EUropean Best Information through Regional Outcomes in Diabetes

A European model for the Automatic Production of Standardized Performance Indicators: the BIRO statistical engine

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The problem

- Performance reports have become common practice to benchmark and leverage quality, equity and efficiency in health systems
- The methodology applied is frequently advanced and results are not easy to interpret for policy makers.
- New tools to facilitate the uptake of performance results are increasingly sought at all levels
- International comparisons are hampered by the lack of standardized data and the absence of procedures/software to constantly and automatically check the quality and management of the existing data sources

Theory: Conceptual Model
Practice: Multidimensional sets of Indicators

2002

↓

Ministerial Conference, 2004

↓

Conceptual Paper, 2006

↓

Health Care Quality Indicators Report, 2006

→

HEALTH STATUS
How healthy are the citizens of the OECD member countries?

Health Conditions	Human Function and Quality of Life	Life Expectancy and Well-being	Mortality

NON-HEALTHCARE DETERMINANTS OF HEALTH
Are the non-healthcare factors that also determine health as well as if/how healthcare is used changing across and within OECD member countries?

Health Behaviors and Lifestyle	Personal or Host Resources	Socio-economic Conditions & Environment	Physical Environment

HEALTHCARE SYSTEM PERFORMANCE
How does the healthcare system perform? What is the level of care across the range of patient care needs? What does this performance cost?

	Dimensions of Healthcare Performance				
Healthcare Needs	Quality			Access	Cost / Expenditure
	Effectiveness	Safety	Responsiveness / Patient-centeredness	Accessibility	
Staying healthy					
Getting better					
Living with illness or disability					
Coping with end-of-life					

EQUITY

Efficiency
(Macro- and micro-economic efficiency)

HEALTH SYSTEM DESIGN AND CONTEXT
What are the important design and contextual aspects that may be specific to each health system and which may be useful for interpreting the quality of its healthcare?

Other country-related determinants of performance (e.g. capacity, societal values/preferences, policy)	Health System Delivery Features

Quality of Care in Diabetes

[IDF Diabetes Atlas, Fourth Edition, 2009]

2004-2008: >1,500 publications on quality of care

- Multicentric data in a single country
- Analysis on a single centre
- Only N=3 studies comparing quality across countries

1999-2003: sample of 50% papers:

- N=5 internazional studies

OECD "Health Care Quality Indicators Project"

N=9 diabetes indicators originally identified

- N=2 computed:
  - Annual eye examination, Amputation rates

Why are international comparisons so difficult?

[IDF Diabetes Atlas, Fourth Edition, 2009]

"So, why is it that there is a large number of studies of diabetes care within countries, many based on multiple sites, yet so few international comparisons? ***The simple answer is lack of consistently applied standards that would enable international comparisons. Standard systems and definitions, applied to comparable populations result in data that can be collected and compared relatively easily. The more unified systems are, the easier these comparisons become."***

Data Sources of Performance Indicators

Linked Administrative Data

Clinical Databases

Epidemiological Studies

Unified model: cathedral or bazaar?

vs

Mixed models

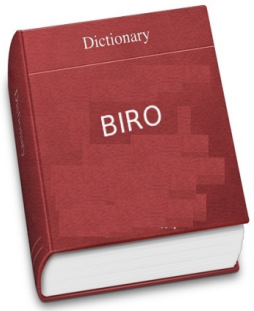
L'Aquila – Piazza Duomo

Best Information through Regional Outcomes (BIRO)

- BIRO project (2005-2009): DG-SANCO co-funded project in diabetes
- ***Aim: to provide European health systems with an ad hoc, evidence and population-based diabetes information system***
- EUBIROD project (2008-2011) builds upon BIRO
- ***Aim: "to implement a sustainable European Diabetes Register through the coordination of existing national/regional frameworks and the systematic use of the BIRO system in 20 European countries***

Coordination rather than unification: a pragmatic model

Recipe = Dictionary

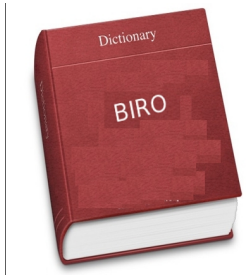


Ingredients = EU Standardized Data definitions

Discard Heterogeneity

Product = Indicators

BIRO Diabetes Core EU Dataset



N=48

1. ID Patient
2. ID Centre
3. Type of Diabetes
4. Sex
5. Date of Birth
6. Date of Diagnosis
7. Episode Date
8. Smoking Status
9. N.Cigarettes (x day)
10. Alcohol Intake (g/x day)
11. Weight
12. Height
13. BMI
14. Systolic Blood Pressure
15. Dyastolic Blood Pressure
16. HbA1c
17. Creatinine
18. Microalbumin
19. Total Cholesterol
20. HDL
21. Trygliceride
22. Eye Examination
23. Retinopathy Status
24. Maculopathy Status
25. Foot Examination
26. Foot Pulses
27. Foot vibration
28. End Stage Renal Failure
29. Renal Dyalisis
30. Renal Transplant
31. Stroke
32. Foot Ulceration
33. Acute Myocardial Infarction
34. Laser
35. Hypertension
36. Blindness
37. Amputation
38. Antihypertensive Medication
39. Hypoglicemic Drug Therapy
40. Oral Drug Therapy
41. Pump Therapy
42. Nasal Therapy
43. Average Injections (x day)
44. Self monitoring
45. Diabetes Specific Education
46. Lipid Lowering Therapy
47. Anti-platelet Therapy
48. Patient enrollment in DMP for diabetes

