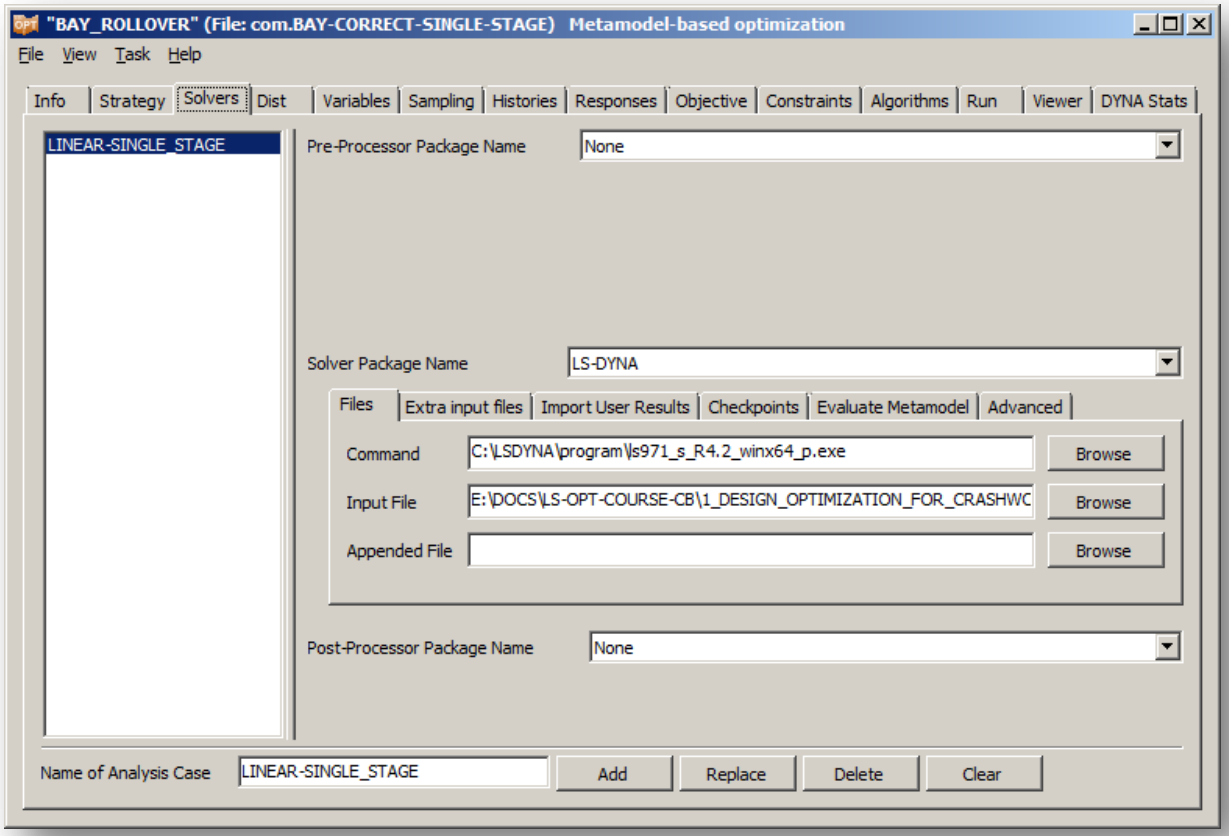
Strategy Tab

- Strategy for the analysis
- Tolerance for termination



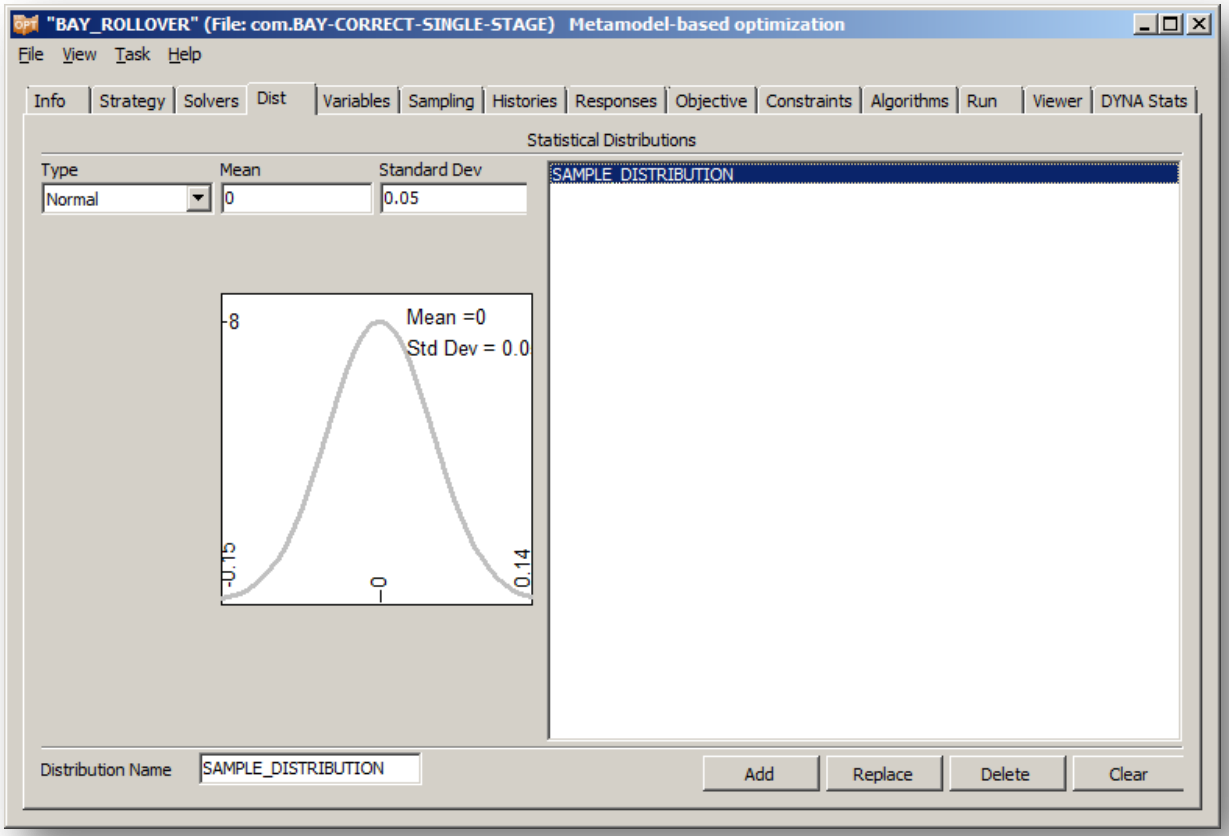
Solver Tab

- Define path to the input file
- Define path to the solver



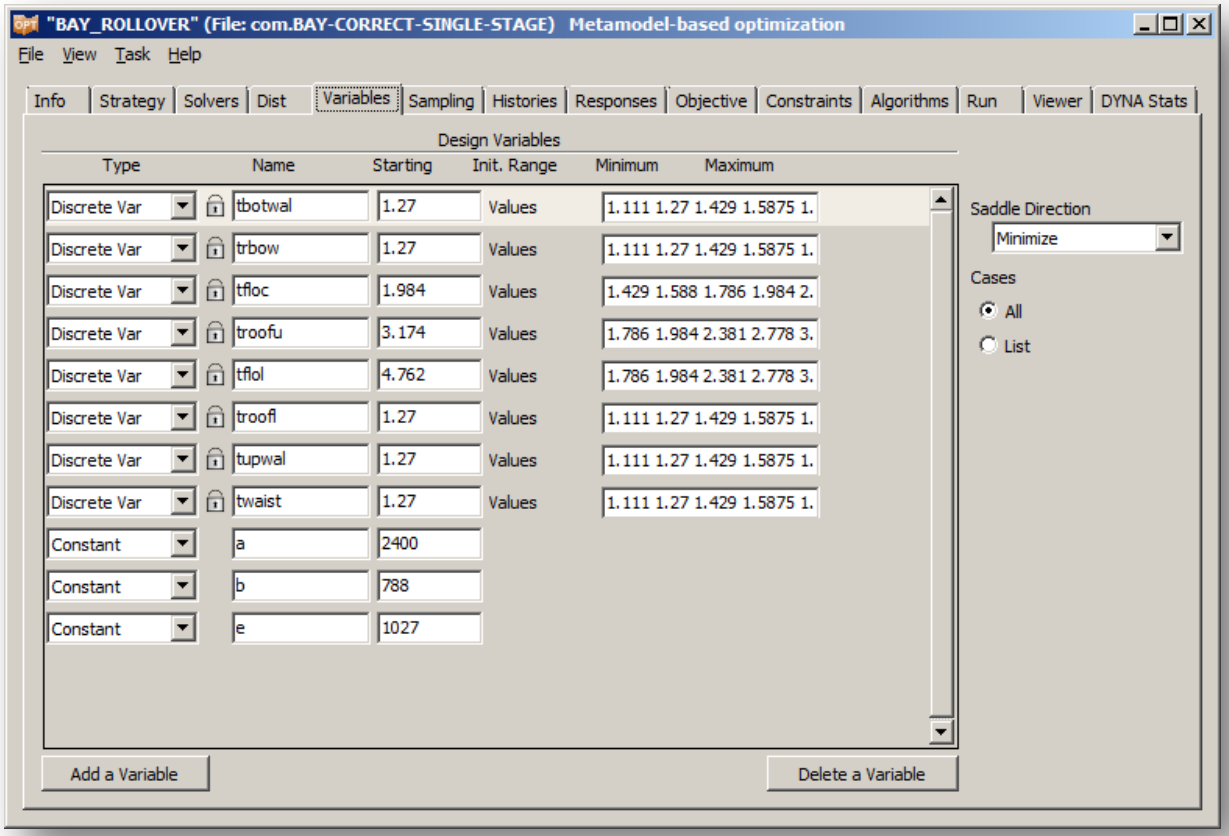
Distributions Tab

- Define distributions of variables for probabilistic studies



Variables Tab

- Define: Variables, Constants, Dependents, Noise variables, Discrete variables
- To ensure communication between LS-DYNA and LS-OPT definition of variables and constants will require modification of your key word file.



Variables Tab

In the LS-DYNA input file the variables should be defined in the following way:

```
*PARAMETER
