MadAnalysis 5 *status and news*

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Thank you

to the whole MadAnalysis user community

especially

A. ALLOUL, J. ANDREA, L. BASSO , S. BEIN, G. CHALONS,

K. DE CAUSMAECKER, U. GOERLACH, S. KRAML, S. KULKARNI,

K. MATAWARI, L. MITZKA, D. SENGUPTA

Outlines

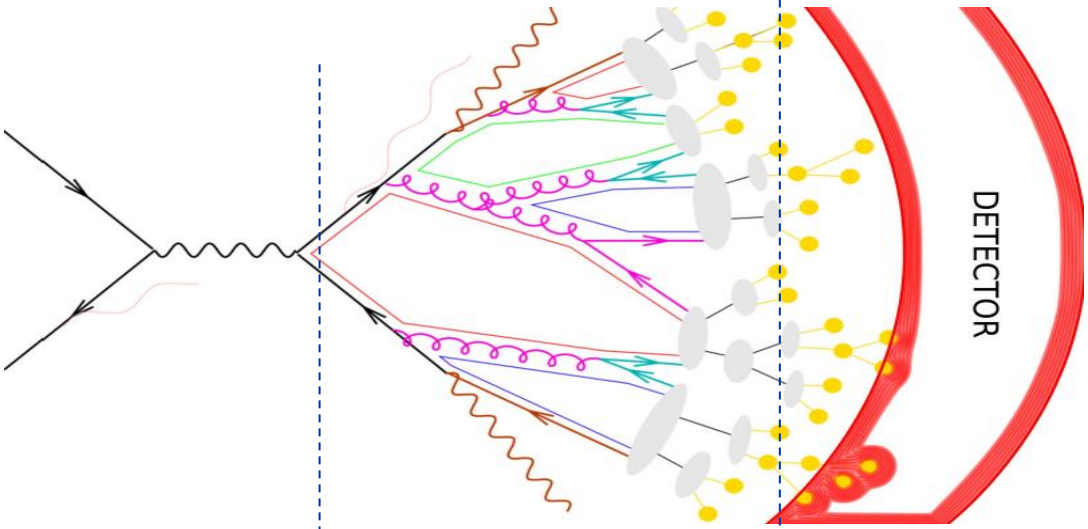
Based on MadAnalysis 5
v1.1.10 and v1.1.11beta

1. Reminder : what is MadAnalysis?
2. The normal mode and its metalanguage
3. Fast-simulation packages
4. The expert mode and recasting an analysis
5. The new validation suite
6. Summary & perspectives

1. Reminder

Starting points of the project:

Several levels of sophistication for phenomenological analyses



Parton level	Hadron level	Reconstructed objects level
LHE files	STDHEP/HEPMC files	LHCO, ROOT files

Relevant features of design

- ☑ User-friendly
- ☑ Flexible
- ☑ Efficient
- ☑ Easy to maintain

A unique framework : MadAnalysis 5

1. Reminder

Scope:

Defining an analysis with a dedicated metalanguage

Reading of signal and background event files

Supporting any event file format
(STDHEP, HEPMC, LHE, LHCO, ROOT)