Local "Mapping" of Diabetes Data

BIROBox

Help

B.I.R.O. Best Information through Regional Outcomes

BIROBox
Setup

BIRO Database
Database Engine

Local Report
Statistical Engine

Data Transmission
Communication Software

Global Report
Central Engine

Global Connection
Web Portal

Fields mapping configuration

Configure mapping between BIRO fields and local fields

BIRO field
Date of Birth
Date of Diagnosis
Patient ID
Sex
Sub-Data Source ID
Type of Diabetes
Alcohol Intake
Alcohol status
Amputation
Anti Platelet Therapy
Average Injections
Blindness
BMI
Cigarettes per day
Creatinine
Diabetes Specific Education
Diastolic blood-pressure
End Stage Renal Failure
Episode Date
Eye Examination
Foot Examination
Foot Pulses
Foot Sensation
Foot Ulcer
HbA1c
HDL
Height
Hypertension
Hypertensive Medication
Hypoglicaemic Drug Therapy
Laser
LDL
Lipid Therapy
Maculopathy
Microalbumin
Myocardial Infarction
Nasal Therapy
Oral Therapy

BIRO field name: TYPE_DM

BIRO field description:

Type of Diabetes

Extract from local database

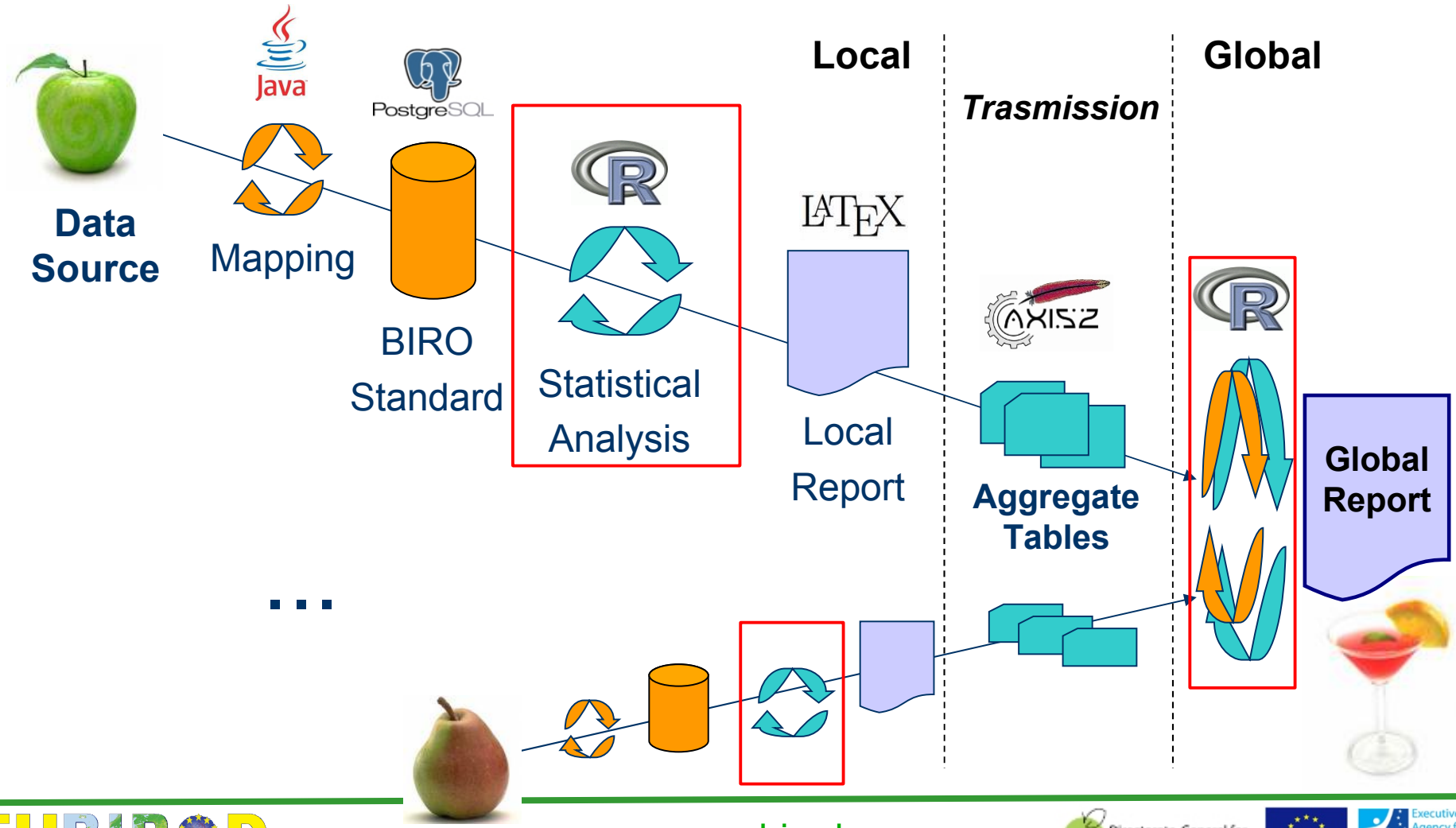
Local field name

tipoDiabeteInt

BIRO category		Expression	Local value	BIRO Value
Type 1	if	is custom text	1	1
Type 2	if	is custom text	2	2
Other Types	if	is custom text	0	3