r<your-variable-1>, <initial-value-1>
r<your-variable-n>, <initial-value-n>
```

For example:

```
*PARAMETER
rvarone, 1.0
rvartwo, 4.5
```

In the place where the variable should be used type `&varone` and so one.
For example:

```
*SECTION_SHELL
2,2,0.,0.,0.,0.,0.,0.
&varone,&varone,&varone,&varone
```

Variables Tab

Another method to feed the data from LS-OPT® to an input file is by using:
`<< >>` symbols

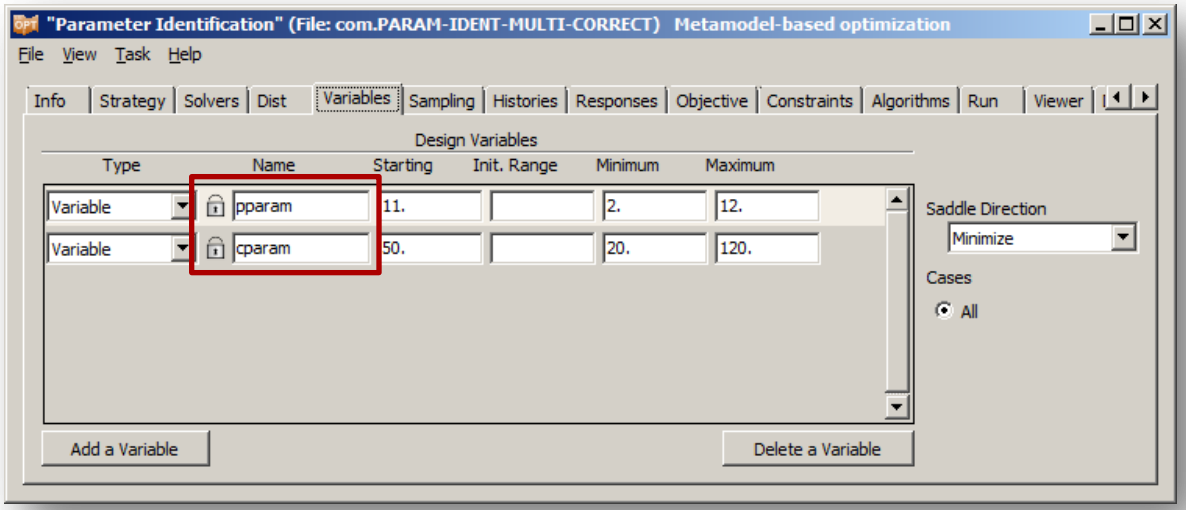
For example:

```
*MAT_ISOTROPIC_ELASTIC_PLASTIC
$#     MID        RO         G      SIGY      ETAN      BULK
         1 9.999E-06        7.  <<sigy>>        0.       16.
```

This approach is more general and can be used also when other solvers are involved.

