

A Grid Computing environment for Design and Analysis of Computer Experiments

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Great thanks for **Rserve** package and support: **Simon Urbanek**

Overview

Few words about Research and Industry

Computer Experiments framework

PROMETHEE Grid Computing environment

Real world example

Summary

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Summary

Few words about Research and Industry

Reasons to work together

Industry needs

increase productivity

overtake competitors

Applied research needs

industrial applications

funding

Few words about Research and Industry

Reasons to work together

Industry needs

- increase productivity
- overtake competitors

Applied research needs

- industrial applications
- funding

Resiliency against partnership

Industry needs

- short term RoI
- efficient productive integration over existing practice

Applied research needs

- "formal bridge" between theory and application
- mid / long term & continuous partnership

Few words about Research and Industry

A well-suited partnership **DICE Consortium**

<http://www.dice-consortium.fr> (Deep Inside Computer Experiments)

Industrial partners

Research partners

Few words about Research and Industry

A well-suited partnership **DICE Consortium**

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Industrial partners: applications and testing

"orthogonal" high tech fields:

automotive, oil, aerospace, nuclear plants & safety

shared funding: 40 000 € / year.partner

Research partners: scientific and software deliverables

supplementary skills

contractual contribution and goals

hold scientific organization (PhD, postdoc, ...)

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hold scientific organization (PhD, postdoc, ...)

Finite term project

3 years long & every 6 month meeting focus on advances

software deliverables to be released as OSS (GPL/LGPL) in the end

scientific deliverables to be released in ~ public domain in the end

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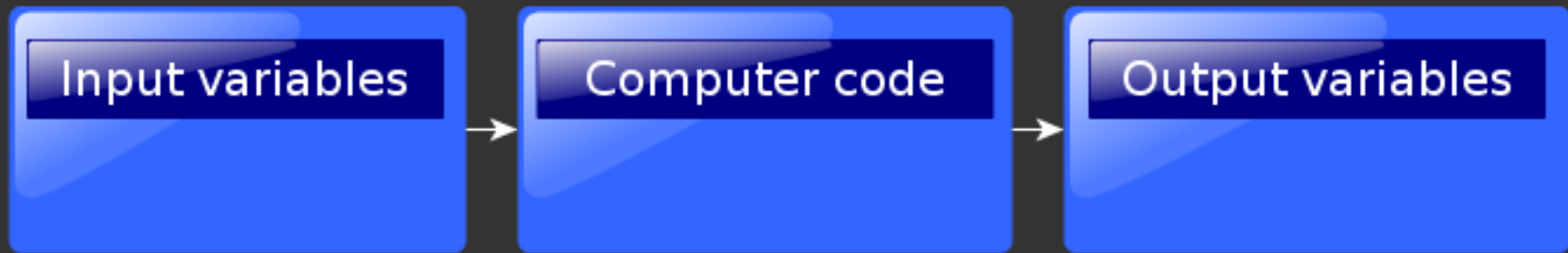
Computer Experiments framework

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Computer Experiments framework



Computer code

Used as an unknown function

(Maybe) heavy CPU cost

Represents any existing simulation solver: finite-elements, Monte Carlo, ...
Fortran, C, close source, ...

Input variables

Environment, control or simulation variables

Scalar, vector, time sequences, ...

Output variables

Interest values

Scalar, vector, time sequences, ...

Computer Experiments framework



From math. tools ...

Design of experiments
Surrogate modeling

DiceDesign, lhs, stats, ...
DiceKriging, DiceEval, tgp, ...

Computer Experiments framework



From math. tools ...

Design of experiments
Surrogate modeling

DiceDesign, lhs, stats, ...
DiceKriging, DiceEval, tgp, ...

... To engineering issues

Sensitivity analysis
Uncertainties propagation
Optimization
Inversion

DiceScreening, sensitivity, ...
DiceMRM, lhs, boot, ...
DiceOptim, ...
...?

Computer Experiments framework



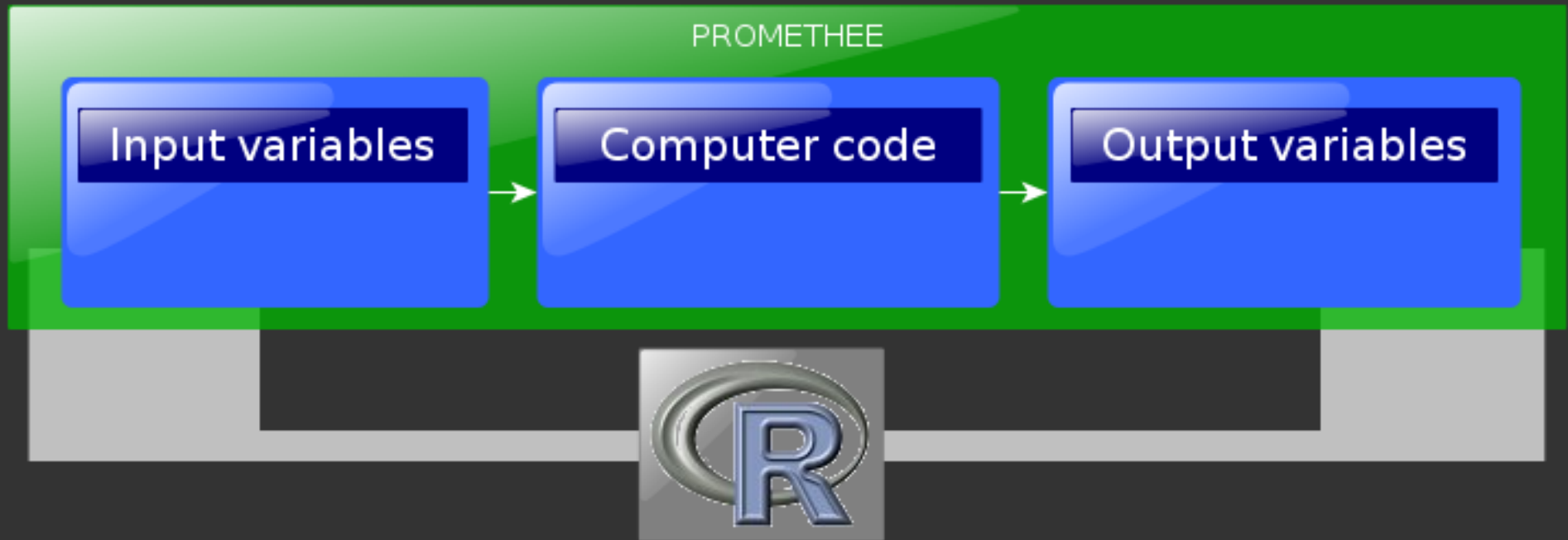
Software continuous integration: input / code / output

Wrap "Computer code" as a [R] function

support computing environment (remote exec, network, grid load, ...)

integrate parallel capabilities of algorithms (primary issue !)