Previous | Finish

The complete BIRO model
www.biro-project.eu



Fundamental BIRO definitions

Region

a network sharing a common homogeneous framework for the collection of health information (e.g. group of professionals/centres, local health authority, single provinces, regions, states, or group of states)

Statistical Object

An element of a distributed information system carrying essential data in the form of embedded, partial aggregate components, required to compute a summary measure or relevant parameter for the whole population from multiple sites

BIRO Indicators (N=72)

http://www.biro-project.eu/documents/downloads/D14_4_BIRO_Monograph.pdf

Demographic Characteristics (N=2)

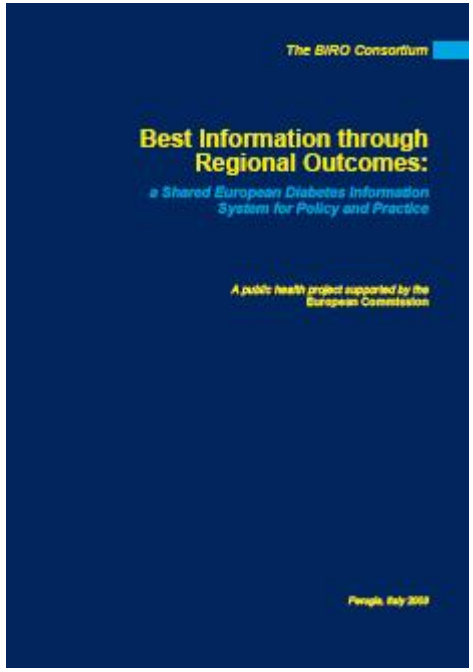
Clinical Characteristics (N=18)

Health System (N=21)

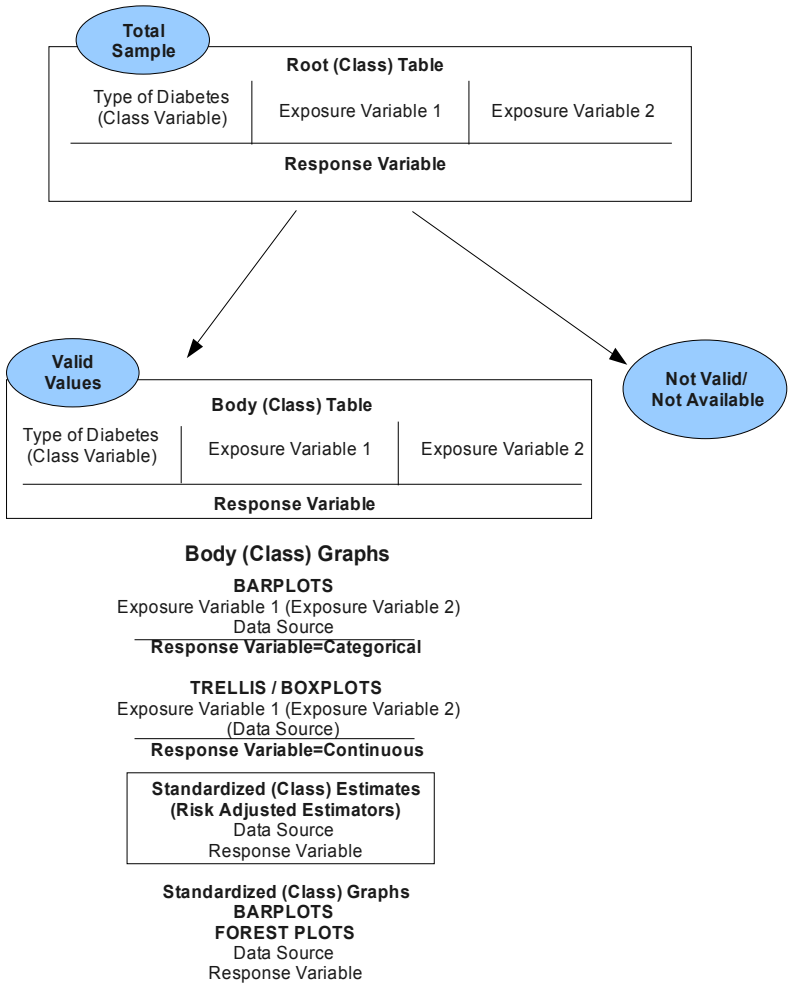
Population (N=3)

Standardized / Risk Adjusted (N=28)