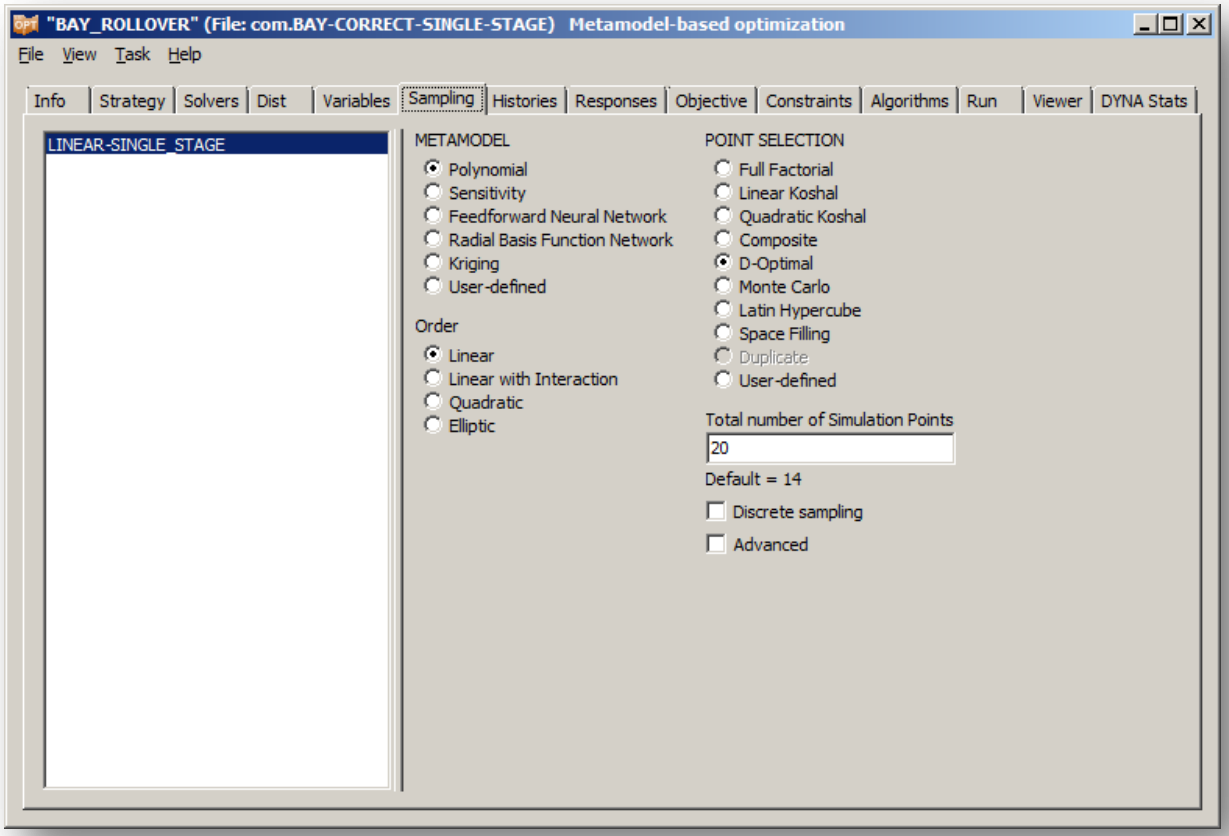
For example in Perl scripts:

```
$variable=<<value>>;
```



