

# Présentation Uranie v1.1



# Séminaire IMPEC

# F. Gaudier

CEA/DEN/DANS/DM2S/SFME/LGLS

CEA - Cadarache, le 13/10/2008



URANIE

# ”DataServer”

”Sampler” . .

## ”Launcher” . .

## ”Modeler” ..

## ”Optimizer” .

”UncertMode

## ”Sensitivity”

Plan de ...

URANIE : CEA/DEN Uncertainty Platform  
URANIE : Fonctional diagram  
URANIE : Fonctional diagram  
URANIE : Graphical User Interface  
URANIE - XML User Interface  
URANIE : Batch mode  
Projects using URANIE



URANIE  
"DataServer"  
"Sampler" ...  
"Launcher" ...  
"Modeler" ...  
"Optimizer" ...  
"UncertModeler"  
"Sensitivity" ...  
Plan de ...

URANIE : CEA/DEN Uncertainty Platform



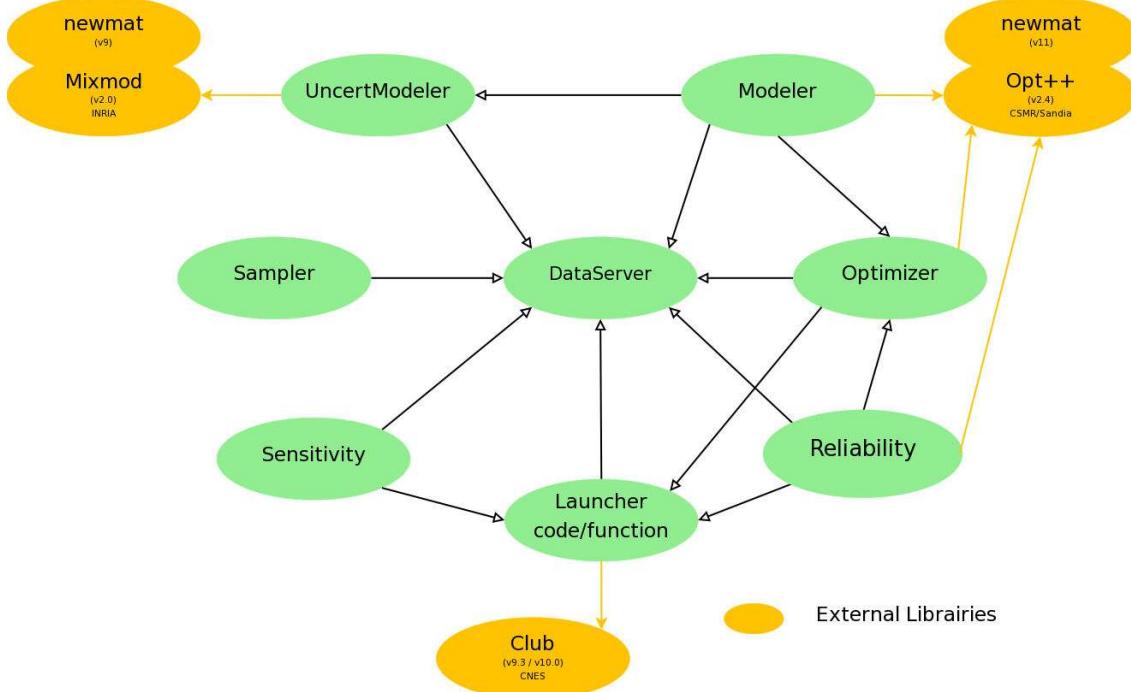
-  ROOT for data analysis, CLUB (CNES),  MIXMOD (INRIA),  
 OPT++ (Sandia)
  -  QT for GUI
  - Data access :
    - Flat file with header ( "Salomé Table" )
    - TTree (internal ROOT)
    - SQL Data base (MySQL, PostgreSQL, ...)
  - Uncertainty/Sensitivity methods in URANIE
    - Design Of Experiments (SRS, LHS, ROA, qMC, MCMC, Copula)
    - Surrogate models (Polynomial, Artificial Neural Networks, Splines)
    - Sensitivity analysis (Pearson, Spearmann, Sobol, Fast, Morris)
    - Optimization (MetaModeling, Genetic Algorithms)
    - Computing distribution



**URANIE**  
"DataServer"  
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"Sensitivity" ...  
**Plan de ...**

# URANIE : Fonctional diagram

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URANIE  
"DataServer"  
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Plan de ...

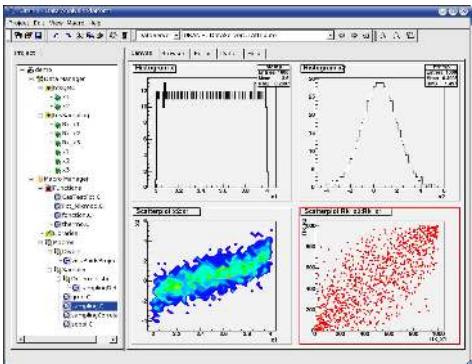
## URANIE : Fonctional diagram



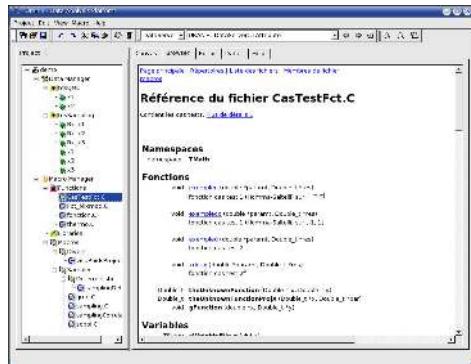
**URANIE**  
"DataServer"  
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"Sensitivity" . . .  
**Plan de . . .**

Libraries	Lines ( *.h, *.cxx)	Classes
DataServer	13 000	21
Sampler	10 000	14
Launcher	5 000	10
Modeler	9 000	9
Optimizer	4 000	6
Sensitivity	3 000	6
UncertModeler	2 000	5
<b>Sous-Total</b>	46 000	70
IHM	13 000	34
editor	1 000	7
cppeditor	300	2
<b>Sous-Total</b>	14 300	43
<b>Total</b>	60 300	113