Computer Experiments framework



Software continuous integration: input / code / output

Wrap "Computer code" as a [R] function

support computing environment (remote exec, network, grid load, ...)

integrate parallel capabilities of algorithms (primary issue !)

Integrate [R] within grid computing environment

language interface & objects mapping [R] / {Java, C++, C#, Python, ...}

sequential access to algorithms (ask(...) & tell(...))

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Software overview

Engineering through "Computer Experiments"

Allows engineer to easily apply "brute" factorial design ...

... then induces to formalize its model and goals in a DoE approach

Frequently needs for supplementary features (through dedicated code plugin)

PROMETHEE

Grid Computing environment

Software overview

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Distributed computing

Compatible with larger set of CPU boxes:

server, workstation, grid, cluster, ... and even (Windows) office desktop !

Easy dynamic merge of heterogeneous power

PROMETHEE

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Application fields agnostic software

Any ASCII I/O software is compatible

All algorithms selectable for any computing software

PROMETHEE

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Extendability & wrapping

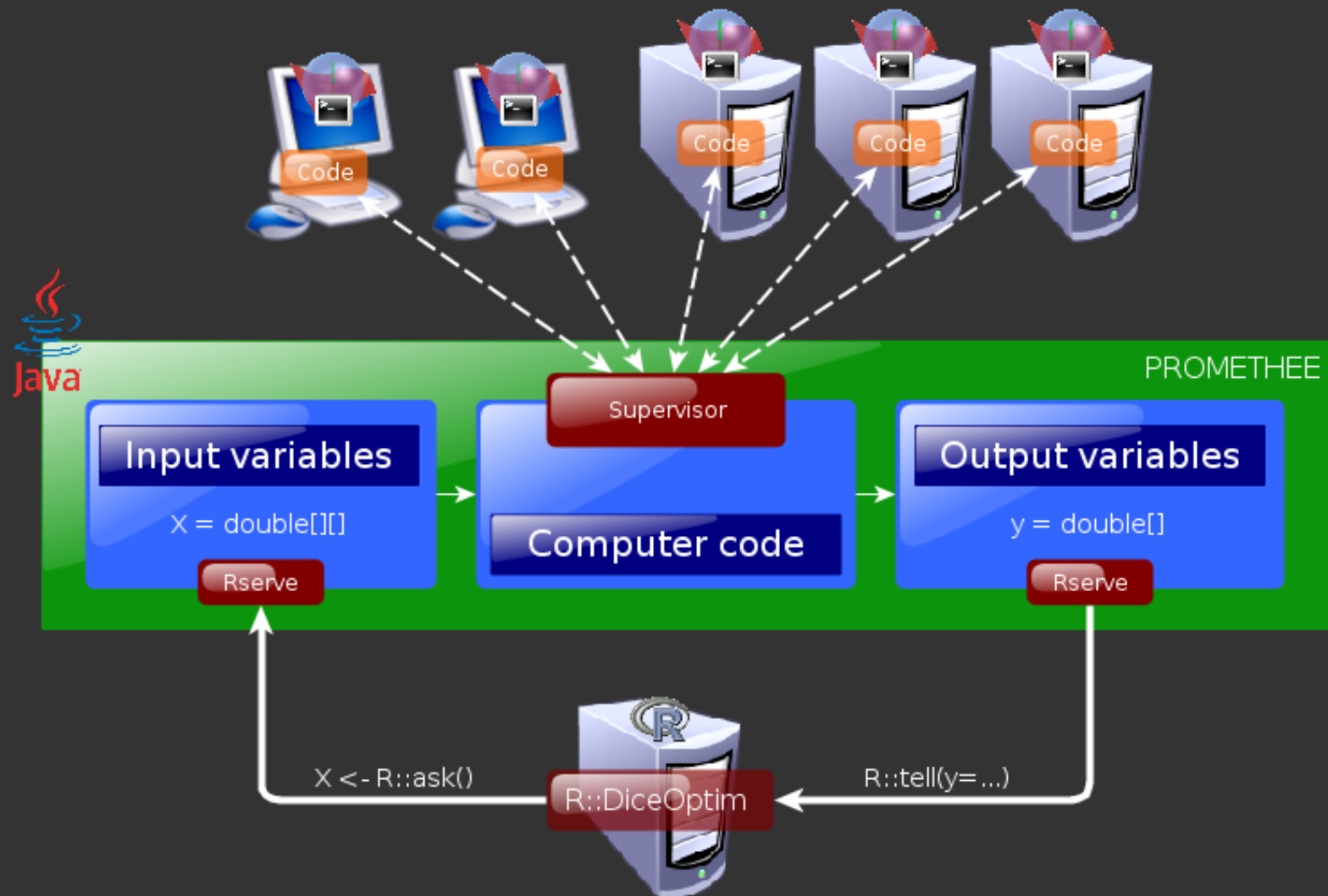
Basic (Groovy-DSL scripting) and extended (Java) plugins for computing code