optional

Processing data

- Clustering
- Fast-simulation

Analyzing data

- Selection cuts
- Filling histograms

Analysis report

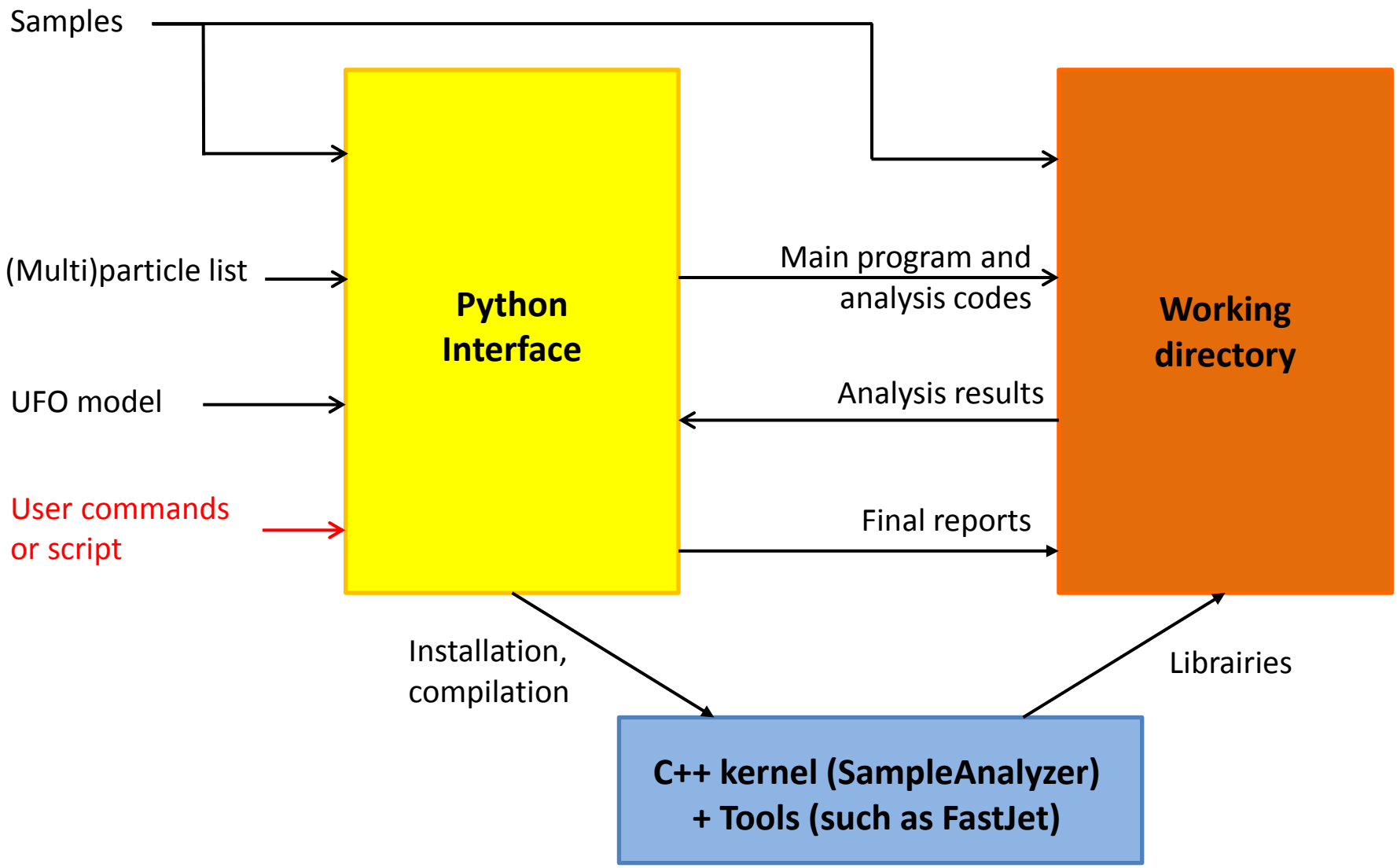
histograms,
selection efficiencies,
S/B-like ratio table

optional

Storing events into output files

LHE and LHCO file formats

1. Reminder


Samples
(Multi)particle list
UFO model
User commands
or script
Python
Interface
Main program and
analysis codes
Analysis results
Final reports
Working
directory
Installation,
compilation
Librairies
C++ kernel (SampleAnalyzer)
+ Tools (such as FastJet)

2. Normal mode

User-friendly console with PYTHON

Just type:

./bin/ma5

```
Platform: Linux 2.6.18-348.12.1.el5 [Linux mode]
Reading user settings ...
Checking mandatory packages:
     - python                    [OK]
     - python library: numpy     [OK]
     - g++                       [OK]
     - GNU Make                  [OK]
     - Root                      [OK]
     - PyRoot libraries          [OK]
Checking optional packages:
     - pdflatex                  [OK]
     - latex                     [OK]
     - dvipdf                    [OK]
     - zlib                      [OK]
     - FastJet                   [OK]
     - Delphes                   [OK]
     - Delphes-MA5tune           [OK]
Checking the MadAnalysis library:
  => MadAnalysis libraries found.
  => MadAnalysis test program works.
************************************************************
MadGraph 5 NOT found:
  => Particle labels from input/particles_name_default.txt
  => 87 particles successfully exported.
  => Multiparticle labels from
madanalysis/input/multiparticles_default.txt
  => Creation of the label 'invisible' (-> missing energy).
  => Creation of the label 'hadronic' (-> jet energy).
  => 8 multiparticles successfully exported.

ma5>_
```

2. Normal mode

Compilation and other software tricks behind the scene = physicist-friendly

- **Inspection of your system:**
  - Autodetection of the required packages (g++, root)
  - Autodetection of the optional packages (zlib, delphes, fastjet, …)
  - Autodetection of MadGraph if it is installed.

- First time you used MadAnalysis: compilation of the core libraries
  New architecture and recipe: more OS-independent

- **Debug mode could also used to investigate in case of difficulties**.
  → `./bin/ma5 --debug`

- **Users could bypass or force a step of the MadAnalysis recipe**
  →configuration file `madanalysis/inputs/user_configuration.dat`

- Optional libraries could be installed quickly from the Python interface with only one instruction.

2. Normal mode

A metalanguage for describing your analysis

- Designed to be short and intuitive
- Tab completion is very useful!

Example through a tutorial

Step 1: Defining new particles and multiparticles

```
ma5> define mu = mu+ mu-
```

Step 2: Importing datasets

```
ma5> import tt*.lhe
```

```
ma5> import tt*.lhe as ttbar
ma5> import Wj*.lhe as Wjets
```

Step 3: Defining plots

```
ma5> plot MET
ma5> plot PT(mu)
```

```
ma5> plot M(mu+ mu-)
```

Plethora of observables: **N, E, ET, M, MT, P, PT, PX, PY, PZ, THETA, ETA, …, ALPHAT**

New observables: **MT2, MT2W** 

2. Normal mode

A metalanguage for describing your analysis

- Designed to be short and intuitive
- Tab completion is very useful!

Example through a tutorial

Step 4: Defining cuts

```
ma5> reject MHT < 50
ma5> select N(mu) >= 2
```

selecting / rejecting events

```
ma5> select (mu) PT > 50
ma5> select 80 < M (mu+ mu-) < 100
```