# URANIE : Graphical User Interface

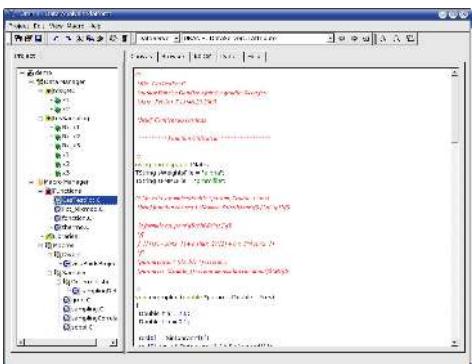


Visualization



User Help

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Editor

	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18	d19	d20	d21	d22	d23	d24	d25	d26	d27	d28	d29	d30	d31	d32	d33	d34	d35	d36	d37	d38	d39	d40	d41	d42	d43	d44	d45	d46	d47	d48	d49	d50	d51	d52	d53	d54	d55	d56	d57	d58	d59	d60	d61	d62	d63	d64	d65	d66	d67	d68	d69	d70	d71	d72	d73	d74	d75	d76	d77	d78	d79	d80	d81	d82	d83	d84	d85	d86	d87	d88	d89	d90	d91	d92	d93	d94	d95	d96	d97	d98	d99	d100	d101	d102	d103	d104	d105	d106	d107	d108	d109	d110	d111	d112	d113	d114	d115	d116	d117	d118	d119	d120	d121	d122	d123	d124	d125	d126	d127	d128	d129	d130	d131	d132	d133	d134	d135	d136	d137	d138	d139	d140	d141	d142	d143	d144	d145	d146	d147	d148	d149	d150	d151	d152	d153	d154	d155	d156	d157	d158	d159	d160	d161	d162	d163	d164	d165	d166	d167	d168	d169	d170	d171	d172	d173	d174	d175	d176	d177	d178	d179	d180	d181	d182	d183	d184	d185	d186	d187	d188	d189	d190	d191	d192	d193	d194	d195	d196	d197	d198	d199	d200	d201	d202	d203	d204	d205	d206	d207	d208	d209	d210	d211	d212	d213	d214	d215	d216	d217	d218	d219	d220	d221	d222	d223	d224	d225	d226	d227	d228	d229	d230	d231	d232	d233	d234	d235	d236	d237	d238	d239	d240	d241	d242	d243	d244	d245	d246	d247	d248	d249	d250	d251	d252	d253	d254	d255	d256	d257	d258	d259	d260	d261	d262	d263	d264	d265	d266	d267	d268	d269	d270	d271	d272	d273	d274	d275	d276	d277	d278	d279	d280	d281	d282	d283	d284	d285	d286	d287	d288	d289	d290	d291	d292	d293	d294	d295	d296	d297	d298	d299	d300	d301	d302	d303	d304	d305	d306	d307	d308	d309	d310	d311	d312	d313	d314	d315	d316	d317	d318	d319	d320	d321	d322	d323	d324	d325	d326	d327	d328	d329	d330	d331	d332	d333	d334	d335	d336	d337	d338	d339	d340	d341	d342	d343	d344	d345	d346	d347	d348	d349	d350	d351	d352	d353	d354	d355	d356	d357	d358	d359	d360	d361	d362	d363	d364	d365	d366	d367	d368	d369	d370	d371	d372	d373	d374	d375	d376	d377	d378	d379	d380	d381	d382	d383	d384	d385	d386	d387	d388	d389	d390	d391	d392	d393	d394	d395	d396	d397	d398	d399	d400	d401	d402	d403	d404	d405	d406	d407	d408	d409	d410	d411	d412	d413	d414	d415	d416	d417	d418	d419	d420	d421	d422	d423	d424	d425	d426	d427	d428	d429	d430	d431	d432	d433	d434	d435	d436	d437	d438	d439	d440	d441	d442	d443	d444	d445	d446	d447	d448	d449	d450	d451	d452	d453	d454	d455	d456	d457	d458	d459	d460	d461	d462	d463	d464	d465	d466	d467	d468	d469	d470	d471	d472	d473	d474	d475	d476	d477	d478	d479	d480	d481	d482	d483	d484	d485	d486	d487	d488	d489	d490	d491	d492	d493	d494	d495	d496	d497	d498	d499	d500	d501	d502	d503	d504	d505	d506	d507	d508	d509	d510	d511	d512	d513	d514	d515	d516	d517	d518	d519	d520	d521	d522	d523	d524	d525	d526	d527	d528	d529	d530	d531	d532	d533	d534	d535	d536	d537	d538	d539	d540	d541	d542	d543	d544	d545	d546	d547	d548	d549	d550	d551	d552	d553	d554	d555	d556	d557	d558	d559	d560	d561	d562	d563	d564	d565	d566	d567	d568	d569	d570	d571	d572	d573	d574	d575	d576	d577	d578	d579	d580	d581	d582	d583	d584	d585	d586	d587	d588	d589	d590	d591	d592	d593	d594	d595	d596	d597	d598	d599	d600	d601	d602	d603	d604	d605	d606	d607	d608	d609	d610	d611	d612	d613	d614	d615	d616	d617	d618	d619	d620	d621	d622	d623	d624	d625	d626	d627	d628	d629	d630	d631	d632	d633	d634	d635	d636	d637	d638	d639	d640	d641	d642	d643	d644	d645	d646	d647	d648	d649	d650	d651	d652	d653	d654	d655	d656	d657	d658	d659	d660	d661	d662	d663	d664	d665	d666	d667	d668	d669	d670	d671	d672	d673	d674	d675	d676	d677	d678	d679	d680	d681	d682	d683	d684	d685	d686	d687	d688	d689	d690	d691	d692	d693	d694	d695	d696	d697	d698	d699	d700	d701	d702	d703	d704	d705	d706	d707	d708	d709	d710	d711	d712	d713	d714	d715	d716	d717	d718	d719	d720	d721	d722	d723	d724	d725	d726	d727	d728	d729	d730	d731	d732	d733	d734	d735	d736	d737	d738	d739	d740	d741	d742	d743	d744	d745	d746	d747	d748	d749	d750	d751	d752	d753	d754	d755	d756	d757	d758	d759	d760	d761	d762	d763	d764	d765	d766	d767	d768	d769	d770	d771	d772	d773	d774	d775	d776	d777	d778	d779	d780	d781	d782	d783	d784	d785	d786	d787	d788	d789	d790	d791	d792	d793	d794	d795	d796	d797	d798	d799	d800	d801	d802	d803	d804	d805	d806	d807	d808	d809	d810	d811	d812	d813	d814	d815	d816	d817	d818	d819	d820	d821	d822	d823	d824	d825	d826	d827	d828	d829	d830	d831	d832	d833	d834	d835	d836	d837	d838	d839	d840	d841	d842	d843	d844	d845	d846	d847	d848	d849	d850	d851	d852	d853	d854	d855	d856	d857	d858	d859	d860	d861	d862	d863	d864	d865	d866	d867	d868	d869	d870	d871	d872	d873	d874	d875	d876	d877	d878	d879	d880	d881	d882	d883	d884	d885	d886	d887	d888	d889	d890	d891	d892	d893	d894	d895	d896	d897	d898	d899	d900	d901	d902	d903	d904	d905	d906	d907	d908	d909	d910	d911	d912	d913	d914	d915	d916	d917	d918	d919	d920	d921	d922	d923	d924	d925	d926	d927	d928	d929	d930	d931	d932	d933	d934	d935	d936	d937	d938	d939	d940	d941	d942	d943	d944	d945	d946	d947	d948	d949	d950	d951	d952	d953	d954	d955	d956	d957	d958	d959	d960	d961	d962	d963	d964	d965	d966	d967	d968	d969	d970	d971	d972	d973	d974	d975	d976	d977	d978	d979	d980	d981	d982	d983	d984	d985	d986	d987	d988	d989	d990	d991	d992	d993	d994	d995	d996	d997	d998	d999	d1000	d1001	d1002	d1003	d1004	d1005	d1006	d1007	d1008	d1009	d10010	d10011	d10012	d10013	d10014	d10015	d10016	d10017	d10018	d10019	d10020	d10021	d10022	d10023	d10024	d10025	d10026	d10027	d10028	d10029	d10030	d10031	d10032	d10033	d10034	d10035	d10036	d10037	d10038	d10039	d10040	d10041	d10042	d10043	d10044	d10045	d10046	d10047	d10048	d10049	d10050	d10051	d10052	d10053	d10054	d10055	d10056	d10057	d10058	d10059	d10060	d10061	d10062	d10063	d10064	d10065	d10066	d10067	d10068	d10069	d10070	d10071	d10072	d10073	d10074	d10075	d10076	d10077	d10078	d10079	d10080	d10081	d10082	d10083	d10084	d10085	d10086	d10087	d10088	d10089	d10090	d10091	d10092	d10093	d10094	d10095	d10096	d10097	d10098	d10099	d100100	d100101	d100102	d100103	d100104	d100105	d100106	d100107	d100108	d100109	d100110	d100111	d100112	d100113	d100114	d100115	d100116	d100117	d100118	d100119	d100120	d100121	d100122	d100123	d100124	d100125	d100126	d100127	d100128	d100129	d100130	d100131	d100132	d100133	d100134	d100135	d100136	d100137	d100138	d100139	d100140	d100141	d100142	d100143	d100144	d100145	d100146	d100147	d100148	d100149	d100150	d100151	d100152	d100153	d100154	d100155	d100156	d100157	d100158	d100159	d100160	d100161	d100162	d100163	d100164	d100165	d100166	d100167	d100168	d100169	d100170	d100171	d100172	d100173	d100174	d100175	d100176	d100177	d100178	d100179	d100180	d100181	d100182	d100183	d100184	d100185	d100186	d100187	d100188	d100189	d100190	d100191	d100192	d100193	d100194	d100195	d100196	d100197	d100198	d100199	d100200	d100201	d100202	d100203	d100204	d100205	d100206	d100207	d100208	d100209	d100210	d100211	d100212	d100213	d100214	d100215	d100216	d100217	d100218	d100219	d100220	d100221	d100222	d100223	d100224	d100225	d100226	d100227	d100228	d100229	d100230	d100231	d100232	d100233	d100234	d100235	d100236	d100237	d100238	d100239	d100240	d100241	d100242	d100243	d100244	d100245	d100246	d100247	d100248	d100249	d100250	d100251	d100252	d100253	d100254	d100255	d100256	d100257	d100258	d100259	d100260	d100261	d100262	d100263	d100264	d100265	d100266	d100267	d100268	d100269	d100270	d100271	d100272	d100273	d100274	d100275	d100276	d100277	d100278	d100279	d100280	d100281	d100282	d100283	d100284	d100285	d100286	d100287	d100288	d100289	d100290	d100291	d100292	d100293	d100294	d100295	d100296	d100297	d100298	d100299	d100300	d100301	d100302	d100303	d100304	d100305	d100306	d100307	d100308	d100309	d100310	d100311	d100312	d100313	d100314	d100315	d100316	d100317	d100318	d100319	d100320	d100321	d100322	d100323	d100324	d100325	d100326	d100327	d100328	d100329	d100330	d100331	d100332	d100333	d100334	d100335	d100336	d100337	d100338	d100339	d100340	d100341	d100342	d100343	d100344	d100345	d100346	d100347	d100348	d100349	d100350	d100351	d100352	d100353	d100354	d100355	d100356	d100357	d100358	d100359	d100360	d100361	d10036