Basic ([R]) and extended (Java::Rserve or Java::*) plugins for algorithms

PROMETHEE

Grid Computing environment

Network integration overview

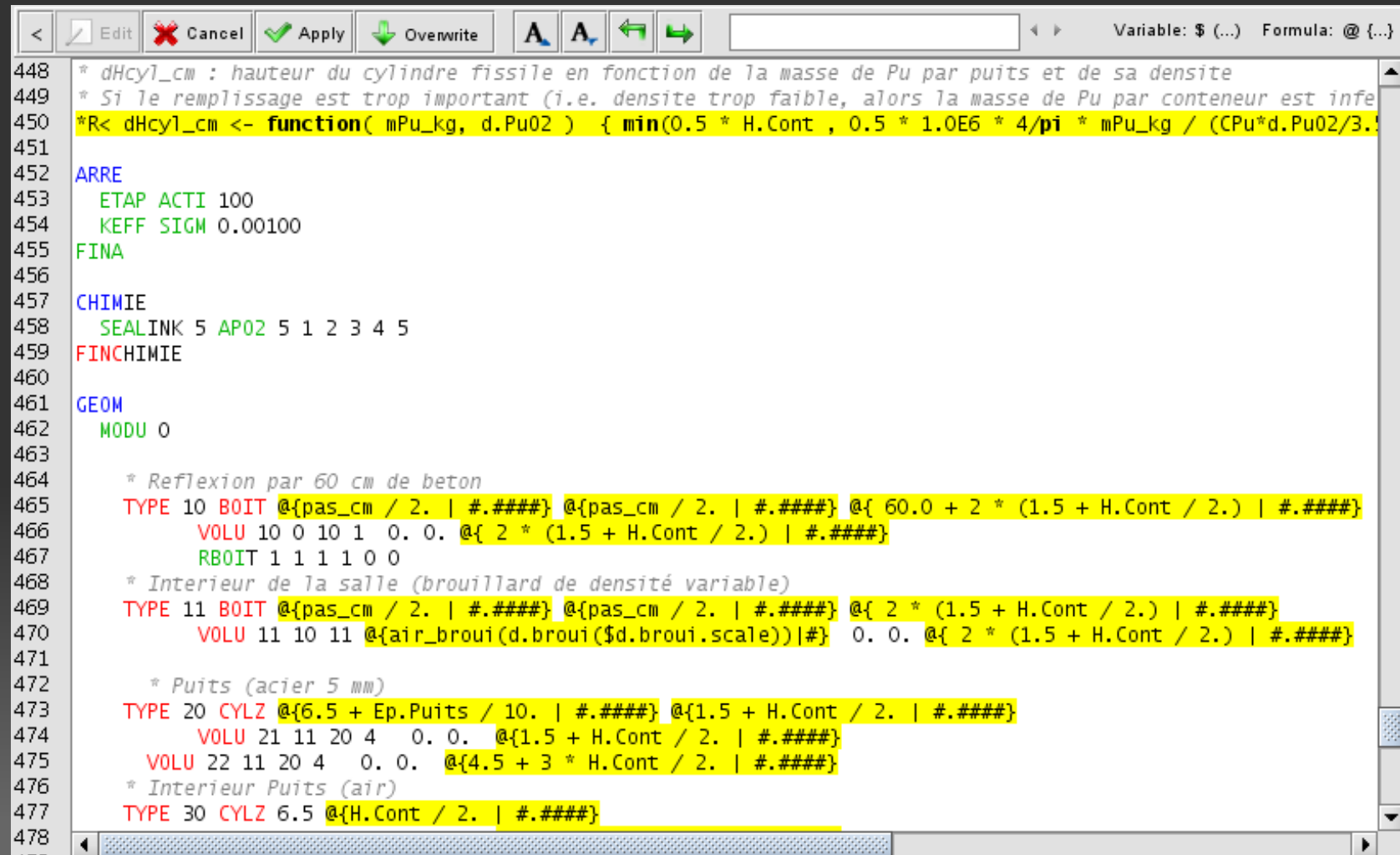


PROMETHEE

Grid Computing environment

[R] tech. overview

[R] used as a script engine for dataset parameterizing



```
448 * dHcyl_cm : hauteur du cylindre fissile en fonction de la masse de Pu par puits et de sa densite
449 * Si le remplissage est trop important (i.e. densite trop faible, alors la masse de Pu par conteneur est infe
450 *R< dHcyl_cm <- function( mPu_kg, d.Pu02 ) { min(0.5 * H.Cont , 0.5 * 1.0E6 * 4/pi * mPu_kg / (CPu*d.Pu02/3.
451
452 ARRE
453   ETAP ACTI 100
454   KEFF SIGM 0.00100
455 FINA
456
457 CHIMIE
458   SEALINK 5 APO2 5 1 2 3 4 5
459 FINCHIMIE
460
461 GEOM
462   MODU 0
463
464   * Reflexion par 60 cm de beton
465   TYPE 10 BOIT @{{pas_cm / 2. | #.####}} @{{pas_cm / 2. | #.####}} @{{ 60.0 + 2 * (1.5 + H.Cont / 2.) | #.####}}
466     VOLU 10 0 10 1 0. 0. @{{ 2 * (1.5 + H.Cont / 2.) | #.####}}
467     RBOIT 1 1 1 1 0 0
468   * Interieur de la salle (brouillard de densite variable)
469   TYPE 11 BOIT @{{pas_cm / 2. | #.####}} @{{pas_cm / 2. | #.####}} @{{ 2 * (1.5 + H.Cont / 2.) | #.####}}
470     VOLU 11 10 11 @{{air_broui(d.broui($d.broui.scale))|#}} 0. 0. @{{ 2 * (1.5 + H.Cont / 2.) | #.####}}
471
472   * Puits (acier 5 mm)
473   TYPE 20 CYLZ @{{6.5 + Ep.Puits / 10. | #.####}} @{{1.5 + H.Cont / 2. | #.####}}
474     VOLU 21 11 20 4 0. 0. @{{1.5 + H.Cont / 2. | #.####}}
475     VOLU 22 11 20 4 0. 0. @{{4.5 + 3 * H.Cont / 2. | #.####}}
476   * Interieur Puits (air)
477   TYPE 30 CYLZ 6.5 @{{H.Cont / 2. | #.####}}
478
```

PROMETHEE

Grid Computing environment

[R] tech. overview

[R] used as a script engine for dataset parameterizing

[R]/Rserve used as an API inside Java DoE algorithm plugin

```
R.voidEval("km" + currentiteration + "_" + hcode + " <- km(y~" + kmodel + ","
+ "optim.method='gen',"
+ "penalty = NULL,"
+ "covtype='" + covtype + "',"
+ nuggetnoise_str
+ "design=X" + currentiteration + "_" + hcode + ","
+ "response=Y" + currentiteration + "_" + hcode + ","
+ "control=list(" + control_km + "))");

REXP exists = R.eval("exists('km" + currentiteration + "_" + hcode + "')");
if (exists == null || !(exists.asInteger() == 1)) {
    return new Status(Decision.DESIGN_OVER, "No km object built.");
}

R.saves(new File(_repository, "km" + (currentiteration) + "_" + hcode + ".Rdata"), (currentiteration) + "_" + hcode);

R.voidEval("EGO" + currentiteration + "_" + hcode + " <- max_qEI.CL(model=km" + currentiteration + "_" + hcode + ","
+ "npoints=" + batchSize + ","
+ "L=c(" + liar + "(" + (search_min ? "" : "-") + "Y" + currentiteration + "_" + hcode + "$y)," + liar_noise + "),"
+ "lower=c(" + ASCII.cat(",", " min) + "),"
+ "upper=c(" + ASCII.cat(",", " max) + "),"
+ "control=list(" + control_ego + ")")
+ (expertfunction != null ? ",weight.EI=" + expertfunction : "") + ")");

/*REXP*/ exists = R.eval("exists('EGO" + currentiteration + "_" + hcode + "')");
if (exists == null || !(exists.asInteger() == 1)) {
    return new Status(Decision.DESIGN_OVER, "No EGO object built.");
}
```


PROMETHEE

Grid Computing environment

[R] tech. overview

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[R]/Rserve used as an API inside Java DoE algorithm plugin