selecting / rejecting a particle or a combination

Step 5: Applying the analysis to the samples

```
ma5> submit
```

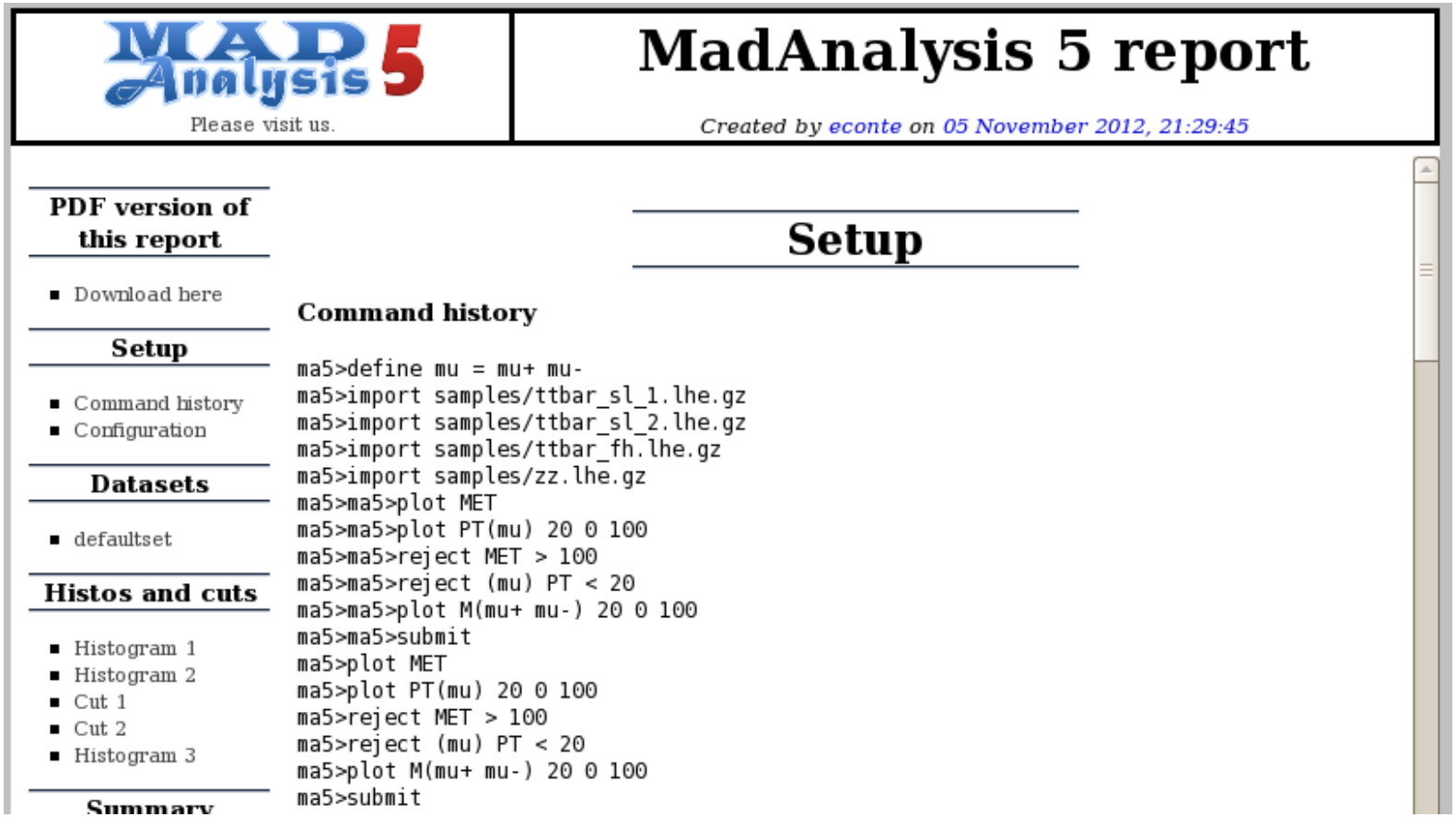
Step 6: Displaying results

```
ma5> open
```

2. Normal mode

Reports

All results are gathered in a single report, available in HTML, PDF or DVI format.



3. Fast-simulation packages

MadAnalysis is interfaced to several fast-simulation detector packages

Home made simulation based on FastJet

- Large choice of jet clustering algorithms
- Lepton isolation
- b-tagging (and c-tagging) (mis)efficiency

Delphes

Full functionalities of the last release of Delphes 3:

- ATLAS & CMS simulation
- Possibility to include pile-up events

Delphes MA5tune NEW

Special tuning of the Delphes package provided by MadAnalysis 5 for the CMS detector simulation

- Simple analysis.
- Study the impact of one detector effect on a result.

Analysis requiring realistic detector simulation

3. Fast-simulation packages

What's new in Delphes MA5 tune package?

- **Lepton isolation**

Delphes3 strategy	MA5tune strategy = Delphes2 strategy
• Determining what is a isolated and a non-isolated lepton during the simulation processing. • Using this information in the particle flow algorithm.	• Let the user deciding what is an isolated lepton → optimization according to the analysis. • Let the user remove double counting.

- **More realistic parametrization of the b-tagging(mis-)efficiency**
  - Using official CMS results
  - New track counting algorithm of Delphes is not used.

