





### Introduction

Abstract Interfaces for Data Analysis

"The goal of the AIDA project is to define abstract interfaces for common physics analysis objects, such as histograms, ntuples, fitters. The adoption of these interfaces makes it easier for developers and users to select and use different tools without having to learn new interfaces or change their code. In addition it is possible to exchange data (objects) between AIDA compliant applications through a standard XML format."

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### Features

Abstract Interfaces for Data Analysis



Interfaces ... start with "I"



 AIDA defines behavior, analysis tool provides implementation

Object factories

independence of user code from AIDA implementation

- easy to switch implementations
  - IAnalysisFactory af = IAnalysisFactory.create();

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### Abstract Interfaces for Data Analysis

- Initial idea formed at HepVis-99 workshop at Orsay.
- Informal AIDA discussions at CERN in 2000

History

- AIDA workshops:
  - January 2001 Paris/Orsay
  - April 2001 Boston (preceding HepVis 2001)
  - June 2002 CERN
  - July 2003 CERN
- Informal meetings
  - e.g. during Geant4 meetings and V.C.

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### AIDA Organization and Developers

### Abstract Interfaces for Data Analysis

- Open source project
- No formal collaboration/author list
  - currently an informal CERN-LAL-SLAC effort
- Interfaces are designed by discussion and (eventual) consensus
  - Takes some time, but result is well though out and robust

#### Past and present contributors:

Guy Barrand, Pavel Binko, Grzegorz Chwajol, Mark Dönszelmann, Wolfgang Hoschek, Tony Johnson, Emmanuel Medernach, Dino Ferrero Merlino, Lorenzo Moneta, Jakub Moscicki, Ioannis Papadopoulos, Andreas Pfeiffer, Max Sang, Victor Serbo, Max Turri

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### AIDA Status Abstract Interfaces for Data Analysis AIDA Version 3.0 (Oct 2002) second end-user release. AIDA 3.2 coming out soon AIDA 2.2 first end-user release Interfaces available in C++ and Java automatically generated with AID (http://java.freehep.org) easy to add more languages http://aida.freehep.org General information, relevant links Tutorial, users' guide, examples Downloads and web-browsable source code Massimiliano Turri, SLAC INFN-LNF, 7 July 2003















IFitter

- Abstract Interfaces for Data Analysis
   Histograms
  - Clouds
  - Profiles
  - Data Point Sets
  - Ntuples
    - Evaluators
    - Filters
  - Plotting
  - Fitter

- fitting to all the data storage types IFitResult result = fitter.fit(data, function)
- change fit method ( $\chi^2$ ,max. Likelihood, etc)
- change optimizer (Minuit, etc)
- control parameters (bounds, fix, step, etc.)
- set constraints
- create scans and contours
- use function's analytical gradient

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### Example code

#### Abstract Interfaces for Data Analysis

IAnalysisFactory	aF	= IAnalysisFactory.create();
ITree	tree	<pre>= aF.createTreeFactory().create();</pre>
IHistogramFactory	histF	= aF.createHistogramFactory( tree );
IFitFactory	fitF	= aF.createFitFactory();
IFitter	fitter	<pre>= fitF.createFitter("Chi2");</pre>
IPlotter	plotter	<pre>= aF.createPlotterFactory().create("Plot");</pre>

```
Random r = Random();
for (i=0; i<10000; i++)
gaussHist.fill(r.nextGaussian());</pre>
```

IFitResult chi2Fit = fitter.fit(gaussHist,"g");

```
plotter.createRegions();
plotter.region(0).plot( gaussHist );
plotter.region(0).plot( chi2Fit.fittedFunction() );
```

```
plotter.show();
```

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#### AIDA Tools and Users Abstract Interfaces for Data Analysis Three implementations are available within: Anaphe/Lizard (C++) http://anaphe.web.cern.ch/anaphe Open Scientist (C++) http://www.lal.in2p3.fr/OpenScientist JAIDA/JAS (Java) + AIDA-JNI 3.0 (C++) http://java.freehep.org/lib/freehep/doc/aida Users **GEANT4:** Analysis Advanced examples BaBar online (via JAS) GAUDI/ATHENA users Linear Collider users LCG is considering the adoption of AIDA in their Architectural Blueprint Massimiliano Turriphysicist Interfaces (PI) group Is Working to create an AIDA implementation based on ROOT classes



### Future

### Abstract Interfaces for Data Analysis

- Achieve component level interoperability
  - e.g.: use ANAPHE histograms, fit with JAS3 fitter and plot with OpenScientist
  - at last week's workshop we focused on developer interfaces
  - first prototype due before October's workshop

### AIDA 4.0 end of 2003

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ΤΔς	Outline	
JAJ		
Java Analysis Studic		
Introduction to J	AS	
JAS3 - a new JAS		
Tour of major com	ponents of JAS3	
AIDA		
<ul> <li>Root and PAW</li> </ul>	file readers	
Tuple Explorer		
<ul> <li>Java compiler an</li> </ul>	id loader	
<ul> <li>Scripting Langua</li> </ul>	iges	
<ul> <li>Pnuts</li> </ul>		
Record loop		
<ul> <li>Spreadsheet</li> </ul>		
JAS3 Architectur	'e	
Status		
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### Introduction to JAS