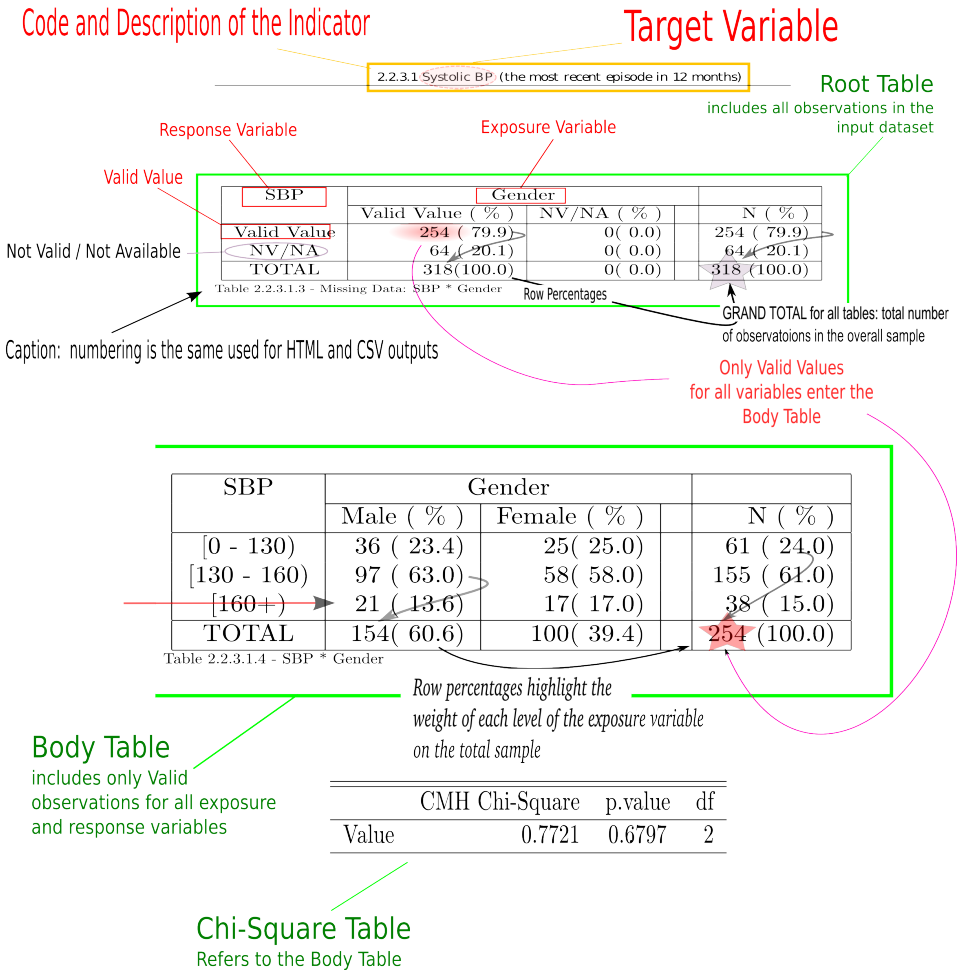
- Epidemiological (N=2)
- Process (N=16)
- Intermediate Outcomes (N=7)
- Terminal Outcomes (N=3)



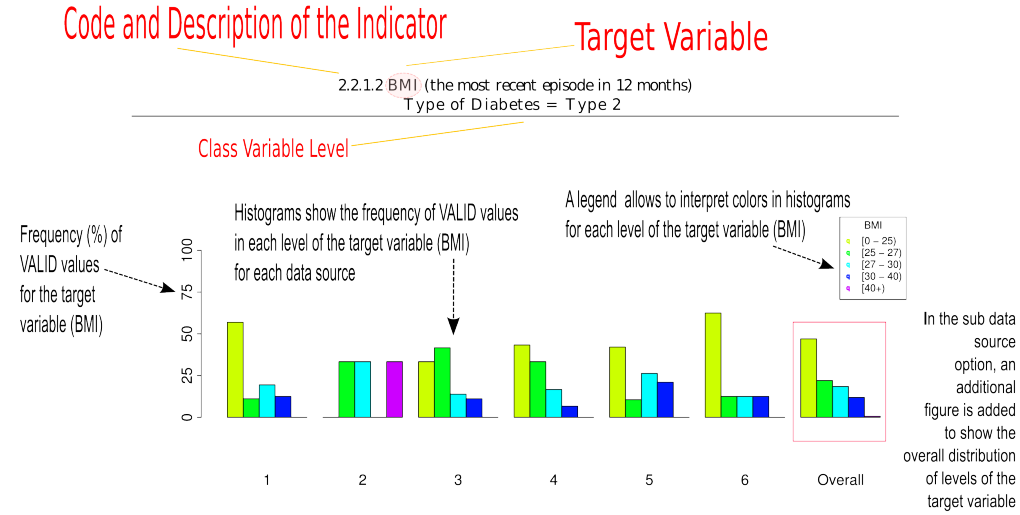
Structure of the Report



Tabular Outputs

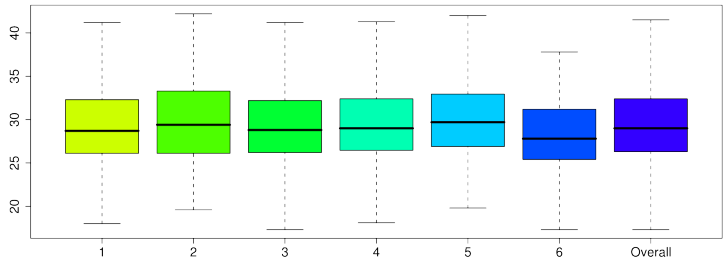


Graphical Outputs



Barplots: 2.2.1.2.26 - BMI by data source (Age = [35 - 55), Type of Diabetes = Type 2)