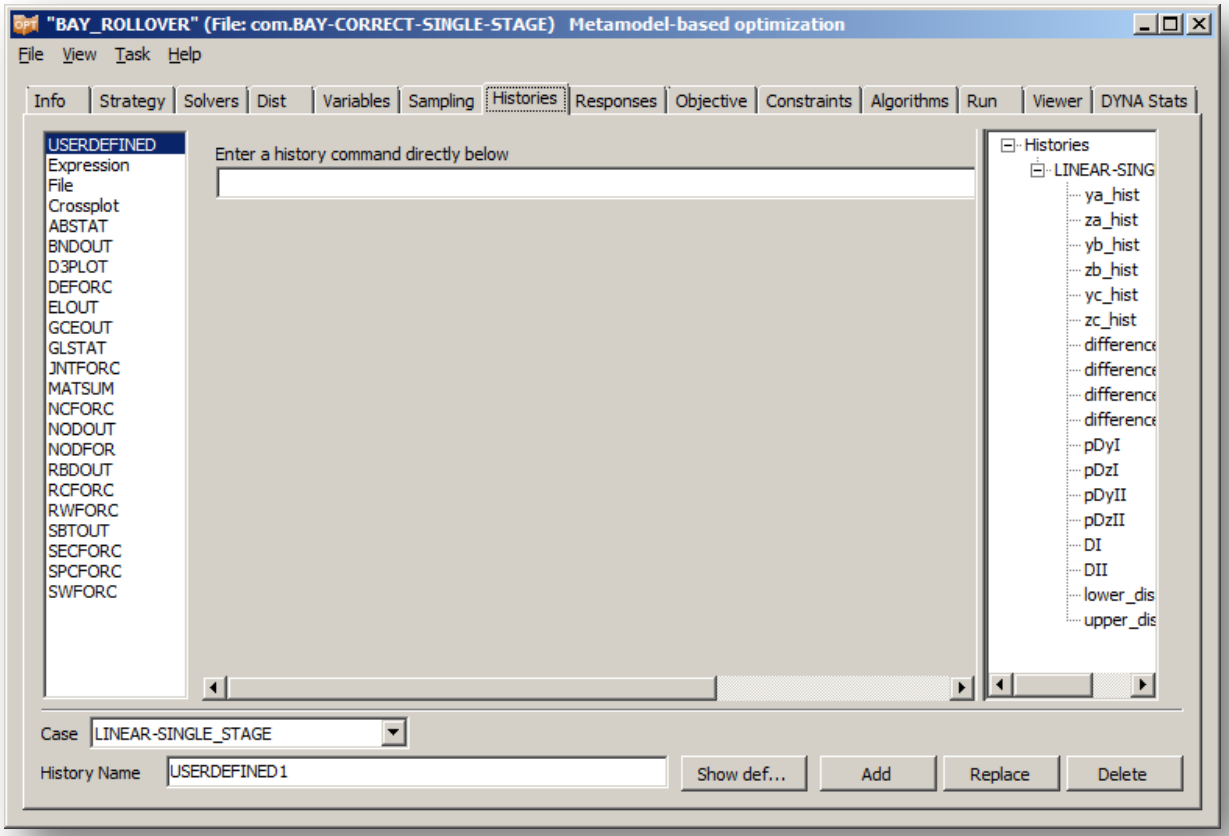
Sampling Tab

- Metamodel type selection
- Sampling method



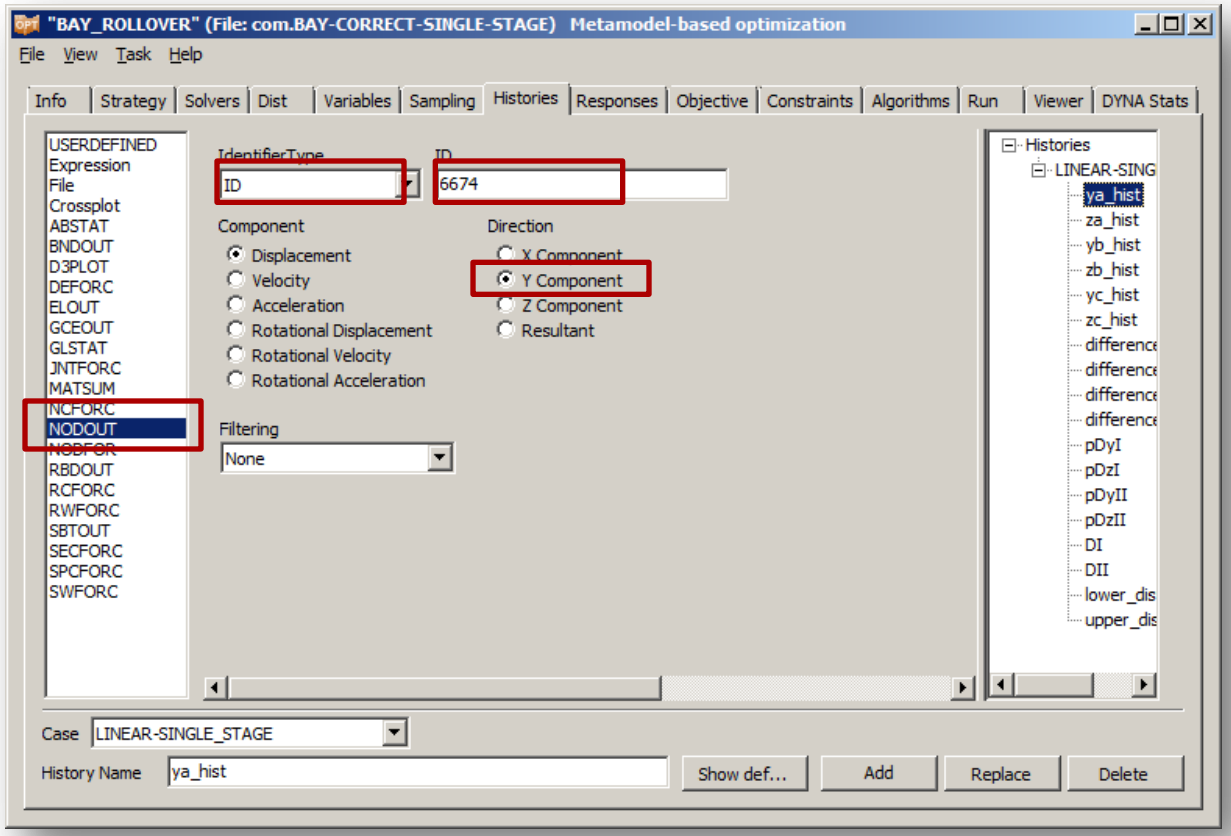
Histories Tab

- Defining time history curves from LS-DYNA output



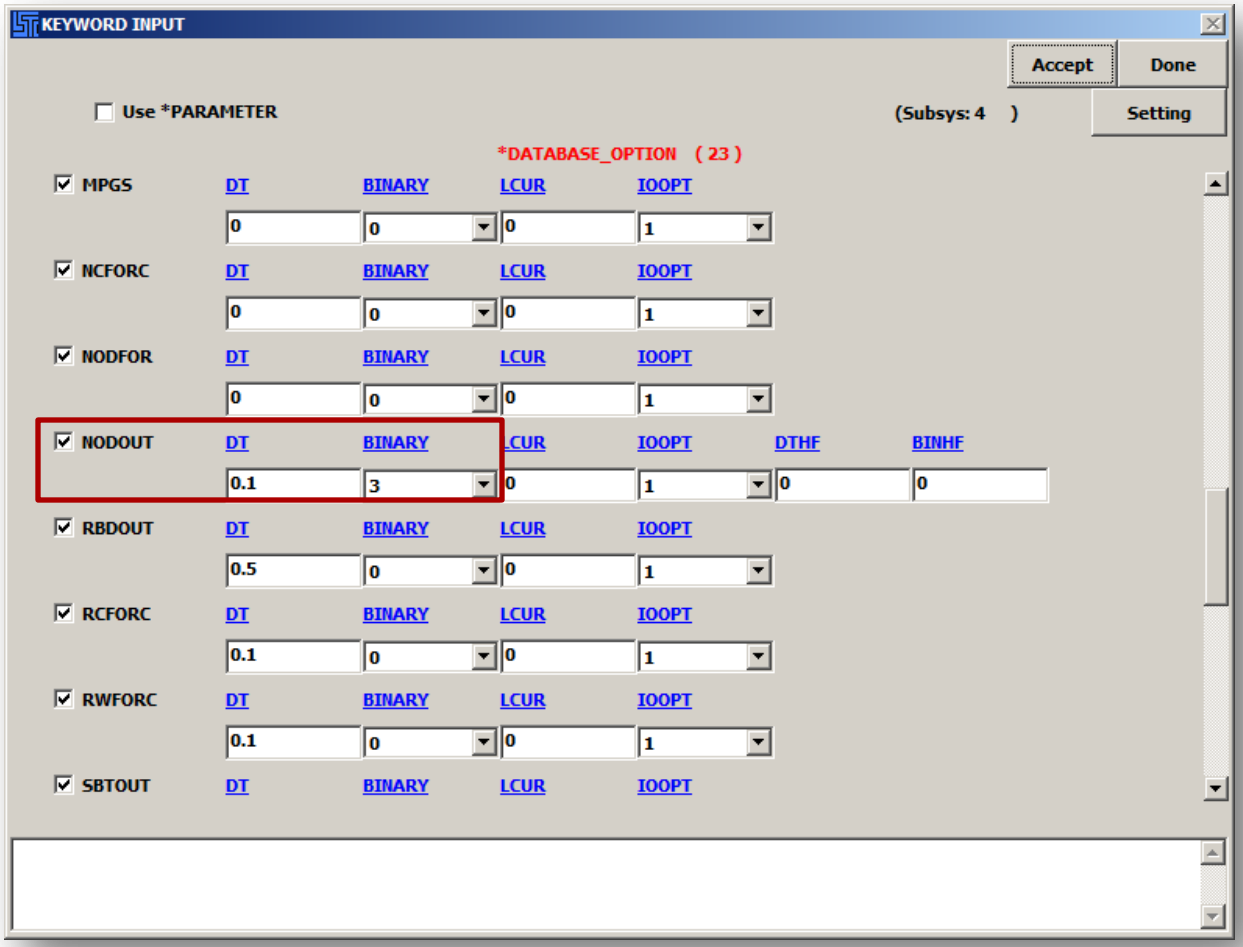
Histories Tab

- For example y-displacement of node ID 6674