#### Java Analysis Studio

- Easy to learn GUI for performing common analysis tasks (plotting, ntuple-analysis, fitting etc.).
- More complex analysis can be performed using a variety of scripting languages (pnuts, jython, etc.), or by writing Java analysis modules.
- Able to read data in a variety of formats including: aida, hbook, root, SQL databases, text-files.
- <u>AIDA</u> compliant analysis system.
- Built-in editor and compiler.
- Simple spreadsheet capabilities.
- Logbook for recording analysis tasks, and optionally publishing results to the web.
- Highly modular structure

Massimiliano Turri Addition, replacement or removal of modules to customize application for a particular problem domain.

### JAS3 - a new JAS

#### Java Analysis Studio

١	First	version of JAS2 released in 2000
	Ha	s worked well, but some limitations
	•	Too heavily based on event loop No all analysis tasks involve looping over events
	•	No support for scripting
	•	Limited fitting capabilities
	•	Limited N-Tuple analysis capabilities
١	Ofter	used for online monitoring, often used outside HEP

Not really designed for this use

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JAS	JAS3 - a new JAS
Java Analysis St	tudio
Opportunitie	es
Realized a	a lot of overlap with WIRED project
<ul> <li>Create</li> </ul>	d FreeHEP Java library to
= Pul	l out (re-factor) common parts of JAS, WIRED
Im	plement new common requirements for JAS and WIRED
	<ul> <li>Vector Graphics, Application Framework, Utilities</li> </ul>
Formed co	ollaboration with developers of similar tools to create
AIDA pac	kage
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### JAS3 Components



### **Opening Files**

🚞 My Data

<u>- 0 ×</u>



# JAS Graphical Interface to AIDA



#### Java Analysis Studio



Printing

Or

### **JAS** Java Editor, Compiler and Loader

#### Java Analysis Studio

JAS3 allows any Java program to be loaded. This example "main routine" is taken directly from the AIDA manual



Scripting

PlotExample	<pre>/ use("pnuts.lib") 2</pre>	
Cloud 1D	3 IAnalysisFactory = class hep.aida.IAnalysisFactory 4 af = IAnalysisFactory::create()	Can also
Histograms	<pre>5 tree = af.createTreeFactory().create() 6 hf = af.createHistogramFactory(tree)</pre>	write and run
Histogram 2D	7 8 Random = class java.util.Random 9 r = Random()	scripts
~	<pre>10 11 pagel = af.createPlotterFactory().create("Pagel") 12 pagel.createRegions(2,2) 13 pagel.show() 14</pre>	
Fnucs version 1.	μ DIC2 (20030320134005)	Console allows
> tree.ls("/",tr	ue)	direct interaction
/Clouds/ /Clouds/Cloud 1D		
/Clouds/Cloud 2D		With scripting
/Histograms/	ogram 1D	language
/Histograms/Hist	ogram 2D	
> page1.hide()		
> h1.rms() 0.99720534541196	63	<b>T</b>
Compiler × 🥔 Pnuts ×		
classpath:/org/freehen/ias/e	xtension/pnuts/web/examples/Example.pnut	15.8/18.1MB

### Pnuts Language

### Java Analysis Studio

- Currently support Pnuts scripting language
  - Complete and well documented
    - http://javacenter.sun.co.jp/pnuts/doc/guide.html
  - Fast (although not as fast as compiled Java)
  - Syntax very similar to Java
  - Can easily call compiled Java classes from scripts
    - best of both worlds

#### Plan to support other languages in future

In particular Python

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### **Tuple Explorer - Plots**

#### Java Analysis Studio

Works with any tuple, read from file or dynamically created



### JAS Tuple Explorer - Define Columns



### **Tuple Explorer - Cuts**



## JAS Tuple Explorer - Tabulate

	TEST OF N-TUPLES ×	TEST OF N-TUPLES ×		
	X			
	-1.0645856857299805	-1.8219432830810547		
	-1.1561870574951172	0.10606658458709717		
	0.9234919548034668	0.9436705112457275		
	-0.1453324556350708	-0.5767195224761963		
	-1.1828880310058594	1.5052518844604492		
	-0.6589415073394775	1.1793384552001953		
र०	-0.07113403081893921	0.21675515174865723		
STAFF	-1.4594354629516602	0.8698277473449707		
EST OF N-TUPLES	2.288097381591797	-0.10320693254470825		
1 ×	-0.7010295391082764	-0.23811495304107666		
I Y	1.2779169082641602	-0.6337225437164307		
Z Histogram	0.04659101366996765	0.4562896490097046		
R Drofilo	-0.9669392108917236	0.44192421436309814		
Prome	0.2991471290588379	1.7279844284057617		
ScatterPlot	1.3541679382324219	0.42571067810058594		
XYPlot	2.5137195587158203	-1.1737737655639648		
	0.9740362167358398	-0.6771807670593262		
Tabulate Selected Colum	0.2995314598083496	-1.1050891876220703		
	0.40701448917388916	0.23615598678588867		
	-0.26456665992736816	-0.3246650695800781		
	0.6188216209411621	0.0503082275390625		
	0.9396443367004395	0.5521800518035889		
	0.07398676872253418	-0.14454609155654907		
	1.9447050094604492	-1.881272315979004		
	-0.05168810486793518	-0.9172494411468506		
	-0.46100854873657227	1.4425582885742188		
	-0.6224050521850586	0.24055129289627075		
	-0.4110802412033081	-0.06928783655166626		
	-1.6539926528930664	0.6170415878295898		
	0.33683133125305176	0.02195928245782852		
	-0.963994026184082	0.15472930669784546		