# URANIE - XML User Interface

XML file ( problem\_uranie.xml )

```
<?xml version="1.0" encoding="iso-8859-1"?>
<!DOCTYPE Problem SYSTEM "/home/uranie/tools/share/uranie/uranie.dtd" >
<Problem>
  <Header name="Etude" title="projet GENTR">
    <Application name="uranie" version="0.4" />
  </Header>
  <DataDictionary>
    <DataField name="x1" law="uniform" min="0.5" max="1.5" />
    <DataField name="x2" law="normal" mean="2.5" std="0.25" />
  </DataDictionary>
  <Sampler method="SRS" N="1500" export="data/sampler_SRS_1500.dat" />
  <Sampler method="LHS" N="1000" export="data/sampler_LHS_1000.dat" />
</Problem>
```



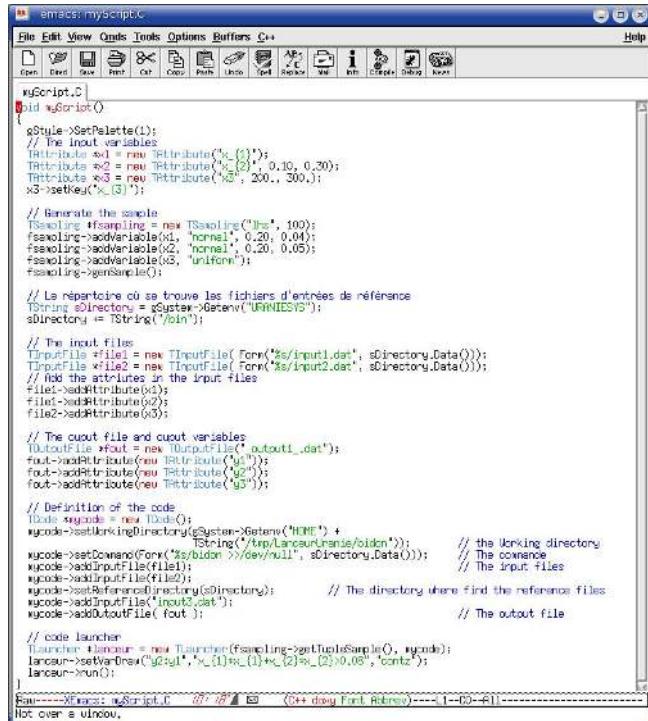
URANIE  
"DataServer"  
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"Sensitivity" ...  
Plan de ...

uranie -s problem\_uranie.xml



# URANIE : Batch mode

> root myScript.C



```
emacs:myScript.C
File Edit View Cmds Tools Options Buffers C++
Open Save Copy Cut Copy Paste Undo Redo Select All Find Replace Help
myScript.C
void uranis()
{
    //Style->SetPalette();
    // The input variables
    TAttribute *x1 = new TAttribute("x1", 0.1);
    TAttribute *x2 = new TAttribute("x2", 0.1, 0.3);
    TAttribute *x3 = new TAttribute("x3", 200., 300.);
    x3->setInt("x3", 3);

    // Generate the sample
    TSampling *sampling = new TSampling("lhs", 100);
    sampling->AddVariables(x1, "normal", 0.2, 0.04);
    sampling->AddVariables(x2, "normal", 0.2, 0.05);
    sampling->AddVariables(x3, "uniform");
    sampling->Generate();

    // La repartition ou se trouvent les fichiers d'entrees de reference
    TString sDirectories = gSystem->Getenv("URANIESYS");
    sDirectory += String("join");

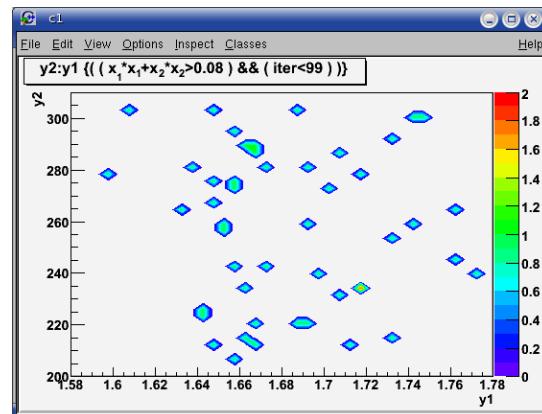
    // The input files
    TInputFile *file1 = new TInputFile(Form("%s/input1.dat", sDirectory.Data()));
    TInputFile *file2 = new TInputFile(Form("%s/input2.dat", sDirectory.Data()));
    // Add the attributes in the input files
    file1->AddAttribute(x1);
    file1->AddAttribute(x2);
    file1->AddAttribute(x3);

    // The output file and output variables
    TOutputFile *fout = new TOutputFile("output1.dat");
    fout->AddAttribute(new TAttribute("y1"));
    fout->AddAttribute(new TAttribute("y2"));
    fout->AddAttribute(new TAttribute("y3"));

    // Definition of the code
    TCode *ycode = new TCode();
    ycode->setWorkingDirectory(gSystem->Getenv("HOME") +
        String("/tmp/Lancuranie/olidn")); // the Working directory
    ycode->setCommand(Copy("syslidan >> oexit", sDirectory.Data())); // the command
    ycode->addInputFile(file1);
    ycode->addReferenceDirectory(sDirectory); // The directory where find the reference files
    ycode->addInputFile("input2.dat");
    ycode->addOutputfile( fout ); // The output file

    // code launcher
    TLauncher *lancaur = new TLauncher(sampling->GetUpsilonSample(), ycode);
    lancaur->setUpsilon("y2>y1", k_u1*k_u2*k_u3*k_u4, 0.05, "cont2");
    lancaur->run();
}

Emacs: myScript.C 87 87 89 (0+ drag first Address)---[1--6--6]---
```



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# Projects using URANIE

- LEONAR tool for severe accidents in french nuclear reactor (**CEA-EDF**)
- Dosimetry computation in french nuclear reactor (**CEA-EDF**)
- Opus project : Meteor code (**CEA**)
- CIVA tool : "Non Destructive Testing" with (**CEA/DRT**)
- Sensitivity Analysis for Cathare code (**CEA/Areva TA**)
- ALLIANCES platform (**CEA/ANDRA/EDF**)  
is to provide a working environment for the simulation and analysis of phenomena to be taken into account for waste storage and disposal studies.
- European project **NURESIM/NURISP**  
The European Platform for NUclear REactor SIMulations, NURESIM, is a Common European Standard Software Platform for modeling, recording, and recovering computer data for nuclear reactors simulations.



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# ”DataServer” library

- ”DataServer” library - Features
- ”DataServer” library - Attributes
- Management of the attributes : Load data
- ”DataServer” module - URANIE ASCII file format
- ”DataServer” library - statistical graphs
- Histogramm - Number of bins
- Treatment - Correlation

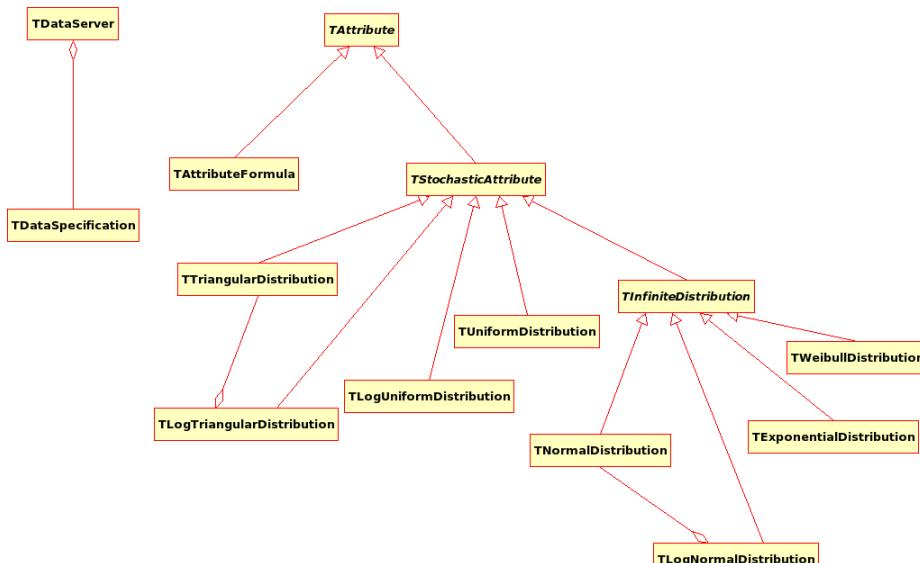
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# ”DataServer” library - Features