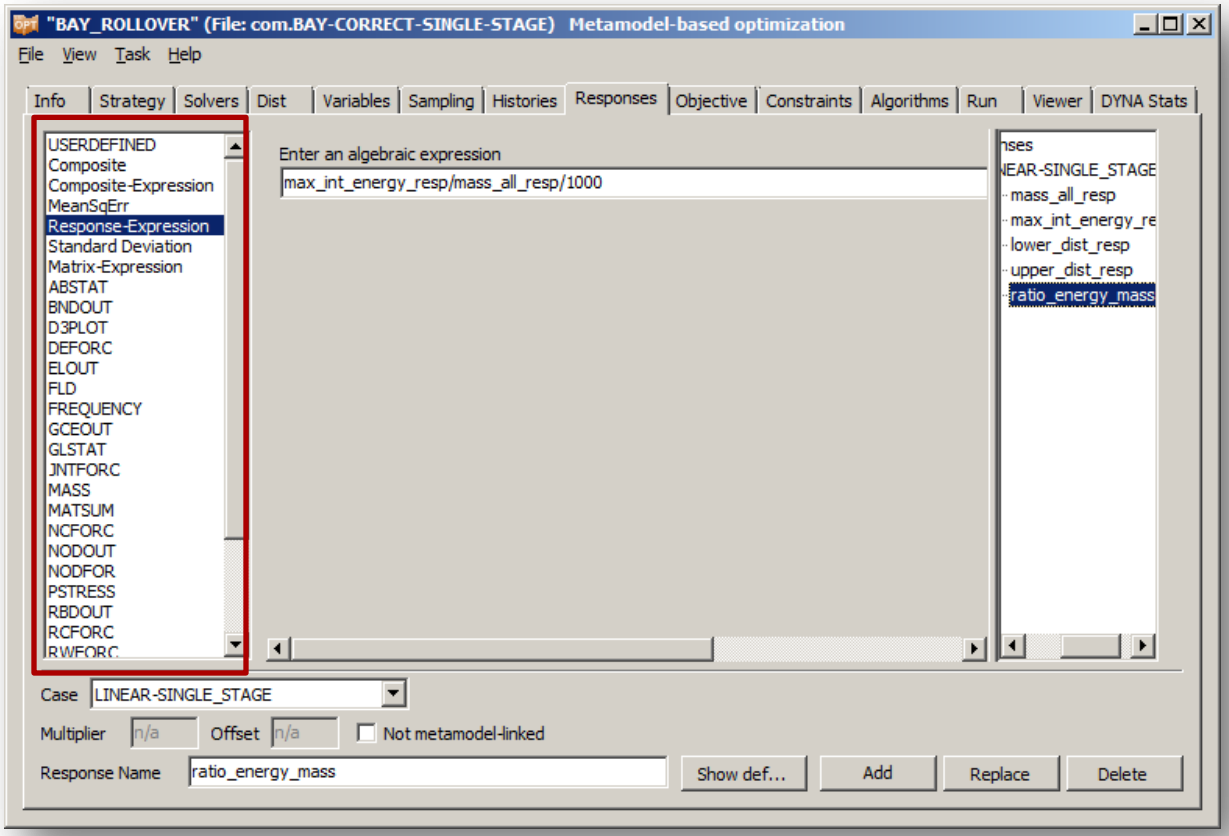
Histories Tab

- Binary output has to be requested in *DATABASE_OPTION card BINARY = 3



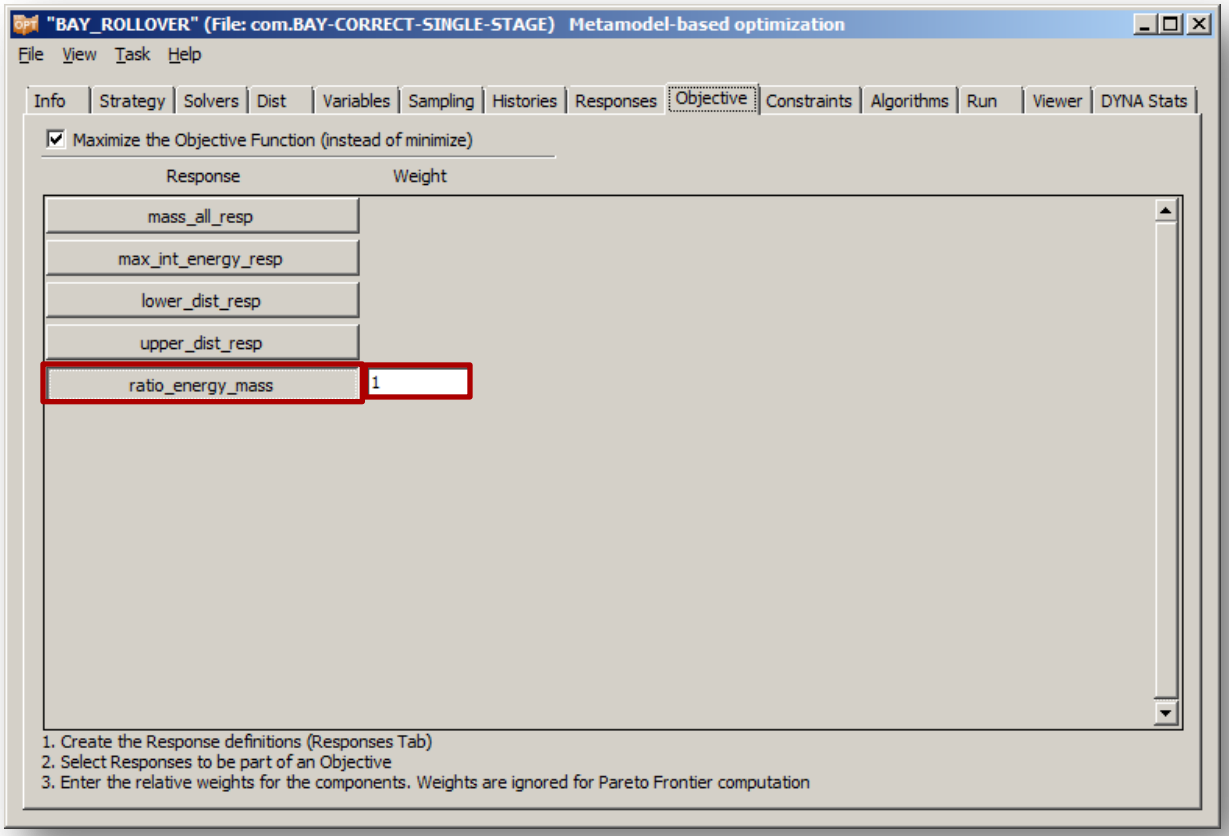
Responses Tab

- Calculate values for defined responses
- The response can be a result of mathematical expression or some quantity directly extracted from LS-DYNA output files