[R] DoE algorithm plugin

```
#help=Efficient Global Optimization (EGO) algorithm
#type=Optimization
#output=Optimum
#parameters=initBatchSize=10,batchSize=10,iterations=10,nugget.estim=f

## constructor and initializer of R session
init <- function() {
  ...
}

## first design building. All variables are set in [0,1].
## d is the dimension, or number of variables
## @param d number of variables
buildInitialDesign <- function(d) {
  ...
}

## iterated design building.
## @param X data frame of current doe variables (in [0,1])
## @param Y data frame of current results
## @return data frame or matrix of next doe step
prepareNextDesign <- function(X,Y) {
  ...
}

## final analysis. All variables are set in [0,1]. Return HTML string
## @param X data frame of doe variables (in [0,1])
## @param Y data frame of results
## @return HTML string of analysis
analyseDesign <- function(X,Y) {
  ...
}
```

```
## first design building. All variables are set in [0,1]. d is the dimension, or
## @param d number of variables
buildInitialDesign <- function(d) {
  lhs <- maximinLHS(n=initBatchSize,k=d)
  if (Xbounds) {
    e=c(0,1)
    id=1
    while(id<d){
      e=rbind(cbind(e,0),cbind(e,1))
      id=id+1
    }
    Xinit=rbind(as.matrix(lhs),as.matrix(e))
  } else { Xinit=as.matrix(lhs) }
  return(Xinit)
}

## iterated design building.
## @param X data frame of current doe variables (in [0,1])
## @param Y data frame of current results
## @return data frame or matrix of next doe step
prepareNextDesign <- function(X,Y) {
  if (iEGO > iterations) return();

  d = dim(X)[2]
  if (dim(Y)[2] == 2) { noise.var <- as.array(Y[,2])
  } else { noise.var <- NULL }

  if (Xautoscale==" | Xautoscale=="FALSE" | Xautoscale=="false") { pEGO <- re
  } else { pEGO <- searchOptim(Xautoscale,init=pEGO,X=X,Y=Y) }
  cat("p=",pEGO,"\n")

  if (search_min) {y=Y[,1]} else {y=-Y[,1]}

  kmi <- km(control=list(trace=FALSE),trend,optim.method='gen',penalty = NULL,c
  EGOi <- max_qEI.CL(model=kmi,npoints=batchSize,L=liar(as.array(Y[,1])),lower=
  Xnext <- unscaleX(EGOi$par,pEGO)
```

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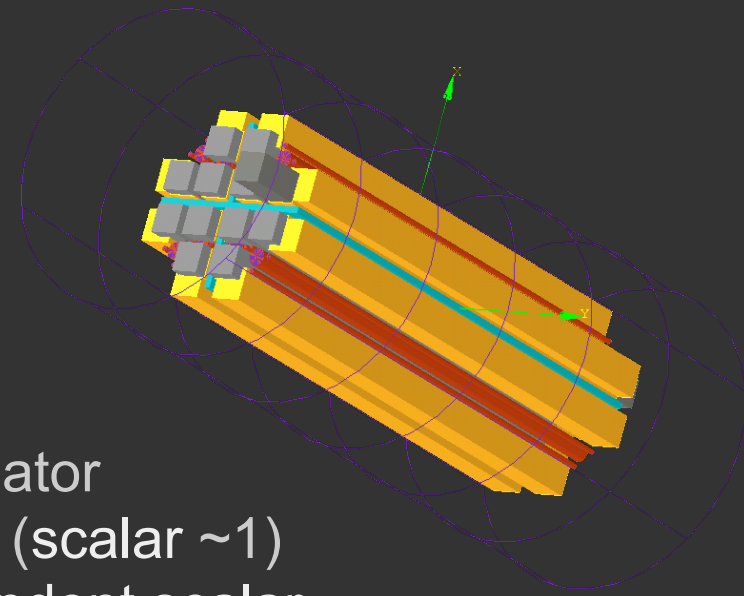
Computer Experiments framework

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Criticality safety assessment

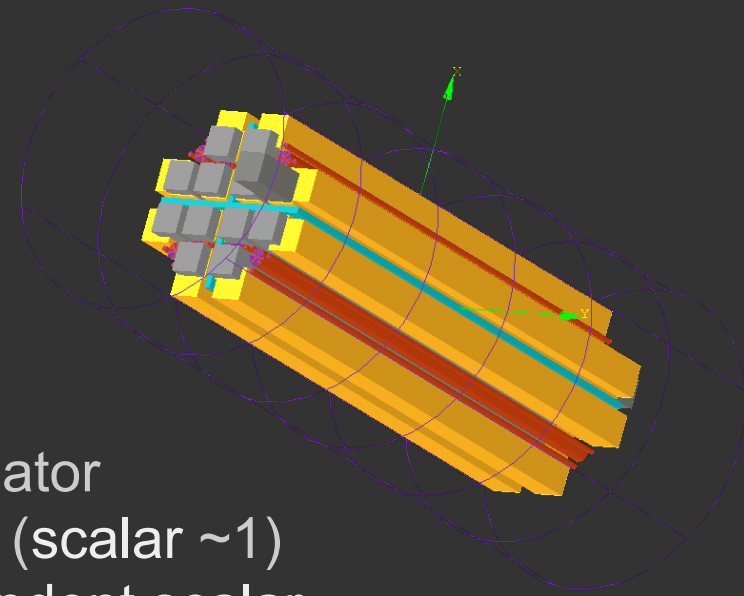
Computer code: Monte Carlo neutrons simulator

Output variables: neutron multiplication factor (scalar ~ 1)

Input variables: many hypothesis as independent scalar
code input parameters

Engineering issue: find optimization (max) of output
over hypothesis range

Real world example



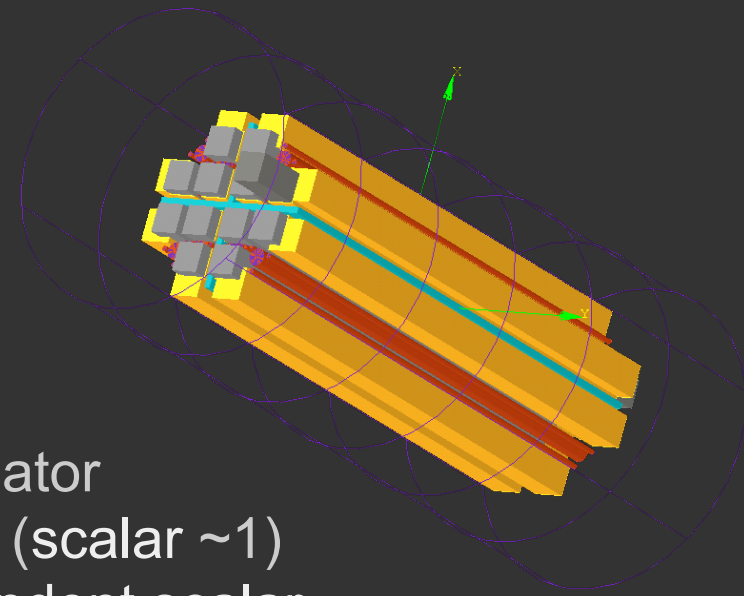
Criticality safety assessment

- Computer code: Monte Carlo neutrons simulator
- Output variables: neutron multiplication factor (scalar ~ 1)
- Input variables: many hypothesis as independent scalar code input parameters
- Engineering issue: find optimization (max) of output over hypothesis range