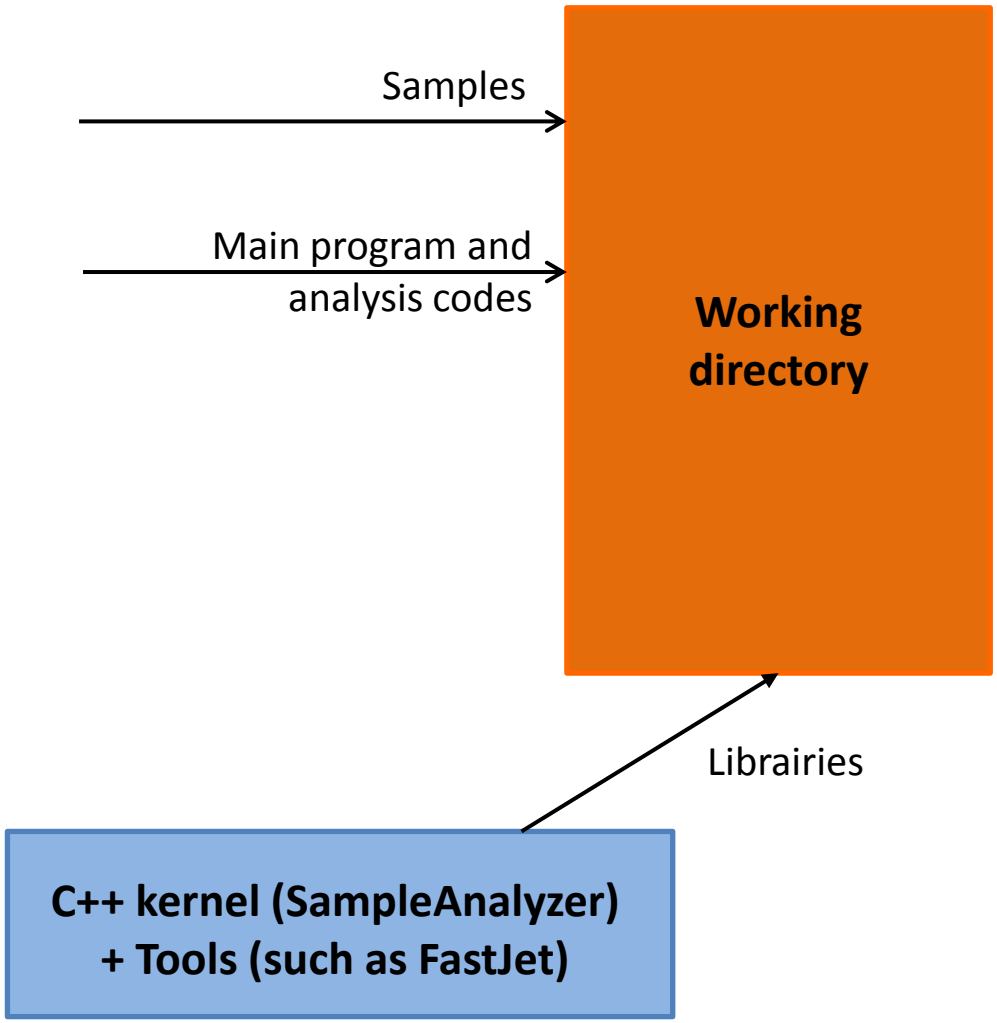
- **Optimization of the Delphes ROOT content** in order to decrease the size of the files. Relevant for heavy analysis requiring a lot of samples and statistics.

4. Expert mode

MadAnalysis has an **expert mode** (developer-friendly) :

- C++ programming within the SampleAnalyzer framework.
- The Python interface creates a blank analysis as a starting point.