1. Management of the attributes ( $\sim$  variables)
    - create/transform attributes
    - Load data from external files/formats (ASCII, TTREE, SQL)
  2. Graphs and treatments specific to uncertainties
  3. Specification of problems XML

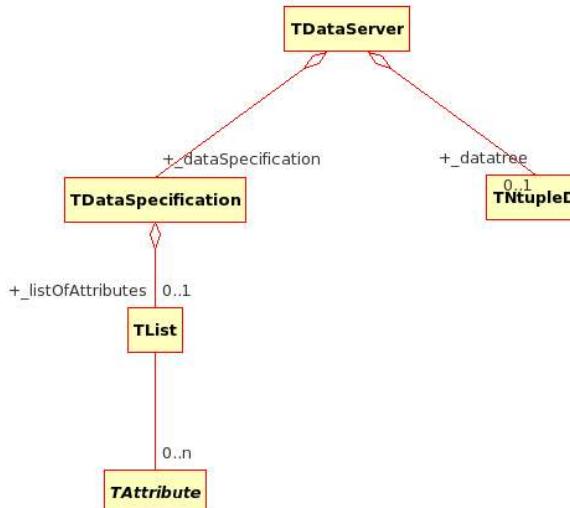


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# ”DataServer” library - Attributes

- An **Attribute** contains :  
Name, Title, Unity, Min/Max/Default/Step values, Key/File
- A random variable is an attribute + a law defined by parameters
- All the attributes are stored in a **TDataServer**

```
TAttribute
# _sunity : TString
# snote : TString
# _blog : Bool_t
# _nshare : Int_t
# _skey : TString
# _sFormatSubstitute : TString
# _filename : TString
# _nline : Int_t
# _field : Int_t
# upperBound : Double_t
# _bHaveUpperBound : Bool_t
# lowerBound : Double_t
# _bHaveLowerBound : Bool_t
# _defaultValue : Double_t
# _bHaveDefaultValue : Bool_t
# _stepValue : Double_t
# _bHaveStepValue : Bool_t
# _minimum : Double_t
# _maximum : Double_t
# _mean : Double_t
# _std : Double_t
# _norigin : Int_t
# dataType :
```



URANIE  
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”UncertModel” ...  
”Sensitivity” ...  
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# Management of the attributes : Load data

- Load data from external files ( ASCII, TTREE, SQL, ...)

```
using namespace URANIE::DataServer;  
{  
TDataServer *tds = new TDataServer();  
tds->fileDataRead("geyser.dat");  
tds->addAttribute("cd", "sqrt(x2) * x1");  
tds->draw("cd:x1");  
}
```

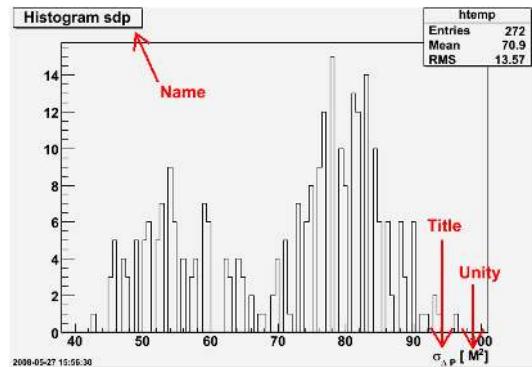


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"Modeler" ...  
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"UncertModeler" ...  
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```
...  
TDataServer *tds = new TDataServer();  
tds->ntupleDataRead("hsimple.root","ntuple","px*py*:py*px", "px*px+py*py<2.0");  
tds->draw("py:px");  
...
```

## ”DataServer” module - URANIE ASCII file format

```
#TITLE: geyser data
#NAME: geyser
#DATE: Mon Mar 12 23:41:09 2007
#COLUMN_NAMES: x1| sdp
#COLUMN_TITLES: x_1|  $\sigma$ _{#Delta P}
#COLUMN_UNITS: Sec| M^2
----- empty line -----
3.600 79.000
1.800 54.000
...
...
```



**Figure 2.1** tds->draw("sdp");

Only the "#COLUMN\_NAMES:" line is obligatory

**WARNING :** the empty line between the header and the matrix data

ceo

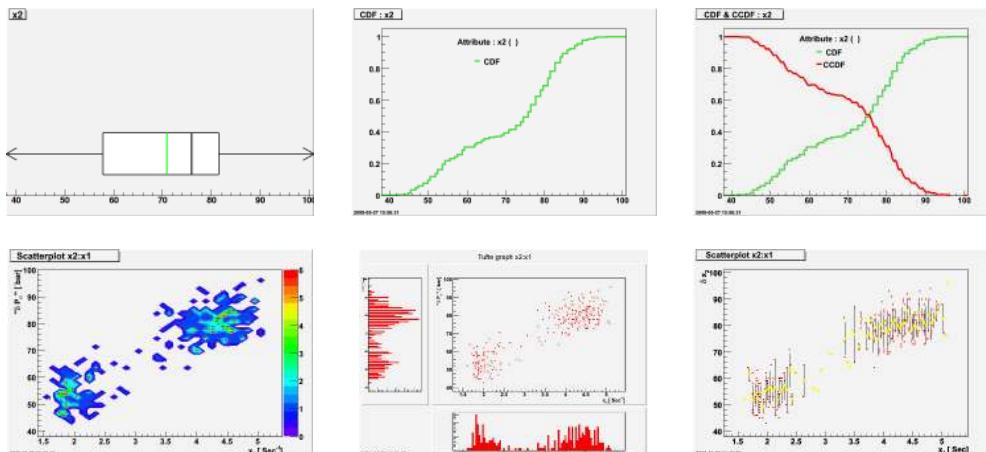


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# ”DataServer” library - statistical graphs

```
tds->drawBoxPlot("x2");
tds->drawCDF("x2","x1<3.0");
tds->drawCDF("x2","x1<3.0","ccdf");
tds->drawScatterplot("x2:x1");
tds->drawTufte("x2:x1");
tds->drawProfile("x2:x1","","same");
```

cea



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# Histogramm - Number of bins

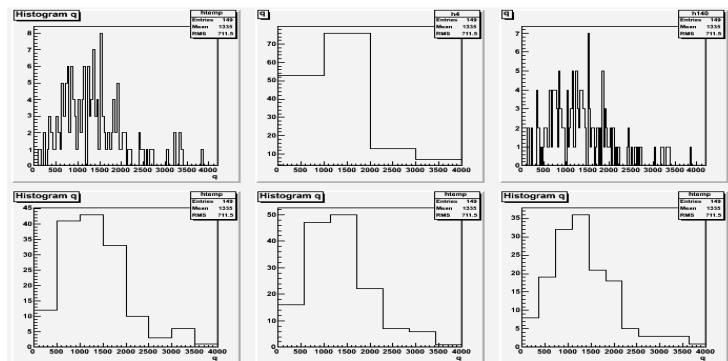
- Defined in the ".rootrc" file

```
# Default histogram binnings for TTree::Draw().  
Hist.Binning.1D.x: 100
```

- Exist in R :
  1. Sturges
  2. Scott
  3. Freedman & Diaconis

```
tds->draw("x", "", "nclass=root");  
tds->draw("x", "", "nclass=sturges");  
tds->draw("x", "", "nclass=fd");  
tds->draw("x", "", "nclass=scott");
```

$$N_{bin} = \log_2(n) + 1$$
$$N_{bin} = (x_{max} - x_{min}) * \sqrt[3]{n} / 3.5\hat{\sigma_x}$$
$$N_{bin} = (x_{max} - x_{min}) * \sqrt[3]{n} / 2 * (Q_x^{0.75} - Q_x^{0.25})$$



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# Treatment - Correlation

Correlations matrix (**Pearson, Spearmann**) :  $\rho_{XY} = \frac{\text{IE}[ (X-\mu_X)(Y-\mu_Y) ]}{\sigma_X \sigma_Y}$