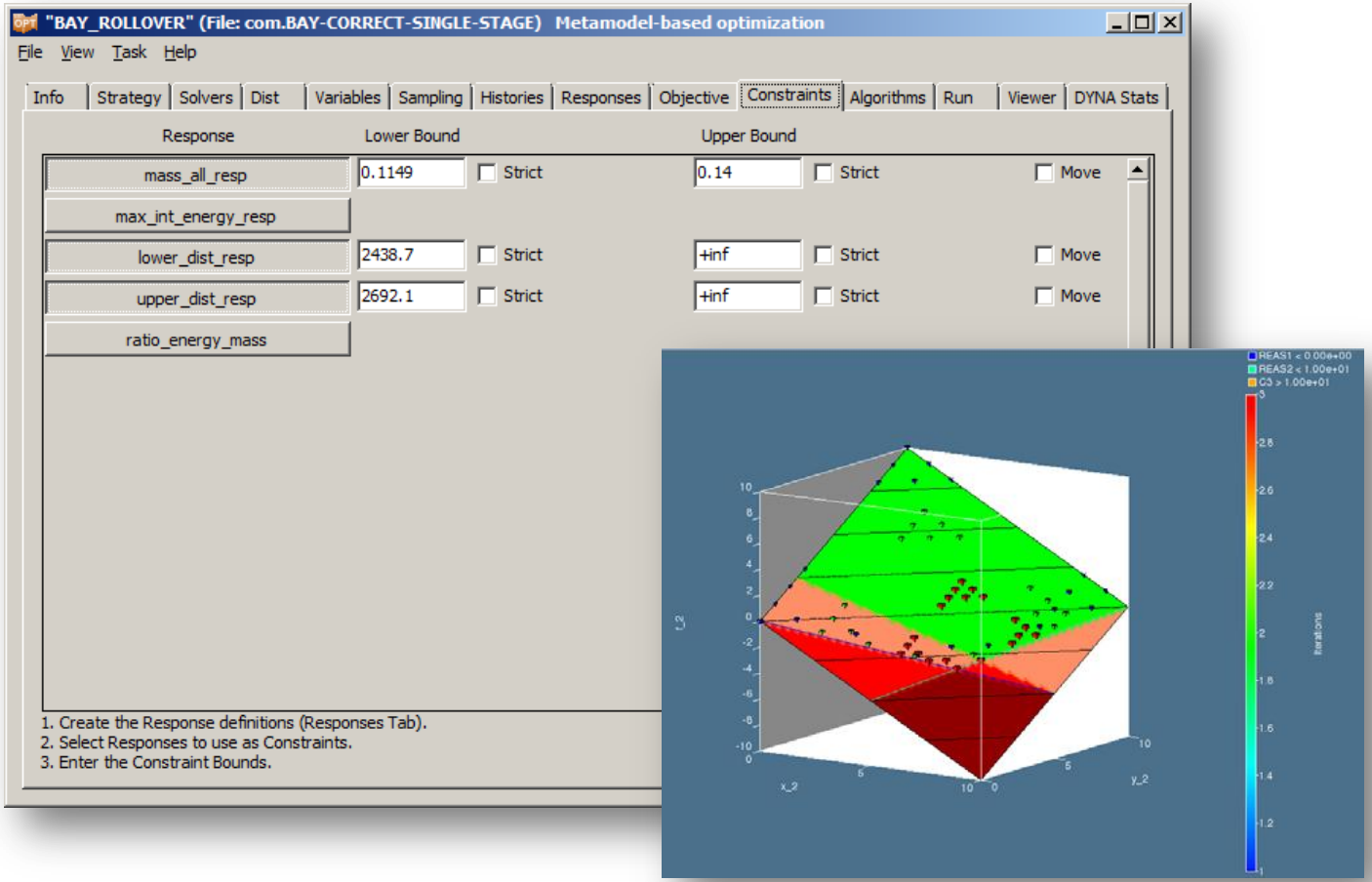
Objective Tab

- Define objectives in terms of responses
- Multiple objectives are admissible



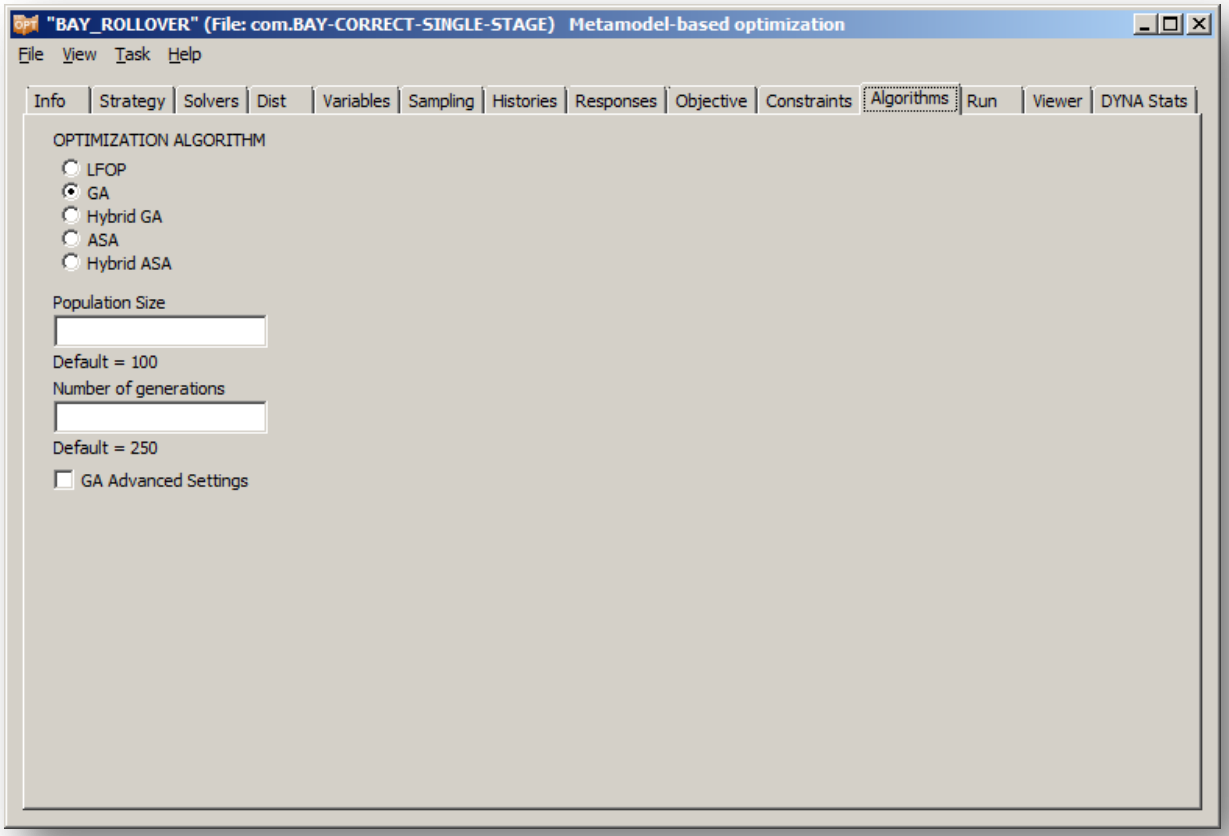
Constraints Tab

- Impose constraints on the Responses



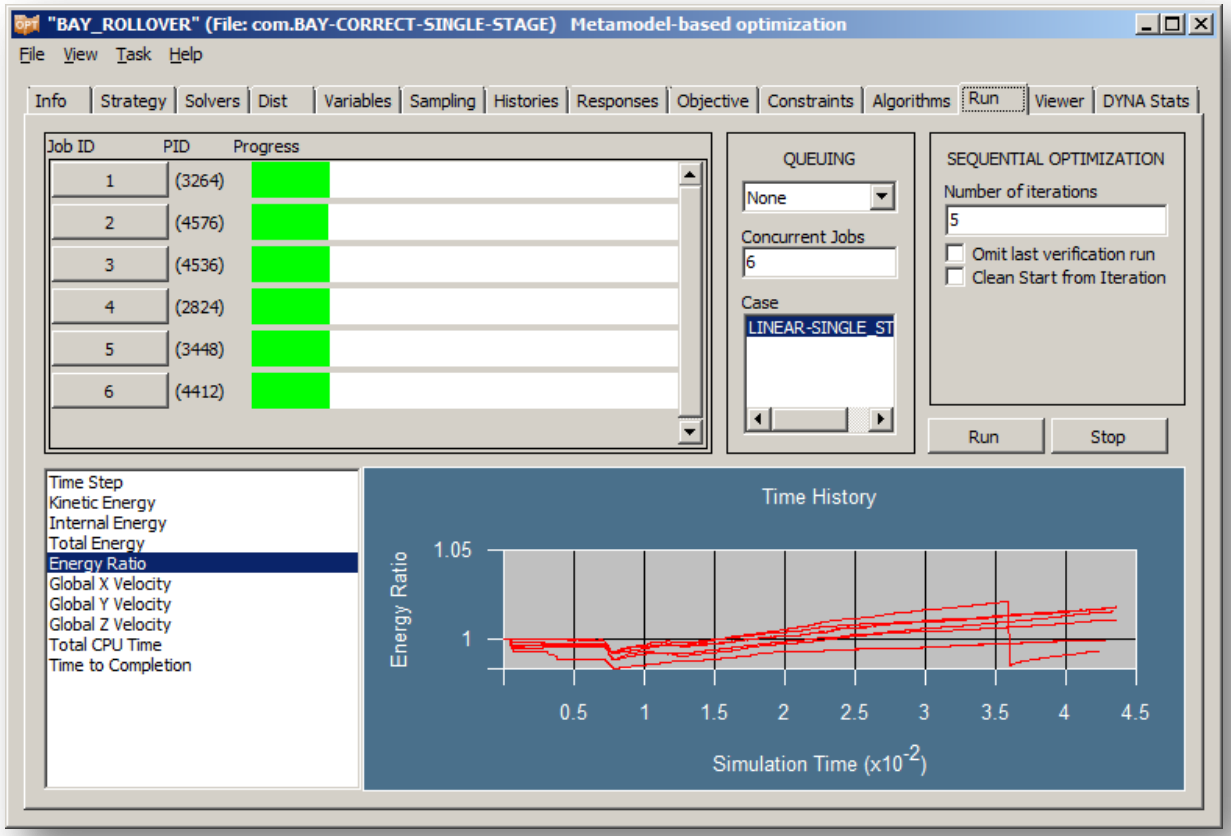
Algorithms Tab

- Choose the optimization algorithm



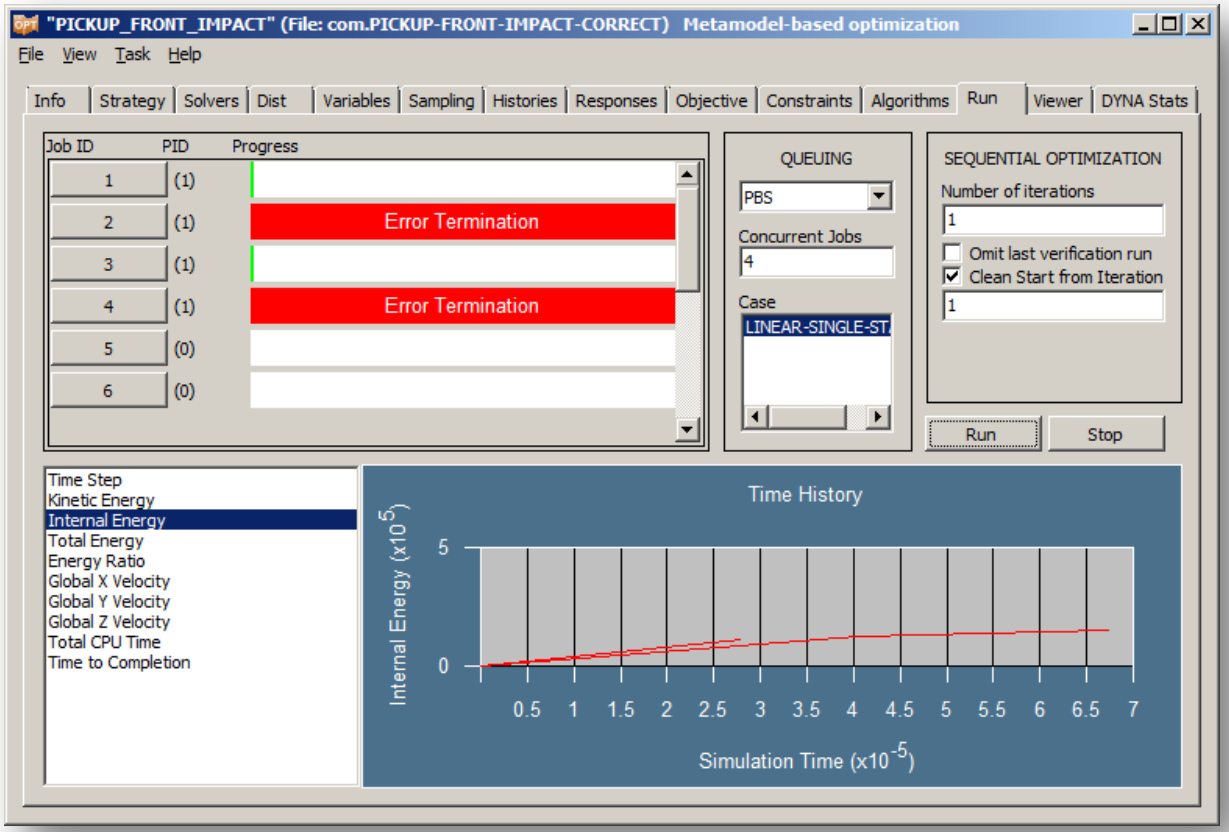
Run Tab - Tracking Jobs Progress

- #of iterations
- # of concurrent jobs
- scheduler type
- tracking progress



Run Tab

- The job scheduler will mark an error-terminated job.
- Results of abnormally terminated jobs are ignored.
- If there are not enough results to construct the approximate design surfaces, LS-OPT will terminate with an appropriate message.



Command File

- Number of solvers, variables, histories etc. needs to be specified
- Definitions with single quotes ‘ ‘
- Standard mathematical entities are acceptable
- Math expressions are given in { }
- Lines starting with $ are ignored

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File Edit Format View Help

```
"TUBE-CRUSH-DESIGN-OPT"
Author "Cezary Bojanowski"
$ Created on Wed Sep 30 18:31:38 2009
solvers 1
responses 3
histories 1
$
$ DESIGN VARIABLES
$
variables 3