In the SUB DATA SOURCE output, BOXPLOTS are used
to compare distributions across centres for continuous response variables



Boxplots: 2.2.1.2 3 - BMI by data source (Type of Diabetes = Type 2)

Standardization
(AHRQ Quality Indicators)

Risk adjustment model (in each region)

$$Y(\%) = \beta_0+\beta_1(\text{females})+\beta_2(\text{age\_class1})+\ldots\beta_k(\text{age\_class4})$$

Source unit

$$Y_i \text{ expected} = \beta_0+\beta_1(\text{females})+\beta_2(\text{age\_class1})+\ldots\beta_k(\text{age\_class4})$$

$$\sum \text{Pred}_i \times 100 = \text{Expected Rate}$$

Standardized Rate= (observed rate/expected rate)*population rate

Logistic regression for risk adjustment: why using individual data?

Complete Sample

Box 3.4.2. Output Logistic Model on all observations

The LOGISTIC Procedure
Model Information

Data Set	WORK._MODEL_
Response Variable	HI_HBA
Number of Response Levels	2
Number of Observations	17102
Model	binary logit
Optimization Technique	Fisher's scoring

Response Profile

Ordered Value	HI_HBA	Total Frequency
1	1	4856
2	0	12246

Probability modeled is HI_HBA=1.

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.6862	0.1028	44.5243	<.0001
GENDER	1	-0.2297	0.0343	44.7555	<.0001
CL_AGE2	1	0.0916	0.1092	0.7027	0.4019
CL_AGE3	1	-0.1465	0.1040	1.9842	0.1589
CL_AGE4	1	-0.2491	0.1086	5.2637	0.0218

Box 3.4.3. Output Logistic Model on aggregate data

The LOGISTIC Procedure
Model Information

Data Set	WORK.IN_SEDIS
Response Variable	HI_HBA
Number of Response Levels	2
Number of Observations	16
Weight Variable	COUNT
Sum of Weights	17102
Model	binary logit
Optimization Technique	Fisher's scoring

Response Profile

Ordered Value	HI_HBA	Total Weight	Total Frequency
1	1	8	4856.000
2	0	8	12246.000

Probability modeled is HI_HBA=1.

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.6862	0.1028	44.5243	<.0001
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CL_AGE3	1	-0.1465	0.1040	1.9842	0.1589
CL_AGE4	1	-0.2491	0.1086	5.2637	0.0218