```
TDataServer * tds = new TDataServer("tds", "Sampling");
tds->addAttribute(new TUniformDistribution("x1", 3., 4.));
tds->addAttribute(new TNormalDistribution("x2", 0.5, 1.5));

TSampling *sampling = new TSampling(tds, "lhs", 20);
sampling->setUserCorrelation("x1", "x2", 0.789);
sampling->generateSample();

tds->computeCorrelationMatrix("x1:x2");
tds->computeCorrelationMatrix("x1:x2","","rank");
```

Variables	x1	x2
x1	1	
x2	0.775	1

Pearson

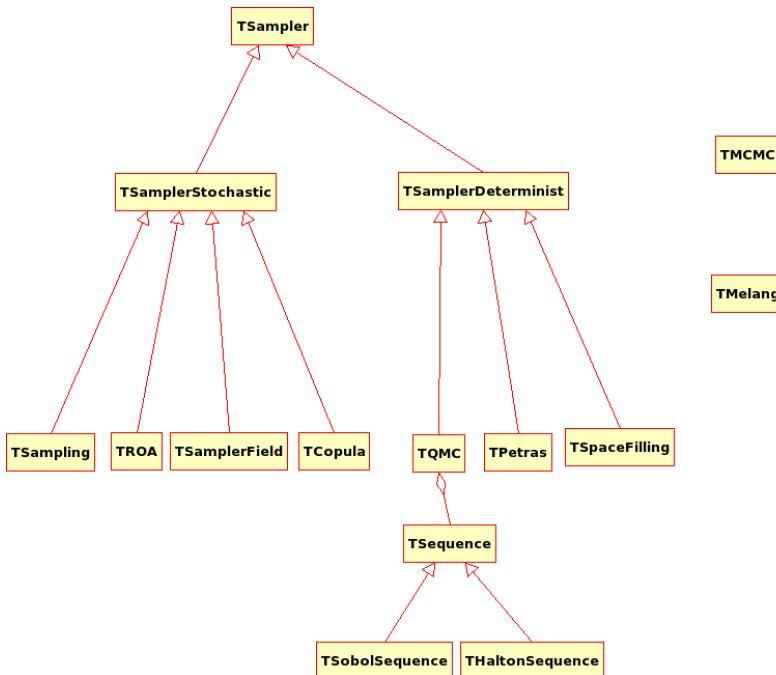
Rank	x1	x2
x1	1	
x2	0.782	1

Spearmann

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# ”Sampler” library

Stochastic TSampling  
Deterministic Sampling  
Generate a sampling from a **TDataServer** object



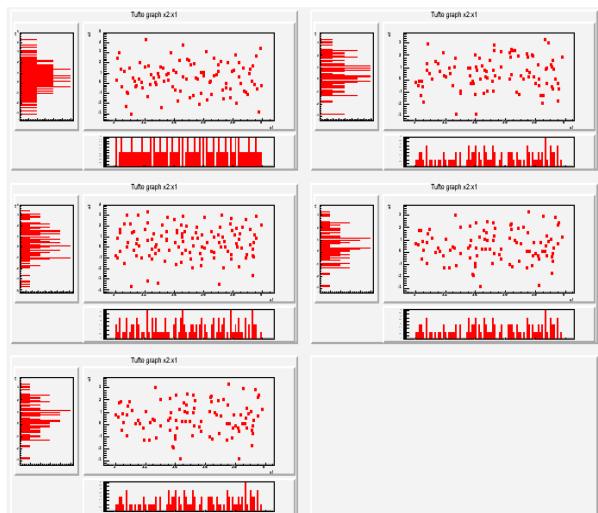
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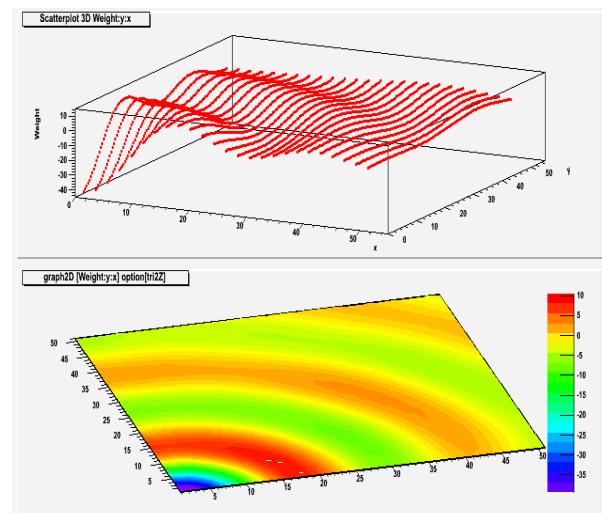
URANIE  
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”Sampler” ...  
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”Modeler” ...  
”Optimizer” ...  
”UncertModel” ...  
”Sensitivity” ...  
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# Stochastic TSampling

- "Simple Random Sampling" SRS / "Latin Hypercube Sampling" **LHS**
  - ★ Rank correlations
- "Random Orthogonal Array" ROA
- Archimedian Copulas (Gumbel, Clayton, Frank)
- Random Field
- "Markov Chain Monte Carlo" (MCMC) for Gaussian mixture



$x_1$  and  $x_2$  uniform - Size 100



Gaussian Field

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# Deterministic Sampling

- quasi Monte-Carlo Sequences (Halton, Sobol)
- Petras
- Space Filling Design

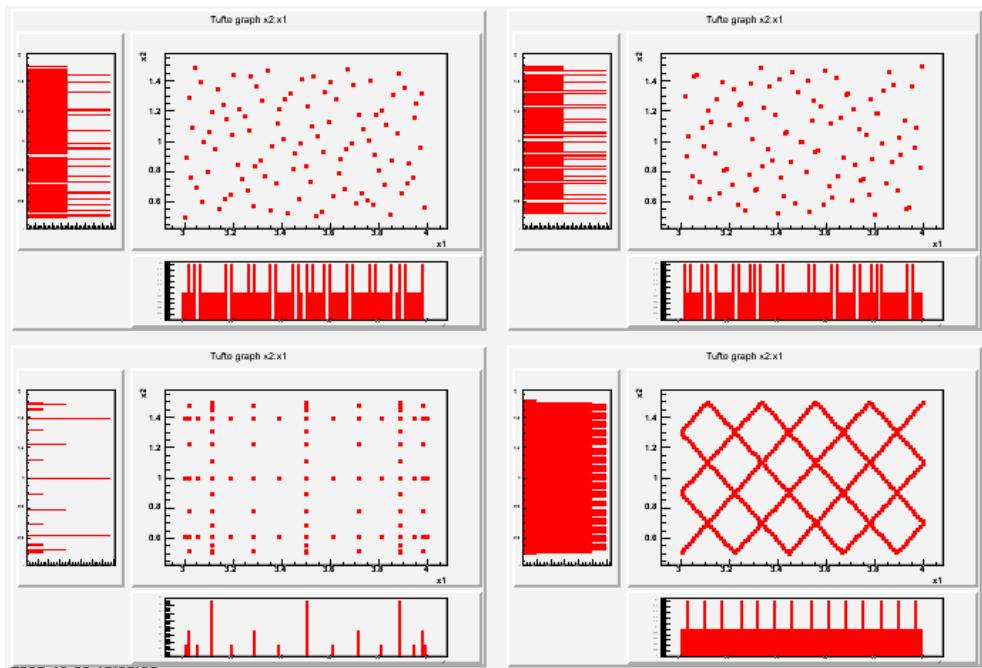


Figure 3.1  $x_1$  and  $x_2$  uniform - Size 100



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# ”Launcher” library

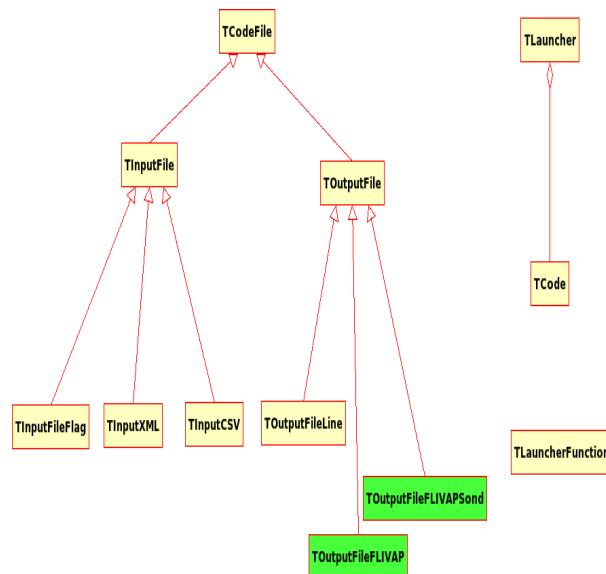
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Input File : ” Key - Value” format

Input File with ”flag”

Distribution CCRT

Feature : Distribute the model evaluations (sequential, cluster)



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# Input File : "Key - Value" format