 Variable 't1' 1
  Lower bound variable 't1' 0.9
  Upper bound variable 't1' 1.1
 Variable 't2' 0.8
  Lower bound variable 't2' 0.72
  Upper bound variable 't2' 0.88
 Variable 't3' 0.9
  Lower bound variable 't3' 0.81
  Upper bound variable 't3' 0.99

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$       OPTIMIZATION METHOD
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
Optimization Method SRSM

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$       SOLVER "SOLVER_1"
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
$ DEFINITION OF SOLVER "SOLVER_1"
$
 solver dyna960 'SOLVER_1'
  solver command "C:\LSDYNA\program\ls971_s_R4.2_winx64_p.exe"
  solver input file "E:\DOCS\LS-OPT-COURSE-CB\1_DESIGN_OPTIMIZATION_FOR_CR
  solver check output on
  solver compress d3plot off
$ ------ Pre-processor --------
$   NO PREPROCESSOR SPECIFIED
```

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File Edit Format View Help

```
$ ------ Post-processor --------
$   NO POSTPROCESSOR SPECIFIED
$ ------ Metamodeling ---------
  solver order linear
  solver experiment design dopt
$ ------ Job information ------
  solver concurrent jobs 8
$
$ RESPONSES FOR SOLVER "SOLVER_1"
$