Old practical method (2 years ago)

- Hierarchical (user's prior) selection of ~ 3 input variables
- By-hand remote code launching (over interactive shell)
- Iterative & orthogonal maximization search (<20 points of calculation)

Real world example



Criticality safety assessment

Computer code: Monte Carlo neutrons simulator

Output variables: neutron multiplication factor (scalar ~ 1)

Input variables: many hypothesis as independent scalar
code input parameters

Engineering issue: find optimization (max) of output
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Hierarchical (user's prior) selection of ~ 3 input variables

By-hand remote code launching (over interactive shell)

Iterative & orthogonal maximization search (<20 points of calculation)

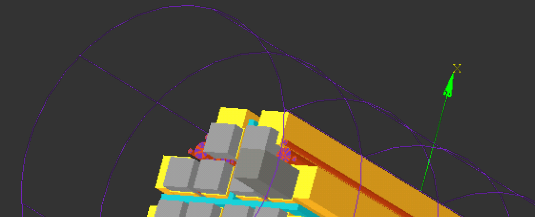
Within Computer Experiments paradigm (PROMETHEE & R::DiceOptim / DiceKriging)

No input variable ignored (no expert prior necessary)

Automatic remote code launching & output parsing

Global maximization of output (may support >1000 points of calculation)

Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables
Puits_PuO2_2variable...	new	1	
Puits_PuO2_2variable...	new	1	d.broui.scale d.Pu...

Model Define

Model: Moret_5A1 Help

Input variable	Default value
----------------	---------------

Dataset

Puits_PuO2_2variables_grille_75x75.jd.1

Output values	Type
mean_keff	float
sigma_keff	float

Variable: \$ (...) Formula: @ {...}

Calculations

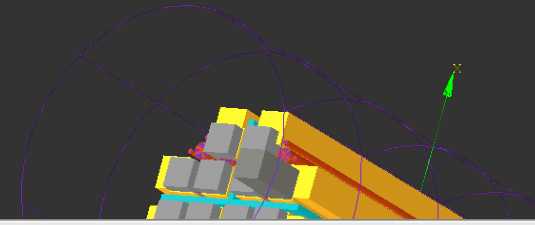
Q	Data set	State	Activity
---	----------	-------	----------

Results

V	Data set	Size	Pts	State
---	----------	------	-----	-------

```
460
461 GEOM
462 MODU 0
463
464 * Reflexion par 60 cm de beton
465 TYPE 10 BOIT 45 45 363
466     VOLU 10 0 10 1 0. 0. 303
467     RBOIT 1 1 1 1 0 0
468 * Interieur de la salle (brouillard de densité variable)
469 TYPE 11 BOIT 45 45 303
470     VOLU 11 10 11 2 0. 0. 303
471
472 * Puits (acier 5 mm)
473 TYPE 20 CYLZ 6.8 151.5
474     VOLU 21 11 20 4 0. 0. 151.5
475     VOLU 22 11 20 4 0. 0. 454.5
476 * Interieur Puits (air)
477 TYPE 30 CYLZ 6.5 150
478     VOLU 31 21 30 2 0. 0. 153
479     VOLU 32 22 30 2 0. 0. 456
480 * Conteneur (acier 2.5 mm)
481 TYPE 40 CYLZ 5.9 150
482     VOLU 41 31 40 4 0. 0. 153
483     VOLU 42 32 40 4 0. 0. 456
484 * Interieur conteneur (air)
485 TYPE 50 CYLZ 5.75 150
486     VOLU 51 41 50 2 0. 0. 153
487     VOLU 52 42 50 2 0. 0. 456
488 * Fissile
489 TYPE 60 CYLZ 5.75 49.8925
490
```


Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables
Puits_PuO2_2variable...	defining	1	d.broui.scale d.Pu...

Model Define

Input

Name	Engineering	Group	Type	Default value	Values
d.broui.scale	<input checked="" type="checkbox"/>		real	0.0	[0.0 ; 1.0]
d.PuO2	<input checked="" type="checkbox"/>		real	4.0	[0.5 ; 3.5]

Output

Engineering	Name	Type
<input checked="" type="checkbox"/>	N(mean_keff,s...	GaussianDensity
<input type="checkbox"/>	mean_keff+3*...	Numeric
<input type="checkbox"/>	mean_keff	Numeric
<input type="checkbox"/>	sigma_keff	Numeric

Calculations

Q	Data set	State	Activity

Results

V	Data set	Size	Pts	State

Engineering N(mean_keff,sigma_keff) as a function of d.broui.scale d.PuO2

Type	Name
<input type="checkbox"/>	No design of experiments
<input type="checkbox"/>	Sensitivity analysis SRC
<input type="checkbox"/>	Calibration EGI
<input type="checkbox"/>	Calibration Dichotomy
<input type="checkbox"/>	Uncertainties prop... Monte Carlo sampling
<input type="checkbox"/>	Sensitivity analysis FAST
<input type="checkbox"/>	Xautoscale
<input type="checkbox"/>	Uncertainties prop... Monte Carlo sampling with statistic ...
<input type="checkbox"/>	Calibration Bounds dichotomy
<input type="checkbox"/>	Uncertainties prop... Wilks formula
<input type="checkbox"/>	Sensitivity analysis Morris screening
<input type="checkbox"/>	Optimization gradientdescent
<input type="checkbox"/>	Sensitivity analysis PCC
<input checked="" type="checkbox"/>	Optimization Efficient Global Optimization

Computing parameters \ Kriging parameters \ Optimization parameters \ Expert know

Min iterations =

Max iterations =

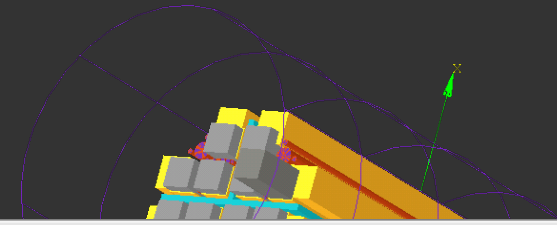
Stop when expected improvement lower than =

Parallel computations =

Initial parallel computations =

Bounding values

Real world example



Configuration Help Ⓡ

Data sets

Data set	State	Pts	Variables

Calculations

Q	Data set	State	Activity
<input checked="" type="checkbox"/>	Puits_PuO2_2variable...	running	13/22