### JAS3 Spreadsheet

#### Java Analysis Studio

- Simple spreadsheet plugin
  - for

JAS

- Displaying results
- Calculations
- Simple Plots
- Supports reading/writing
  - .csv files
  - Excel files
- Cut/Paste with Excel etc
  - Coming Soon...
    - Scripting interface
    - GUI for building plots
    - User defined functions

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11		55.0		54002.0	81003.01	66495.0	201500.0	
12		60.0		62712.0	94068.01	77220.0	234000.0	
13		65.0		71422.0	107133.01	87945.0	266500.0	
14		70.0		80132.0	120198.01	98670.0	299000.0	
15		100.0		132392.0	198588.02	163020.0	494000.0	
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### Miscellaneous Features



### JAS3 Architecture

#### Java Analysis Studio

 Design based on Application Shell, into which many (optional) modules can be plugged

- All of the features we have discussed previously are implemented by one (or more) plugin modules
  - Loose coupling between modules allows for modules to be removed without breaking remainder of program
  - Extra modules (e.g. LCD specific modules) can be easily added
- Highly customizable for different application domains
  - HEP/Astrophysics/Other
  - DST analysis/Online Monitoring/GRID analysis
  - Experiment/User specific modules

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### Status

### Java Analysis Studio

- Currently released JAS3 version 0.7.2
  - AIDA functionality is quite solid
  - Compiler, Loader, Record Loop all quite recently added,
    - Certainly still some rough edges

#### Documentation is still quite limited

- Talks, tutorials, built-in example scripts and programs accessible from simple built-in web-browser
- If you are used to JAS2 you will find some functionality not yet ported to JAS3
  - Remote (client/server) access to data (this is being worked on)
  - 3D Lego/Surface plots

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### JAS JAS 2 - GRID interface (Tech-X)

New Job Wizard	New Job Wizard
-Job name Enter a name for your job: Untitled -Job type What kind of job would you like? C A local job for data analysis. C A remote job for data analysis. C A remote job for generating events. C A remote job for generating events. C Special Job Cancel Help << Previous Next >> Finish	✓ multipole: Online         ✓ node8: Online         □ node4: Java is starting the server         ✓ node3: Online         □ node2: Java is starting the server         ✓ node6: Online         □ node7: Linking csc-11.sio to sandbox         ✓ Cancel         Help            ✓ Previous         Next >>
Create Cancel  Welcome to JAS. W/ Grid plugin	New Job Wizard         multipole: Installing codebase         node8: Waiting on multipole         node4: Waiting on multipole         node3: Linking csc-0.sio to sandbox         node2: Linking csc-14.sio to sandbox         node6: Linking csc-10.sio to sandbox
Each server needs the plugin to do grid jobs.     Verify plugin installations now?     Yes Skip	Cancel     Help     <     Previous     Next >>
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### JAS and the GRID JAS Java Analysis Studio We plan to add client-server/distributed capabilities to JAS3 similar (but better) than those in JAS2 Will be based on (remote) AIDA Want to use Grid standards where they exist Work with others (PPDG-CS11,???) to define standards where they do not exist Tech-X have phase II SBIR approved and will work closely with us Massimiliano Turri, SLAC INFN-LNF, 7 July 2003

### Help us make it better

#### Java Analysis Studio

- We have recently purchased and are now seriously using a commercial bug tracking system.
  - Used not only for bugs, but also for tracking tasks, ideas etc.
  - Please report any problems you find, and make suggestions for changes or improvements you would like to see.
    - http://bugs.freehep.org

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View personal road map		
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0.7 Progress:	🔹 Unassigned 5	
👩 JAS-59 FIXED Infinite loop caused by memory meter 🛊 🖨	Assigned 35	
👩 JAS-89 FIXED NPE on startup under Redhat 8 👔 🔮	(1) In Progress 0	
JAS-52 UNRESOLVED Cannot plot functions	Reopened 0	
📓 JAS-43 UNRESOLVED Header, Footer not implemented for printing 🏦 🍰	Resolved 25	
JAS-75 UNRESOLVED Too many Prut consoles	The second secon	
📓 JAS-33 UNRESOLVED Root reader supports only subset of histograms 🔒 🍰	Open Issues	
🗑 JAS-77 UNRESOLVED JAS3 uses 50% CPU on Mac OS X 🔒 🛔	By Priority	
📓 JAS-71 UNRESOLVED. Compile/Load/Bun peeds more thought 🏦 🔒	Discharger 0	
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