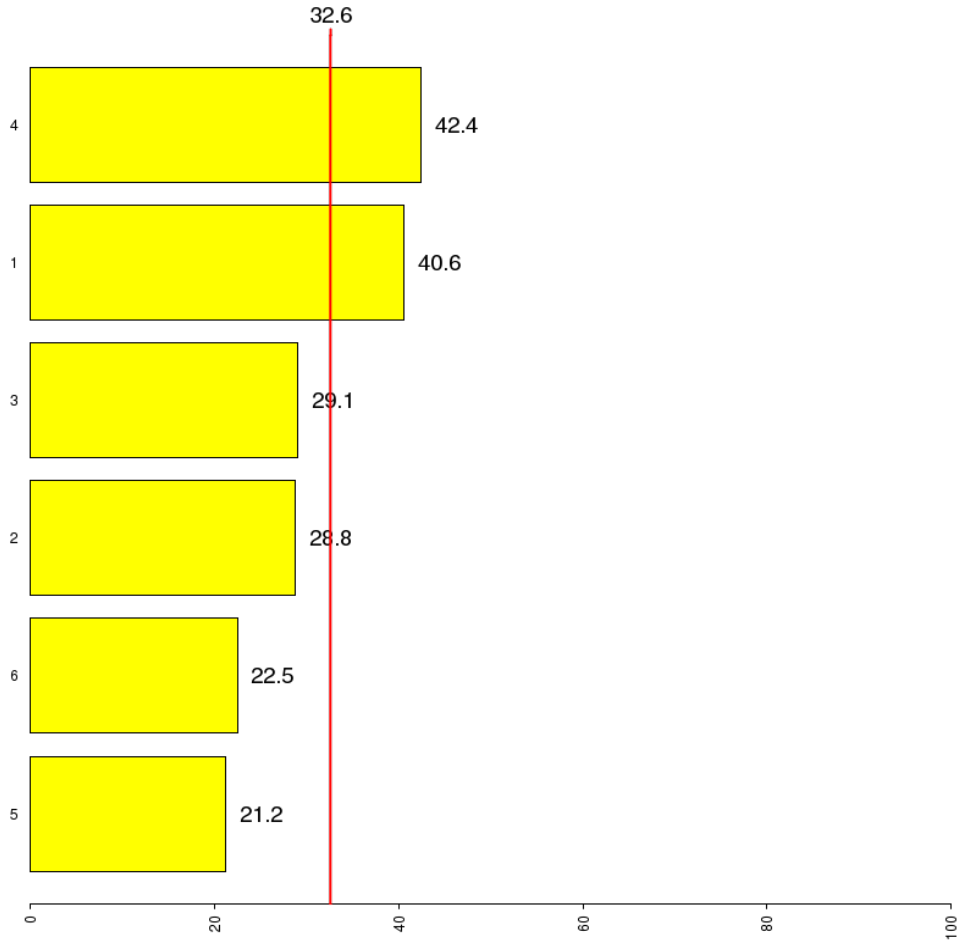
Combinations of Levels of Covariates

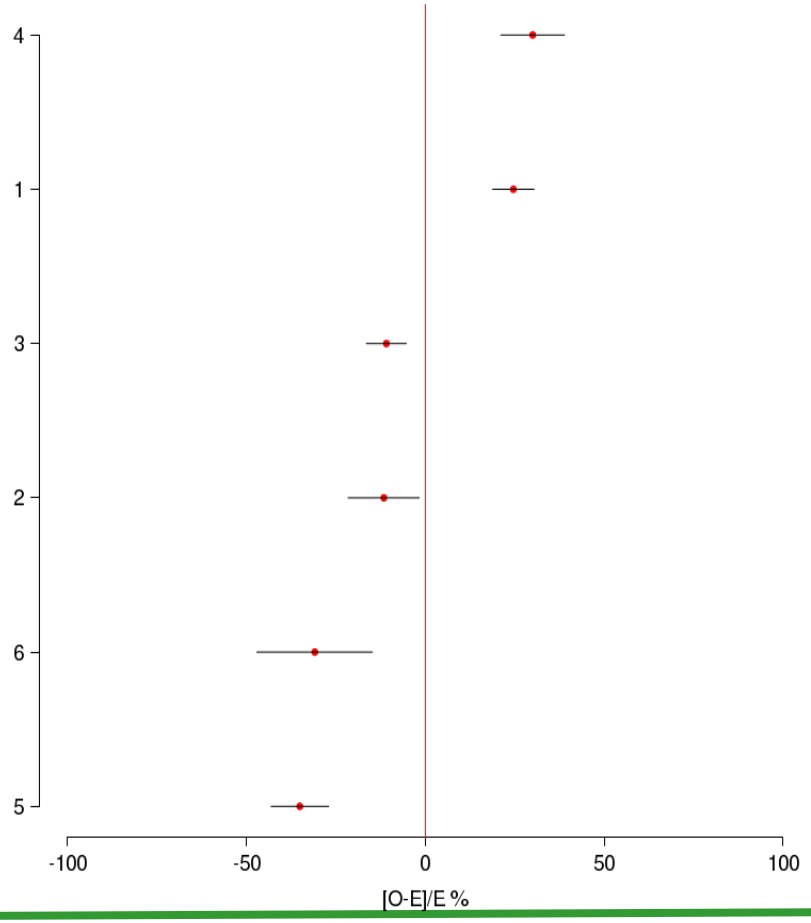
Same results !

Box 3.4.4. Observed/expected rates by centre using logistic regression

Centre	Den.	Num.	%Observed	% Expected	95% Lower	95% Upper
1	7699	2189	28.4	28.5	27.5	29.5
2	2360	1000	42.4	28.0	26.1	29.8
3	3422	916	26.8	28.4	26.9	29.9
4	1239	222	17.9	28.3	25.8	30.8
5	2382	529	22.2	28.4	26.6	30.2