```
#  
#  
# fichier d'entrée 1 du code \b bidon  
# \date Tue Sep 9 09:56:41 2003  
# les 3 premiers paramètres  
  
#  
  
npar = 10 ;  
  
x_{0} = 1.2345 ;  
x_{1} = 0.206846449673 ;  
x_{2} = 0.197665744126 ;
```

```
TAttribute *x1 = new TAttribute("x_{1}", 0.20, 0.04);  
TAttribute *x2 = new TAttribute("x2", 200., 300.);  
x2->setKey("x_{2}");  
  
TInputFile *file1 = new TInputFile("input1.dat");  
  
file1->addAttribute(x1);  
file1->addAttribute(x2);
```

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Hypothesis : unicity of the key

# Input File with "flag"

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```
*** Emacs: flowrate_input_with_flags.in.org *** 3/44 (Fundam)
File Edit View Cmds Tools Options Buffers Help
Open Dired Save Print Cut Copy Paste Undo Redo Replace Mail Info Compile Debug News
flowrate_input_with_f... | flowrate_input_with_f...
# INPUT FILE with FLAG for the "FLOWCREATE" code
# \date 2008-04-22 12:55:17
#
new Implicit_Steady_State sch {
frottement_paroil { 0.0500 33366.67 }
tinit 0.0
tmax 1000000.
nb_pas_dt_max 1500
dt_min 1110.00
dt_max 768.57
facsec 1000000.
kw 11732.14
information_Tu Champ_Uniforme 1 63070.0
information_Tl Champ_Uniforme 1 116.00
information_L {
precision 1200.0
}
convergence {
criterion relative_max_du_dt
precision 1.e-6
}
Solveur Newton3 {
max_iter_matrice 1
max_iter_implicite 1
date 5654321
seuil_convg_implicite 1.e-6
assembleage_implicite 1
solveur_lineaire BiCGS
preconditionneur ILU
seuil_resol_implicite 1.e-5
}
}
Raw --- Emacs: flowrate_input_with_flags.in.org 3/44 (Fundam)
```

Original file

```
*** Emacs: flowrate_input_with_flags.in *** 3/44 (Fundam)
File Edit View Cmds Tools Options Buffers Help
Open Dired Save Print Cut Copy Paste Undo Redo Replace Mail Info Compile Debug News
flowrate_input_with_f... | flowrate_input_with_f...
# INPUT FILE with FLAG for the "FLOWCREATE" code
# \date 2008-04-22 12:55:17
#
new Implicit_Steady_State sch {
frottement_paroil { @rw@ @r@ }
tinit 0.0
tmax 1000000.
nb_pas_dt_max 1500
dt_min @h@e
dt_max @h@e
facsec 1000000.
kw @h@e
information_Tu Champ_Uniforme 1 @tue@
information_Tl Champ_Uniforme 1 @t@e
information_L {
precision @l@e
}
convergence {
criterion relative_max_du_dt
precision 1.e-6
}
Solveur Newton3 {
max_iter_matrice 1
max_iter_implicite 1
date 5654321
seuil_convg_implicite 1.e-6
assembleage_implicite 10
solveur_lineaire BiCGS
preconditionneur ILU
seuil_resol_implicite 1.e-5
}
}
Raw --- Emacs: flowrate_input_with_flags.in 3/44 (Fundam)
```

User Flag file

```
attrw->setKey("myfile.in", "@rw@");
```

Hypothesis : Not unicity of the key but intervention of the user

# Distribution CCRT



```
#BSUB -n 10
#BSUB -J FlowreateSampling
#BSUB -o FlowreateSampling.out
source /home/cont002/gaudier/uranie-platine.cshrc
rm -rf FlowreateSampling.out
root -l -q lanceurFLOWCREATE_SAMPLING.C
```

## > bsub < BsubFile

```
1<?xml version="1.0" encoding="iso-8859-1"?>
2<main>
3 <machine-list>
4   <machine env-file="/home/cont002/gaudier/uranie-platine.cshrc"
5     work-directory="/work/cont002/gaudier/testKERNELSALOME_is205980">platine</machine>
6   <machine env-file="/home/gaudier/uranie.cshrc"
7     work-directory="/work/gaudier/testKERNELSALOME">awa</machine>
8 </machine-list>
9 <ref-directory>/home/gaudier/tmp/testuranie/testKERNELSALOME</ref-directory>
10 <nb-processes>64</nb-processes>
11 <input-file>lanceurFLOWCREATE_SAMPLING.C</input-file>
12 <input-file>flowrate_input_with_keys.in</input-file>
13 <input-file>flowrateborhole.dat</input-file>
14 <output-file>_flowrate_sampler_launcher_.dat</output-file>
15 <command>rm -f platine.error.log</command>
16 <command>rm -f platine.output.log</command>
17 <command>root -b -l -q lanceurFLOWCREATE_SAMPLING.C</command>
18</main>
```

## > uranusDistrib flowreate.xml platine

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"Optimizer" ...  
"UncertModeler"  
"Sensitivity" ...  
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# ”Modeler” library - features

”Modeler” library - resampling method : *Bootstrap*  
Application : *Sinus Cardinal*

Create an analytical function between  $Y$  and  $X$

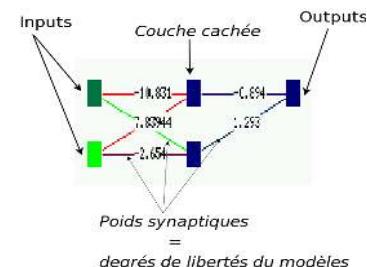
- Learning :
  - ▷ **Opt++** : Levenberg-Marquardt, ...
  - ▷ resampling method : *Bootstrap*, *Leave-one-out*

- Taking into account constraints :

- ▷ Weight sharing
- $\omega_{ij} = \omega_{kl}$
- ▷ Physical informations

$$\frac{\partial y_j}{\partial x_i} < 0, \quad \frac{\partial^2 y_j}{\partial x_i \partial x_k} > 0, \dots$$

- Export function in C, C++, Fortran  
using for code calibration, propagation of uncertainties, ...
- Save in **PMML** format : ”*Predictive Model Markup Language*” (**DMG**)

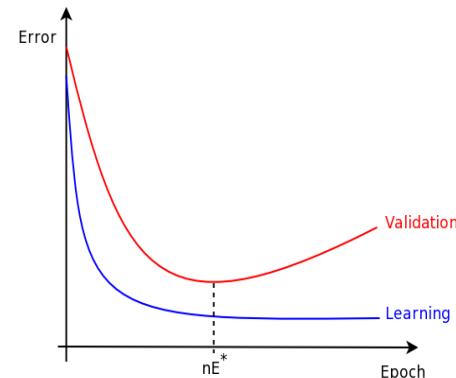


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”Modeler” ...  
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”UncertModel”  
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# ”Modeler” library - resampling method : *Bootstrap*

- **Context:** Small data base
- **Goal** : Estimate the number of epoch
  - 1. Use all the data in the learning process
  - 2. Find the optimal number of epoch  $nE^*$
  - 3. Estimate the validation error  $\epsilon_V$
- **Tool** : Resampling method (Bootstrap)

$$biais \quad \delta = \epsilon_V - \epsilon_L$$

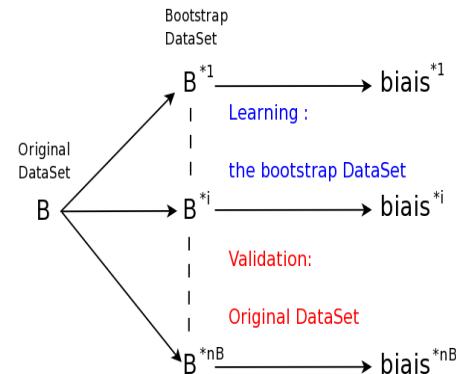


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$$\bar{\delta}^{*,\alpha} = \frac{1}{nB^{*,\alpha}} \sum \delta^{*,i} \quad \forall \delta^{*,i} \in [q_\alpha, q_{1-\alpha}]$$