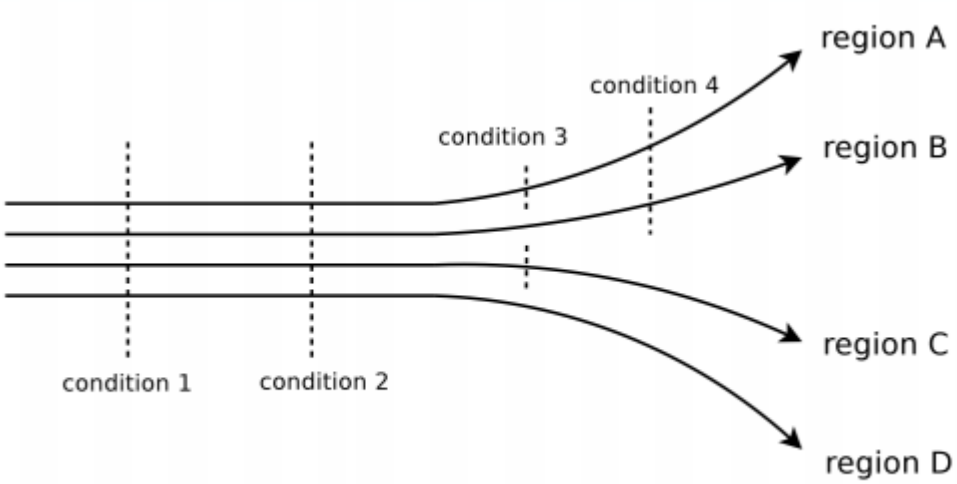
```
./bin/ma5 -e
```



4. Expert mode

Extension of the expert mode for recasting a physics analysis:

- Access for all the information from the Delphes MA5 tune package.
- Support for multiple sub-analyses (signal and control regions)
  → cut-flow chart and plots for each region



E. Conte, B. Dumont, B. Fuks, C. Wymant, arXiv:1405.3982

See Guillaume Chalons talk for an application

Naive approach

```
if (condition 1)
{
   ….
}
if (condition 3)
{
   ….
   if (condition 4)
   {
      ….
   }
}
if (condition 4)
{
   …
}
```

4. Expert mode

Extension of the expert mode for recasting a physics analysis:

- Access for all the information from the Delphes MA5 tune package.
- Support for multiple sub-analyses (signal and control regions)
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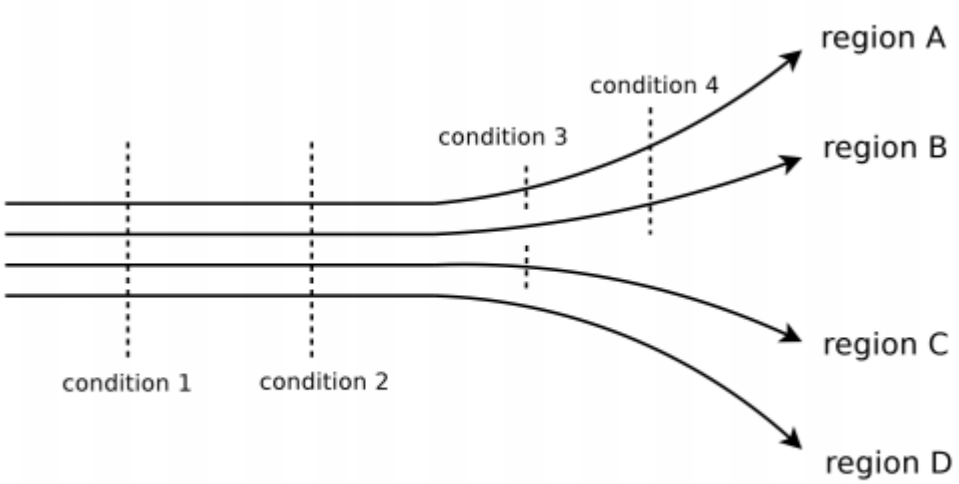

MadAnalysis approach

```
if (condition1, region A+B+C+D)
{
   ….
}

if (condition 3, region A+C)
{
   …
}

if (condition 4, region A+B)
{
   …
}
```

E. Conte, B. Dumont, B. Fuks, C. Wymant, arXiv:1405.3982

See Guillaume Chalons talk for an application

5. Validation suite 2.0

Validation is mandatory when a new version of MadAnalysis must be released.