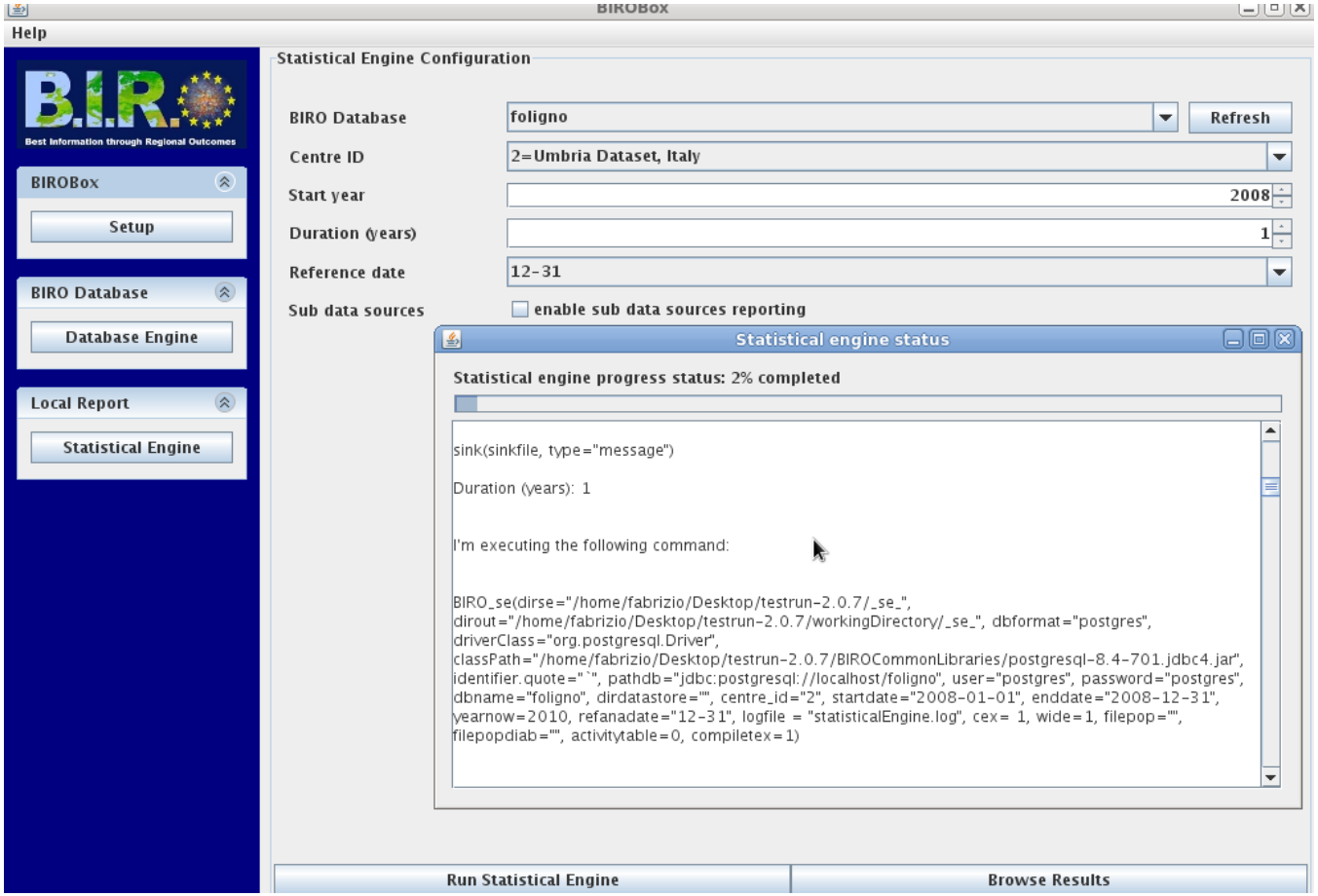
Standardization outputs





BIROX: Ubuntu Linux Virtualized distribution

The BIRO Statistical Engine: Automated Local & Global Report Delivery



Report Delivery

- Outputs are produced in html and pdf formats, together with a very large number of component files that can be conveniently reused in customized web portals

B.I.R.
Best Information through Regional Outcomes

Reference date: 31/12/08

Parameter: 5.3.1 % subjects with most recent HbA1c > 9.0 pct (poor control)

HbA1c	Type of Diabetes		
	Valid Value (%)	NV/NA (%)	
Valid Value	8797 (93.9)	0 (0.0)	8797(93.9)
NV/NA	575 (6.1)	0 (0.0)	575(6.1)
	9372 (100.0)	0 (0.0)	9372 (100.0)

Table 5.3.1.1 - Missing Data: HbA1c * Type of Diabetes

HbA1c	Type of Diabetes		
	Type 1 (%)	Type 2 (%)	
(9 +)	76 (12.2)	618 (7.6)	694(7.9)
(0 - 9]	545 (87.8)	7558 (92.4)	8103(92.1)
	621 (7.1)	8176 (92.9)	8797 (100.0)

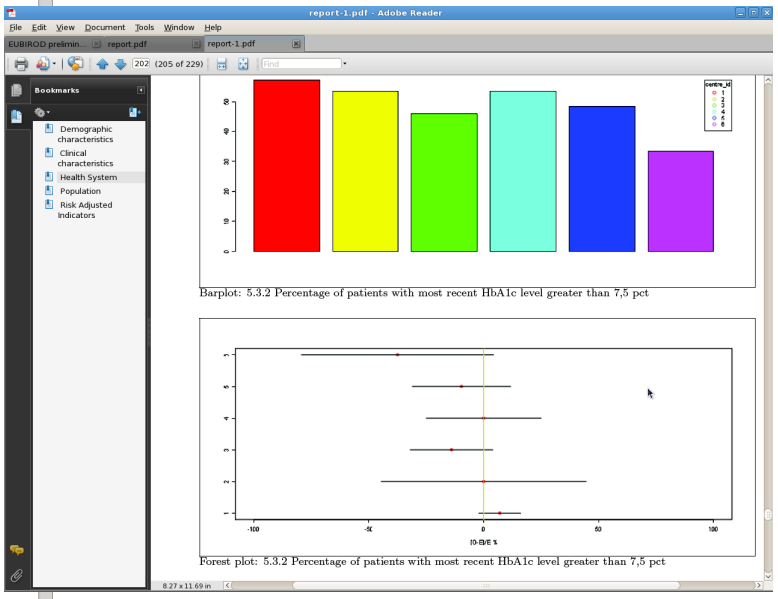
Table 5.3.1.2 - HbA1c * Type of Diabetes

CMH Chi-Square	p.value	df
16.7553	0	1

HbA1c	Gender		
	Valid Value (%)	NV/NA (%)	
Valid Value	8797 (93.9)	0 (0.0)	8797(93.9)
NV/NA	575 (6.1)	0 (0.0)	575(6.1)
	9372 (100.0)	0 (0.0)	9372 (100.0)