Calculators pool Cases of calculations Results

d.broui.scale	d.PuO2	Status	Results
0.05292791611928907	0.608450717292726	neutrosec-3:44775 (00:00:48)	{mean_keff=0.83514, sigma_keff=9.9E-4}
0.43246648176055813	2.419029049342498	neutrosec-5:45716 (00:00:50)	{mean_keff=0.43866, sigma_keff=9.7E-4}
0.6515932745145013	1.2342307517149798	neutrosec-4:33376 (00:00:49)	{mean_keff=0.37587, sigma_keff=9.8E-4}
0.48777681594148314	2.7370404074899852	neutrosec-5:41623 (00:01:00)	{mean_keff=0.48104, sigma_keff=9.5E-4}
0.9752578554261062	0.8738973070091257	neutrosec-3:49300 (00:00:50)	{mean_keff=0.39795, sigma_keff=9.8E-4}
0.7734019996908804	3.2484961713198572	neutrosec-3:44775 (00:01:02)	{mean_keff=0.61211, sigma_keff=9.7E-4}
0.15940660941931936	2.8811014598080265	neutrosec-4:33376 (00:00:51)	{mean_keff=0.66163, sigma_keff=9.7E-4}
0.8569460754127552	1.9132098050322384	neutrosec-5:45716 (00:00:57)	{mean_keff=0.49395, sigma_keff=9.7E-4}
0.266666040988639	1.519644792424515	neutrosec-3:49300 (00:00:50)	{mean_keff=0.47258, sigma_keff=9.8E-4}
0.0	0.5	neutrosec-5:41623 (00:00:51)	{mean_keff=0.64971, sigma_keff=9.9E-4}
1.0	0.5	neutrosec-4:33376 (00:00:44)	{mean_keff=0.34886, sigma_keff=9.9E-4}
0.0	3.5	neutrosec-3:49300 (00:00:53)	{mean_keff=0.87957, sigma_keff=9.7E-4}
1.0	3.5	neutrosec-5:45716 (00:01:01)	{mean_keff=0.67924, sigma_keff=9.5E-4}
0.04690724847512489	2.605851167997531	running@neutrosec-3:44623	Running calculation
0.21815650910991874	3.4989094859937464	running@neutrosec-3:50653	Running calculation
0.11945042439696585	0.5338582812272392	running@neutrosec-3:33010	Running calculation
0.4147155410812902	0.8355990900960537	running@neutrosec-2:47676	Running calculation
0.5022901650518179	2.4808048440609127	running@neutrosec-5:45716	Running calculation
0.43641353099026536	3.4757703140607727	intact	?
0.7343308298286555	1.4604956749642715	intact	?
0.9268426589399511	2.1309098576262833	intact	?
0.3427231896203011	2.049468758283183	intact	?

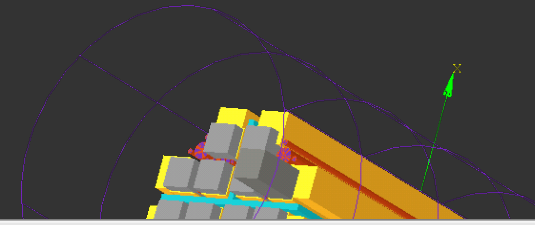
Results

V	Data set	Size	Pts	State

Calculator	Computer	Port	Since	State
neutrosec-5	neutrosec-5	45716	jul. 13 11:41:01	running
neutrosec-3	neutrosec-3	44623	jul. 13 11:43:58	running
neutrosec-3	neutrosec-3	33010	jul. 13 11:43:58	running
neutrosec-3	neutrosec-3	50653	jul. 13 11:43:58	running
neutrosec-2	neutrosec-2	47676	jul. 13 11:43:58	running

time spent: 00:03:14, remaining(est.): 00:02:14, cases: 13/22

Real world example



Configuration Help

Calculators pool \ Cases of calculations \ Results \ Optimum

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

Calculations

Q	Data set	State	Activity
<input checked="" type="checkbox"/>	Puits_PuO2_2variable...	running	18/22

Results

V	Data set	Size	Pts	State
---	----------	------	-----	-------

Optimum

Size = 18
Maximum value is 0.87957 (sd=9.7E-4)
for
d.broui.scale = 0.0
d.PuO2 = 3.5

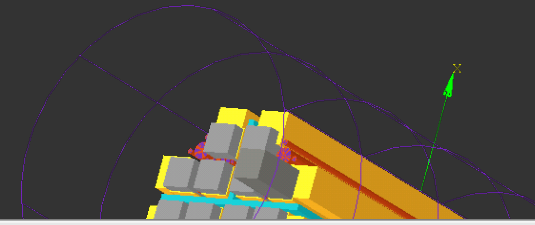
Next expected maximum value may be 0.436672301032858 (sd=0.1021111865913429)
Improvement sequence is 0.03634326569116935

d.PuO2 = 3.5

d.broui.scale = 0

The figure displays two contour plots showing the relationship between the effective multiplication factor $N(\text{mean_keff}, \text{sigma_keff})$ and the design variables $d.\text{PuO}_2$ and $d.\text{broui.scale}$. The left plot shows the response for $d.\text{broui.scale} = 0$, with $d.\text{PuO}_2$ ranging from 0.0 to 1.0. The right plot shows the response for $d.\text{PuO}_2 = 3.5$, with $d.\text{broui.scale}$ ranging from 0.5 to 3.5. Both plots feature a blue contour line representing the optimum path and red dots indicating specific data points.

Real world example



Configuration Help

Calculators pool \ Cases of calculations \ Results \ Optimum

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

Calculations

Q	Data set	State	Activity
<input checked="" type="checkbox"/>	Puits_PuO2_2variable...	running	28/31

Results

V	Data set	Size	Pts	State
---	----------	------	-----	-------

Optimum

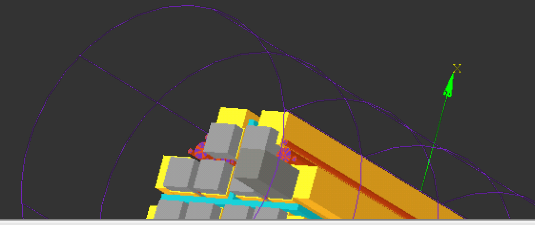
Size = 22
Maximum value is 0.87957 (sd=9.7E-4)
for
d.broui.scale = 0.0
d.PuO2 = 3.5

Next expected maximum value may be 0.40379585564175635 (sd=0.05129131183748922)
Improvement sequence is 0.03634326569116935 0.015487485658755436

d.PuO2 = 3.5

d.broui.scale = 0

Real world example



Configuration Help

Calculators pool \ Cases of calculations \ Results \ Optimum

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

Calculations

Q	Data set	State	Activity
<input checked="" type="checkbox"/>	Puits_PuO2_2variable...	running	36/40

Results

V	Data set	Size	Pts	State
---	----------	------	-----	-------

Optimum

Size = 36
Maximum value is 0.94493 (sd=9.7E-4)
for
d.broui.scale = 0.051841262267356865
d.PuO2 = 1.3152636722486182