The validation suite has been significantly improved:

- Several MadAnalysis configurations are tested (presence of optional packages + release of ROOT).
- A huge collection of tests is launched on each configuration. Corresponding MadAnalysis output (reports or samples) are stored in a private database.
- Validation is performed by comparing test-by-test the results between the new and the previous MadAnalysis results.
  - Comparing numbers
  - Comparing plots

5. Validation suite 2.0

Validation success is summarized in a web page.

Validation MadAnalysis 5

Date of HTML creation: 02/06/2014

Author: Eric Conte

Versions: root-5.34.10/v1.1.10beta_v1.1.11beta/no_options/plots

Number	Scripts' description	Matching (%)	Comparison log files	Scripts v1.1.10beta	Scripts v1.1.11beta	MA5 output log v1.1.10beta	MA5 output log v1.1.11beta
0	testing all observables with Plot and 0 particle	100	plot_0part.log	plot_0part.ma5	plot_0part.ma5	plot_0part.ma5.log	plot_0part.ma5.log
1	testing all observables with Plot and 0 particle	100	plot_0part_H.log	plot_0part_H.ma5	plot_0part_H.ma5	plot_0part_H.ma5.log	plot_0part_H.ma5.log
2	testing all observables with Plot and 0 particle	100	plot_0part_R.log	plot_0part_R.ma5	plot_0part_R.ma5	plot_0part_R.ma5.log	plot_0part_R.ma5.log
3	testing all observables with Plot and 1 particle	100	plot_1part.log	plot_1part.ma5	plot_1part.ma5	plot_1part.ma5.log	plot_1part.ma5.log
4	testing all observables with Plot and 1 particle	100	plot_1part_H.log	plot_1part_H.ma5	plot_1part_H.ma5	plot_1part_H.ma5.log	plot_1part_H.ma5.log
5	testing all observables with Plot and 1 particle	100	plot_1part_R.log	plot_1part_R.ma5	plot_1part_R.ma5	plot_1part_R.ma5.log	plot_1part_R.ma5.log
6	testing all observables with Plot and 1 particle	100	plot_2parts.log	plot_2parts.ma5	plot_2parts.ma5	plot_2parts.ma5.log	plot_2parts.ma5.log
7	testing all observables with Plot and 1 particle	79	plot_2parts_H.log	plot_2parts_H.ma5	plot_2parts_H.ma5	plot_2parts_H.ma5.log	plot_2parts_H.ma5.log
8	testing all observables with Plot and 1 particle	100	plot_2parts_R.log	plot_2parts_R.ma5	plot_2parts_R.ma5	plot_2parts_R.ma5.log	plot_2parts_R.ma5.log
9	testing all observables with Plot and 3 particles	100	plot_3parts.log	plot_3parts.ma5	plot_3parts.ma5	plot_3parts.ma5.log	plot_3parts.ma5.log
10	testing all observables with Plot and 3 particles (HADRON mode)	100	plot_3parts_H.log	plot_3parts_H.ma5	plot_3parts_H.ma5	plot_3parts_H.ma5.log	plot_3parts_H.ma5.log
11	testing all observables with Plot	100	plot_3parts_R.log	plot_3parts_R.ma5	plot_3parts_R.ma5	plot_3parts_R.ma5.log	plot_3parts_R.ma5.log

Summary

- **MadAnalysis 5 = a unique framework with two ways to use it:**
  - **Normal mode:** python interface with intuitive commands.
  - **Expert mode:** requiring programming skills (C++, ROOT).

- **Relevant features of MadAnalysis 5 design:**
  - **User-friendly** → professional analyses in a simple way.
  - **Flexible:** no limit on the analysis complexity.
  - **Easy** to maintain and to validate.

- **Main last developments:**
  - Delphes-MA5tune package for fast-simulation.
  - Support for recasting physics analysis.
  - A new validation suite.

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https://launchpad.net/madanalysis5
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