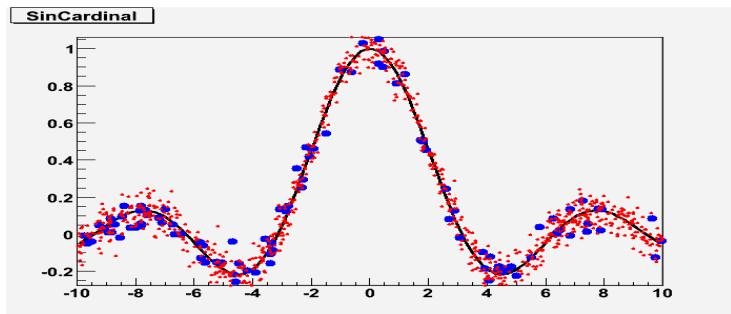
$$\hat{\epsilon}_V = \epsilon_L + \bar{\delta}^{*,\alpha}$$



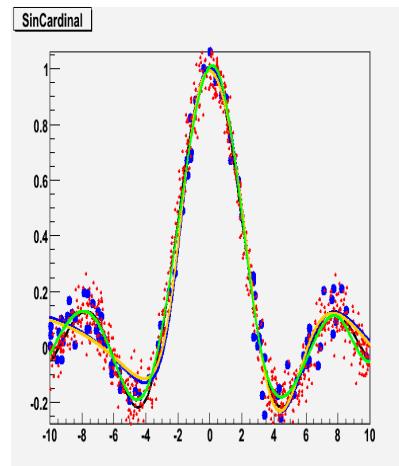
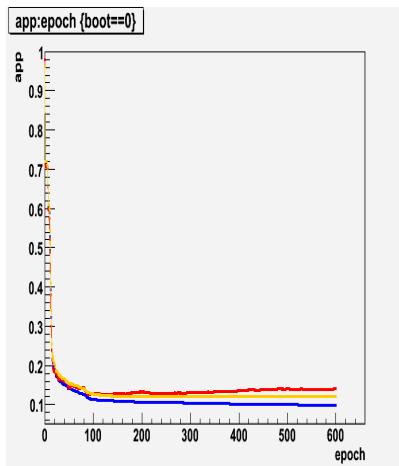
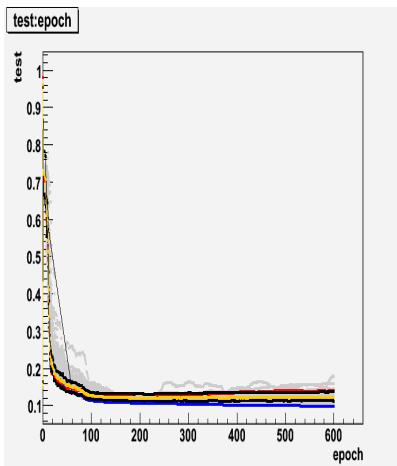
# Application : Sinus Cardinal

$$f(x) = \frac{\sin |x|}{|x|} + \epsilon$$

- Noise  $\epsilon \sim \mathcal{N}(0., 0.06)$
- Learning : 100 (blue)
- Validation : 900 (red)
- Bootstrap :  $nB = 50$



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# ”Optimizer” library

”Optimizer” library . . .

. . .  
. . .

Identification des paramètres de modèles

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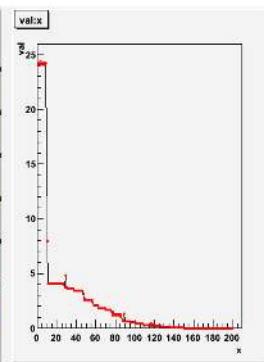
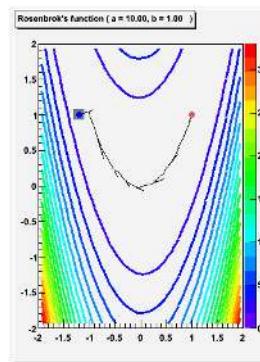
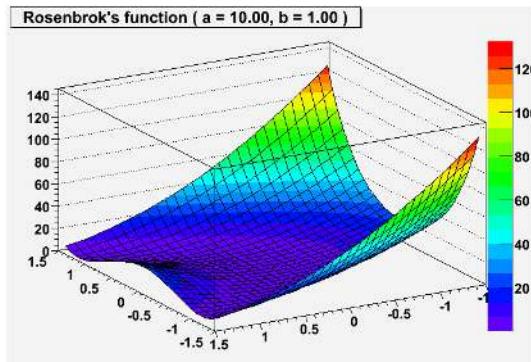
URANIE  
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”Sampler” . . .  
”Launcher” . . .  
”Modeler” . . .  
”Optimizer” . . .  
”UncertModeler” . . .  
”Sensitivity” . . .  
Plan de . . .

- librairie **Minuit2** de **ROOT**

- ★ Prototype des fonctions :    void myFunction (Double\_t \*param, Double\_t \*res)
- ★ un objet URANIE::Launcher::TCode

**Rosenbrock** :  $f(x, y) = a(y - x^2)^2 + b(1 - x)^2$  avec  $a = 100.$  et  $b = 1.$

```
TOptimizer * topt = new TOptimizer(tdsRosenbrock, myRosenbrockCode);  
topt->optimize();
```



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Optimisation non-linéaire sous contraintes avec **opt++**

- Possède plusieurs algorithmes d'optimisation (Direct, gradient, Newton, ...)
- Mode DLL pour les prototypes **opt++**

```
void FCN0(int n,const ColumnVector& x,real& fx,int& ret)
void FCN1(int mode,int n,const ColumnVector& x,real& fx, ColumnVector& gx, int& ret)
void FCN2(int mode,int n,const ColumnVector& x,real& fx, ColumnVector& gx, SymmetricMatrix& Hx, int& ret)
```

Exemple:

```
TDataServer * tds = new TDataServer();
tds->addAttribute( new TAttribute("x1", 2.0, 4.0);
...
TOptimizerOpt *topths65 = new TOptimizerOpt(tds, "hs65.so", "hs65_2", "init_hs65");
topths65->addConstraint("ineq_hs65");
topths65->setFcnTol(1.0e-06);
...
topths65->optimize("nips");
```

- Mode interprété pour le prototype URANIE (en cours de développement)



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## Optimisation multicritères par Algorithme Génétique : Vizir

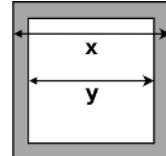
- Prototype des fonctions : `void myFunction (Double_t *param, Double_t *res)`
- Prototype des contraintes : `void myConstraint (Double_t *param, Int_t &res)`

Problème de la barre:

$$f_1(x, y) = (x - 1)^2 + (y - 1)^2 + 1$$

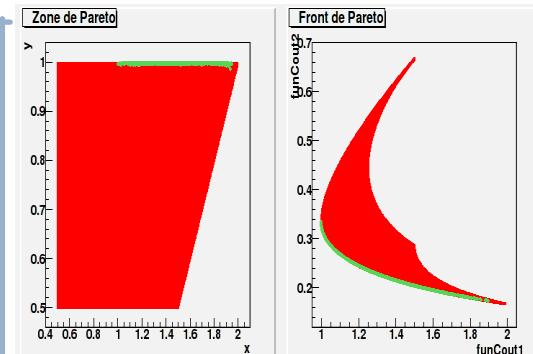
$$f_2(x, y) = (x^2 + y^2 + 1)^{-1}$$

$$g(x, y) = x - y - 1$$



```
TDataServer * tds = new TDataServer();
tds->addAttribute( new TAttribute("x", 0.5, 2.0));
tds->addAttribute( new TAttribute("y", 0.5, 1.0));

VizirMulti *vzrmulti = new VizirMulti(tds, 1000);
vzrmulti->addCost(funCout1);
vzrmulti->addCost(funCout2);
vzrmulti->addHardConstraint(contHard1);
vzrmulti->optimize();
```

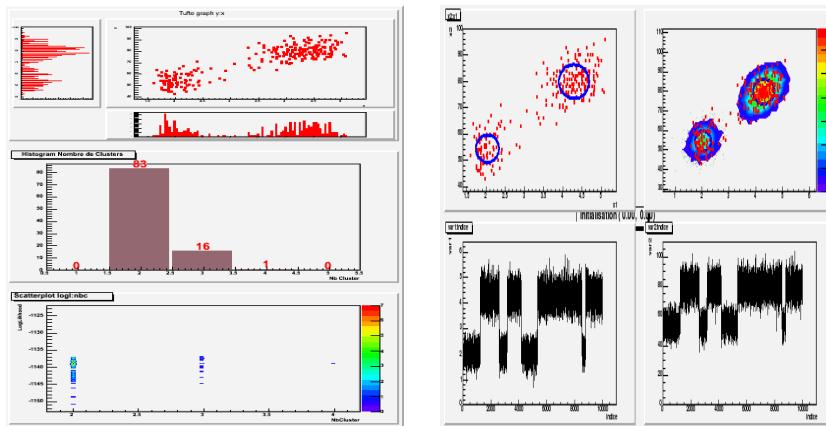


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 ”Optimizer” ...  
 ”UncertModel”  
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# ”UncertModeler” library

Identify a law (Probability Density Function) from a data base.