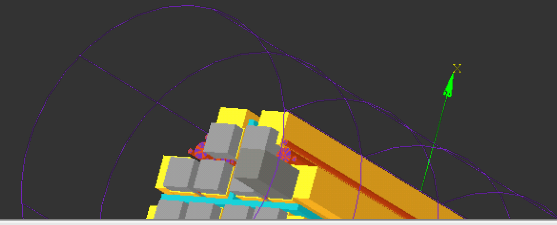
Next expected maximum value may be 0.3305609836167595 (sd=0.037521836022635854)
Improvement sequence is 0.03634326569116935 0.015487485658755436 0.044748414478939784

d.PuO2 = 1.31526367224862 **d.broui.scale = 0.051841262267356**

The left plot shows the relationship between the mean effective multiplication factor (mean_keff) and its standard deviation (sigma_keff) as a function of the PuO2 concentration. The x-axis ranges from 0.0 to 1.0, and the y-axis ranges from 0.3 to 0.9. The data points are scattered, and a blue curve with a shaded confidence interval is fitted to the data, showing a minimum around d.PuO2 = 0.45.

The right plot shows the relationship between the mean effective multiplication factor (mean_keff) and its standard deviation (sigma_keff) as a function of the broui.scale parameter. The x-axis ranges from 0.5 to 3.5, and the y-axis ranges from 0.3 to 0.9. The data points are scattered, and a blue curve with a shaded confidence interval is fitted to the data, showing a minimum around d.broui.scale = 2.5.

Real world example



Configuration Help

Calculators pool \ Cases of calculations \ Results \ Optimum \

Optimum

Size = 49
Maximum value is 0.94493 (sd=9.7E-4)
for
d.broui.scale = 0.051841262267356865
d.PuO2 = 1.3152636722486182

Next expected maximum value may be 0.27124840838756037 (sd=0.006921897341635227)
Improvement sequence is 0.03634326569116935 0.015487485658755436 0.044748414478939784 2.763858399510977E-4 0.01589271212596177

d.PuO2 = 1.31526367224862 **d.broui.scale = 0.05184126226735€**

N(mean_keff,sigma_keff)

0.0 0.2 0.4 0.6 0.8 1.0

0.5 1.0 1.5 2.0 2.5 3.0 3.5

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

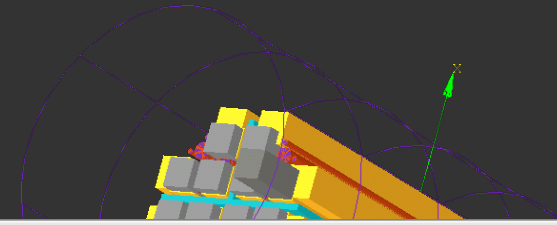
Calculations

Q	Data set	State	Activity
<input checked="" type="checkbox"/>	Puits_PuO2_2variable...	running	49/58

Results

V	Data set	Size	Pts	State
---	----------	------	-----	-------

Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables

Calculators pool \ Cases of calculations \ Results \

Optimum \

Optimum

Size = 49
Maximum value is 0.94493 (sd=9.7E-4)
for
d.broui.scale = 0.051841262267356865
d.PuO2 = 1.3152636722486182

0.27124840838756037 (sd=0.006921897341635227)
9116935 0.015487485658755436 0.044748414478939784 2.763858399510977E-4 0.01589271212596177

367224862 d.broui.scale = 0.051841262267356

Puits_PuO2_2variables_grille_75x75.jd EGO

Puits_PuO2_2variables_grille_75x75.jd

Default branin.sci Puits_PuO2_2variables_grille_75x75.jd

Log Objects

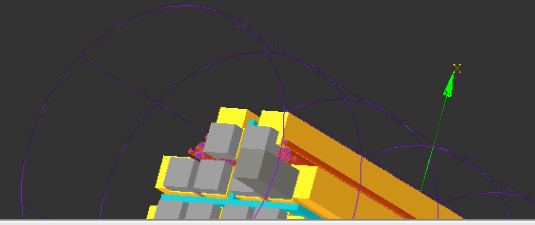
```
Clear Save  
[eval] exists('km4_1389836095')  
[eval] save(file='km4_1389836095.Rdata',list=ls(pattern='4_1389836095'),ascii=TRUE)  
[IO] File km4_1389836095.Rdata received.  
[eval] EGO4_1389836095 <-  
max_qEI.CL(model=km4_1389836095,npoints=9,L=c(max(-Y4_1389836095$y),9.4E-4),  
lower=c(0.0,0.5),upper=c(1.0,3.5),control=list(trace=FALSE),weight.EI=NULL)  
[eval] exists('EGO4_1389836095')  
[eval] save(file='EGO4_1389836095.Rdata',list=ls(pattern='4_1389836095'),ascii=TRUE)  
[IO] File EGO4_1389836095.Rdata received.  
[eval] X5_1389836095 <- rbind(X4_1389836095,EGO4_1389836095$par)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[1,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[2,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[3,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[4,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[5,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[6,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[7,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[8,],envir=EIenv)  
[eval] EI(model=km4_1389836095,newdata=EGO4_1389836095$par[9,],envir=EIenv)  
[eval] EGO4_1389836095$par  
[eval] pred <-  
predict.km(object=km4_1389836095,newdata=EGO4_1389836095$par,type='UK')  
[eval] max(pred$mean)  
[eval] pred$sd[pred$mean==0.27124840838756037]  
[set] bestX_4_1389836095 <- [D@4d0f64e0  
[set] plotfile_582375936 <- sectionview.4.png  
[IO] File sectionview.4.png received.  
[eval] rm(plotfile_582375936)
```

0.0 0.2 0.4 0.6 0.8 1.0

0.3 0.4 0.5 0.6 0.7 0.8 0.9

0.5 1.0 1.5 2.0 2.5 3.0 3.5

Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

Calculations

Q	Data set	State	Activity
---	----------	-------	----------

Results

V	Data set	Size	Pts	State
<input checked="" type="checkbox"/>	Puits_PuO2_2variab...	45 MB	58 seen	

Post processing Files

Optimum

Optimum

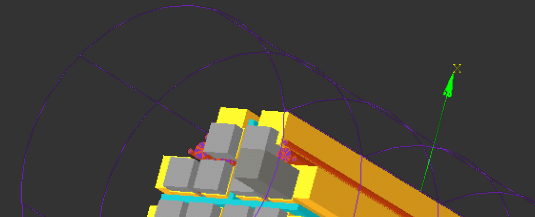
Size = 58
Maximum value is 0.95964 (sd=9.6E-4)
for
d.broui.scale = 0.09327404717601559
d.PuO2 = 1.011042937354369

Next expected maximum value may be 0.34113979499640373 (sd=0.006697966035673094)
Improvement sequence is 0.03634326569116935 0.015487485658755436 0.044748414478939784 2.763858399510977E-4 0.01589271212596177 0.0

d.PuO2 = 1.01104293735437 **d.broui.scale = 0.093274047176015**

The figure consists of two side-by-side scatter plots. The left plot has a y-axis labeled 'N(mean_keff, sigma_keff)' ranging from 0.3 to 0.9 and an x-axis ranging from 0.0 to 1.0. It shows a blue curve that peaks at approximately x=0.1 and reaches a minimum at approximately x=0.45. Red dots represent data points, and a light blue shaded area indicates uncertainty. The right plot has a y-axis labeled 'N(mean_keff, sigma_keff)' ranging from 0.3 to 0.9 and an x-axis ranging from 0.5 to 3.5. It shows a blue curve that peaks at approximately x=1.0 and then levels off. Red dots represent data points, and a light blue shaded area indicates uncertainty.

Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

Calculations

Q	Data set	State	Activity
---	----------	-------	----------

Results

V	Data set	Size	Pts	State
<input checked="" type="checkbox"/>	Puits_PuO2_2variab...	45 MB	58 seen	

Post processing Files

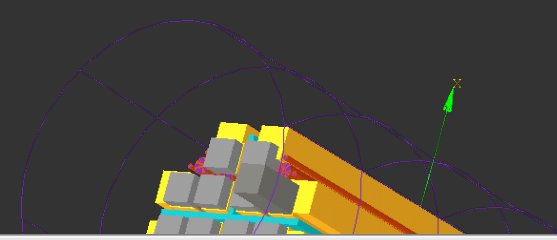
Find:

- d.broui.scale=0.05292791611928907
 - d.PuO2=0.608450717292726
 - input
 - info.txt
 - output
 - EGO1_1389836095.Rdata
- d.broui.scale=0.9268426589399511
 - km0_1389836095.Rdata
- d.broui.scale=0.13092024480849992
- d.broui.scale=0.6288579581305385
- d.broui.scale=0.6887877064291388
- d.broui.scale=0.7917987112887204
- d.broui.scale=0.02364629251749863
- d.broui.scale=0.7173223637510091
- d.broui.scale=0.09327404717601559
- d.broui.scale=0.09272100515632431
- d.broui.scale=0.42006798810325563
- EGO0_1389836095.Rdata
- d.broui.scale=0.7734019996908804
- d.broui.scale=0.6429818482138216
- d.broui.scale=0.5022901650518179
- d.broui.scale=0.3080500189680606
- d.broui.scale=0.4147155410812902
- d.broui.scale=0.17350012273527882
- EGO3_1389836095.Rdata
- d.broui.scale=0.5092528564855456
- d.broui.scale=0.48777661594148314
- d.broui.scale=0.6877512203063816
- d.broui.scale=0.7343308298286555
- km4_1389836095.Rdata
- d.broui.scale=0.7478248702827841
- d.broui.scale=0.2277417614286053
- d.broui.scale=0.266666040988639
- d.broui.scale=0.9752578554261062
- d.broui.scale=0.7888243941124529
- d.broui.scale=0.6515932745145013
- d.broui.scale=0.14221673271788657

Find:

```
1 #Tue Jul 13 11:41:50 CEST 2010
2 state=4
3 start=1279014061873
4 code=moret5
5 input.d.broui.scale=0.05292791611928907
6 duration=48759
7 end=1279014110632
8 calc=neutrosec-3\;44775
9 input.d.PuO2=0.608450717292726
10 output.sigma_keff=9.9E-4
11 output.mean_keff=0.83514
12
```

Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables
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Calculations

Q	Data set	State	Activity
---	----------	-------	----------

Results

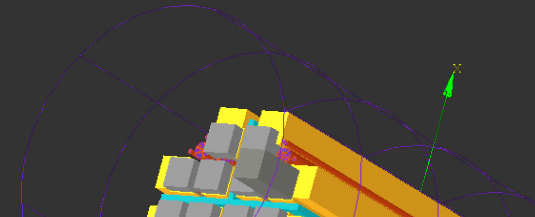
V	Data set	Size	Pts	State
<input checked="" type="checkbox"/>	Puits_PuO2_2variab...	45 MB	58 seen	

Post processing Files

Find:

1	RDA2
2	A
3	2
4	133377
5	131840
6	1026
7	1
8	4105
9	15
10	EG04_1389836095
11	531
12	2
13	526
14	18
15	0.4200679881032556
16	0.1735001227352768
17	0.09272100515632431
18	0.7478248702827841
19	0.1888613025657833
20	0.7173223637510091
21	0.09327404717601559
22	0.9635866039898247
23	0.6288579581305385
24	0.7199285007081926
25	0.5220632401760668
26	0.9962683045576551
27	2.274872636655346
28	2.681435327976942
29	0.7175446518231183
30	1.011042937354369
31	2.959340195637196
32	3.275455127004534
33	1026
34	1
35	4105
36	3
37	dim
38	13
39	2
40	9
41	2
42	1026
43	1
44	4105
45	8
46	dimnames
47	19
48	2
49	16
50	9
51	9
52	0

Real world example



Configuration Help

Data sets

Data set	State	Pts	Variables
----------	-------	-----	-----------

Calculations

Q	Data set	State	Activity
---	----------	-------	----------

Results

V	Data set	Size	Pts	State
<input checked="" type="checkbox"/>	Puits_Pu02_2variab...	45 MB	58 seen	

Post processing

```
richet@sec-11: ~/Promethee/projects/Puits_Pu02_2variables_grille_75x75.jd
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Tapez 'demo()' pour des démonstrations, 'help()' pour l'aide
en ligne ou 'help.start()' pour obtenir l'aide au format HTML.
Tapez 'q()' pour
> load("EGO
EG00_1389836095.R
EG01_1389836095.R
> load("EGO
EG00_1389836095.R
EG01_1389836095.R
> load("EG05_1389
> ls()
[1] "EG05_1389836
> library(DiceKri
> sectionview3d.k
Loading required
[1] 1 2
```

RGL device 3 [Focus]

Overview

Few words about Research and Industry

Computer Experiments framework

PROMETHEE Grid Computing environment

Real world example

Summary

Overview

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Summary

Summary

Industry benefits: a five years leap

Better/stronger day-to-day eng. conclusions

Face new challenges: harder eng. issues now reachable

New abstract & formalized approach of old engineering practices

Research support

Lot of new industrial applications

Lot of feedback on algorithms, underlying hypothesis, *ideas*

New [R] users ...

... and a bit of (wholesome) money :)

Summary

... thanks to integration of

a flexible (technology, license & community)

research software: [R]

a disruptive (re-think *true* needs, use *true* resources)

industrial software: PROMETHEE

... available for free at <http://promethee.irsn.fr>