 response 'TOP_DISP' 1 0 "BinoutResponse -res_type Nodout  -cmp z_displace
 response 'MASS_TOTAL' 1.0 0.0 "DynaMass MASS"
 response 'INT_ENE' 1.0 0.0 "BinoutResponse -res_type GLStat -cmp internal
$
$ HISTORIES FOR SOLVER "SOLVER_1"
$
 history 'TOP_DISP_HIST' "BinoutHistory -res_type nodout  -cmp z_displacem

composites 1
$
$ COMPOSITE EXPRESSIONS
$
 composite 'RATIO_ENE_MASS' {INT_ENE/MASS_TOTAL/1000}
$
$ OBJECTIVE FUNCTIONS
$
 objectives 1
 maximize
 objective 'RATIO_ENE_MASS'
$
$ CONSTRAINT DEFINITIONS
$
 constraints 2
 constraint 'TOP_DISP'
  lower bound constraint 'TOP_DISP' -55
 constraint 'MASS_TOTAL'
  upper bound constraint 'MASS_TOTAL' 3.14
$
$ PARAMETERS FOR METAMODEL OPTIMIZATION
$
 Metamodel Optimization Strategy SINGLESTAGE
$
  iterate param design 0.01
  iterate param objective 0.01
  iterate param stoppingtype and
```

Command File

- Commands

`solvers` *number_of_solvers*
`constants` *number_of_constants*
`variables` *number_of_variables*
`dependents` *number_of_dependent_variables*
`histories` *number_of_response_histories*
`responses` *number_of_responses*
`composites` *number_of_composites*
`objectives` *number_of_objectives*
`constraints` *number_of_constraints*
`distributions` *number_of_distributions*