- Parametric law
  - ★ QQ-plot
- Gaussian mixture **MixMod** (GPL)



URANIE  
”DataServer”  
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”UncertModeler”  
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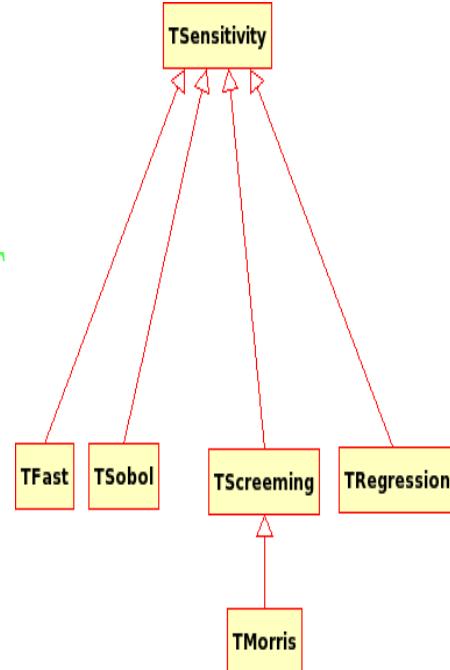
# ”Sensitivity” library

Application : ”Ishigami” function  
En cours de développement

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Perform a sensitivity analysis between the  $X$  and  $Y$  matrix

- Regression methods
  - ★ Pearson (values)
  - ★ Spearman (Rank)
- ”Screeeming” method as **Morris**
- ”Sobol” indexes
  - ★ Monte-Carlo
  - ★ ”Fourier Amplitude Sensitivity Test” **FAST**

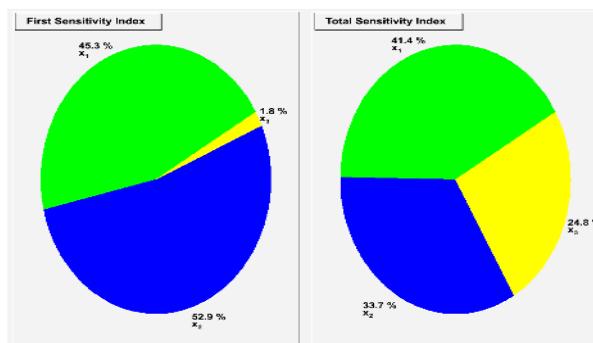
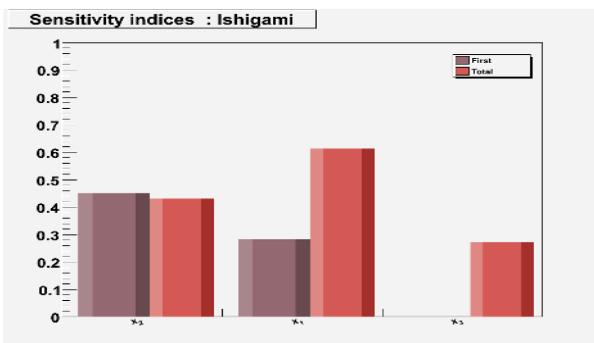
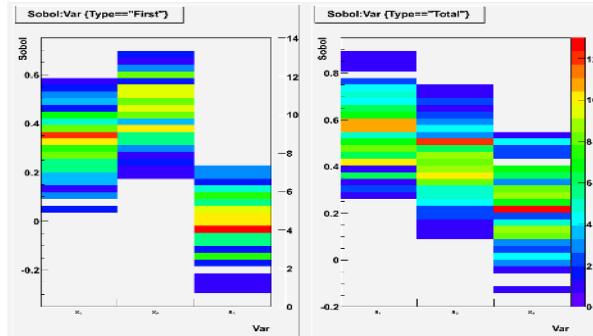
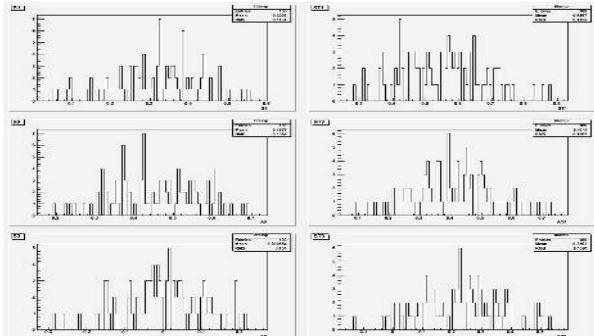


URANIE  
”DataServer”  
”Sampler” ...  
”Launcher” ...  
”Modeler” ...  
”Optimizer” ...  
”UncertModel” ...  
”Sensitivity” ...  
Plan de ...

# Application : "Ishigami" function

- "Ishigami" Benchmark :  $A = 7$  ,  $B = 0.1$  ,  $x_i \sim \mathcal{U}[-\pi, \pi], i = 1, 2, 3$

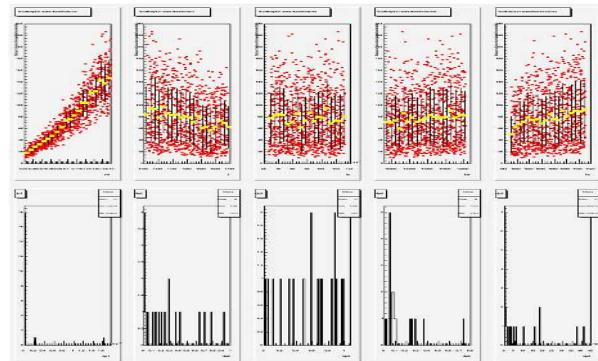
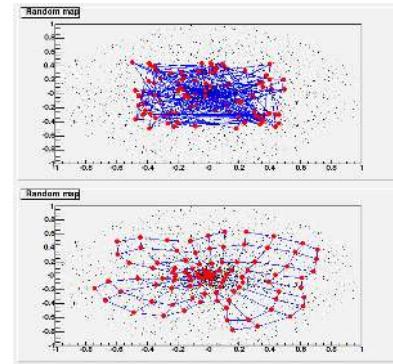
$$f(x_1, x_2, x_3) = \sin x_1 + A \sin^2 x_2 + Bx_3^4 \sin x_1$$



URANIE  
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# En cours de développement

- Quantification vectorielle  
Carte de Kohonen, Neural Gas,
- Test Statistiques :  
Shapiro-Wilks  
Kolmogorov-Smirnov  
Cramer-von Mises  
Anderson-Darling
- Analyse de sensibilité par les tests :  
Common MeaNs (CMN)  
Common MeDians (CMD)  
Common Locations (CL)  
Common Variances (CV)  
Statistical Independence (SI)
- Manuel Utilisateur ( 60%)



cea



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Plan de ...

# Plan de développement 2009-2010

- v1.2 12/2008
  - ★ Mise en LGPL
  - ★ Module NISP, tests (sensibilités)
  - ★ Manuel Utilisateur
  - ★ Portage sous Windows DataServer + Sampler
- v2.0 06/2009
  - ★ Documentation + formation Anglais
  - ★ Mise en place d'une MCO, Portage complet sous Windows
  - ★ JRC methods RBD (Random Balance Designs) + HFR
- v2.2 12/2009
  - ★ Livraison dans le cadre de ROOT
  - ★ module FORM/SORM
- v2.4 12/2010
  - ★ Mise en place des méthodes RaFu (IRSN)
  - ★ Méthodologies intégrées "déterministes/statistiques" (Karlsruhe/Pise)
  - ★ ANISP

Formation

Support aux utilisateurs ...



URANIE  
"DataServer"  
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Plan de ...