Table 5.3.1.3 - Missing Data: HbA1c * Gender

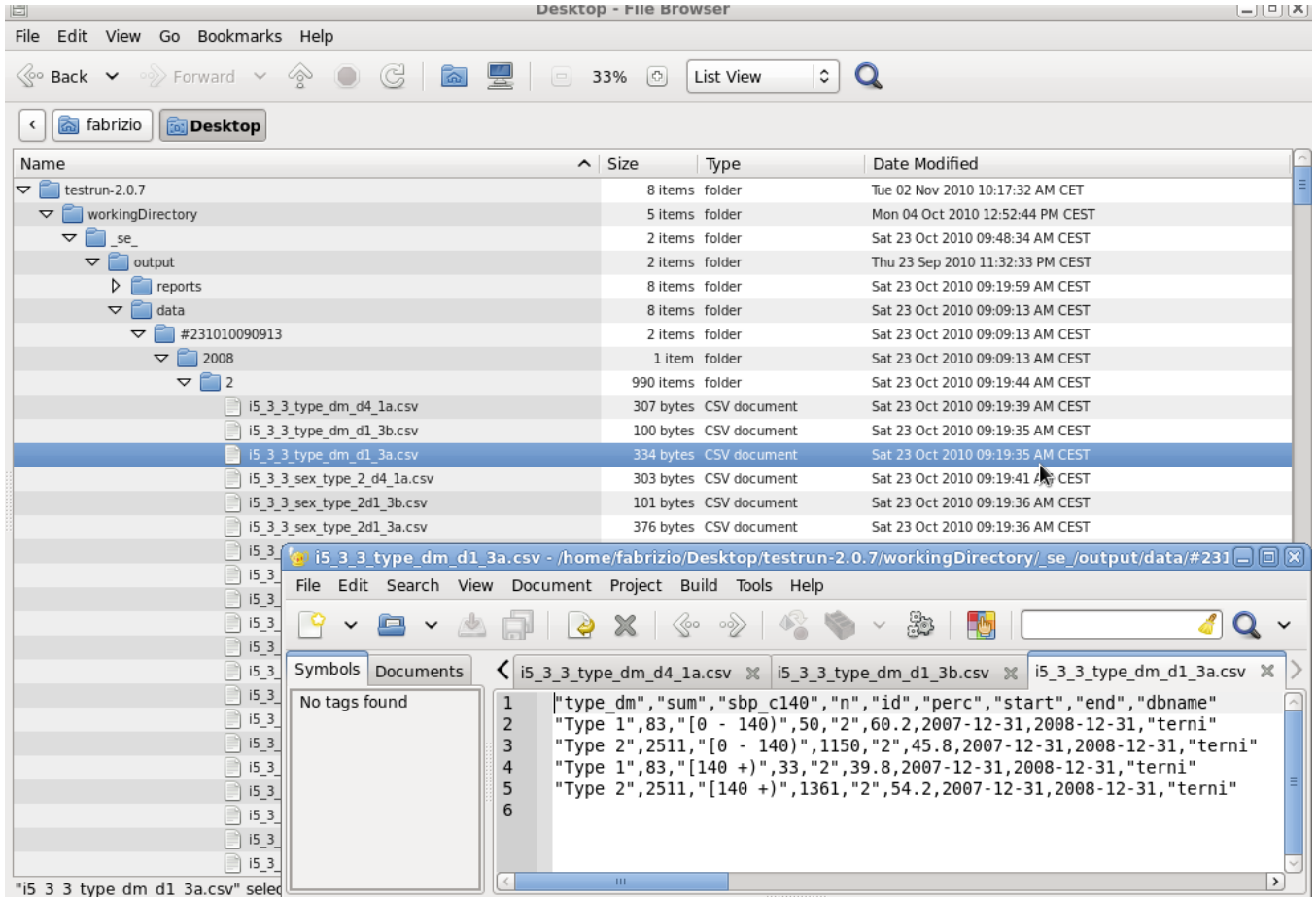
HbA1c	Gender		
	Male (%)	Female (%)	
(9 +)	331 (6.9)	363 (9.0)	694(7.9)
(0 - 9]	4438 (93.1)	3665 (91.0)	8103(92.1)



Barplot: 5.3.2 Percentage of patients with most recent HbA1c level greater than 7,5 pct

Forest plot: 5.3.2 Percentage of patients with most recent HbA1c level greater than 7,5 pct

Statistical Objects Data



Execution Time

Centre	N Patients	N episodes	Elapsed Time
1	2,842	9.097	10' 46”
2	3,202	8,316	9' 23”
3	1,115	1,948	8' 26”
4	1,268	1,456	8' 17”
5	994	1,329	8' 02”
6	318	438	8' 19”
Overall (Statistical Engine)	9,739	22,584	24' 52”
Overall (Central Engine)	9,739	22,584	15' 30”

Conclusions

- The BIRO statistical engine may represent a useful model to collect and analyze standardized data for the routine production of multidimensional sets of performance indicators
- The current version, implemented for the case of diabetes registers, is provided with extensive specifications and is completely open source.
- To make it generally and directly applicable to different sets of performance indicators, the software must be properly reshaped to allow for the inclusion of “user plugins”.
- Plugins must specify parameters for the basic steps required for performance reporting: **mapping** local values to a common standard, applying **definitions and algorithms** to the target indicators, standardization formulas for **risk adjustment**

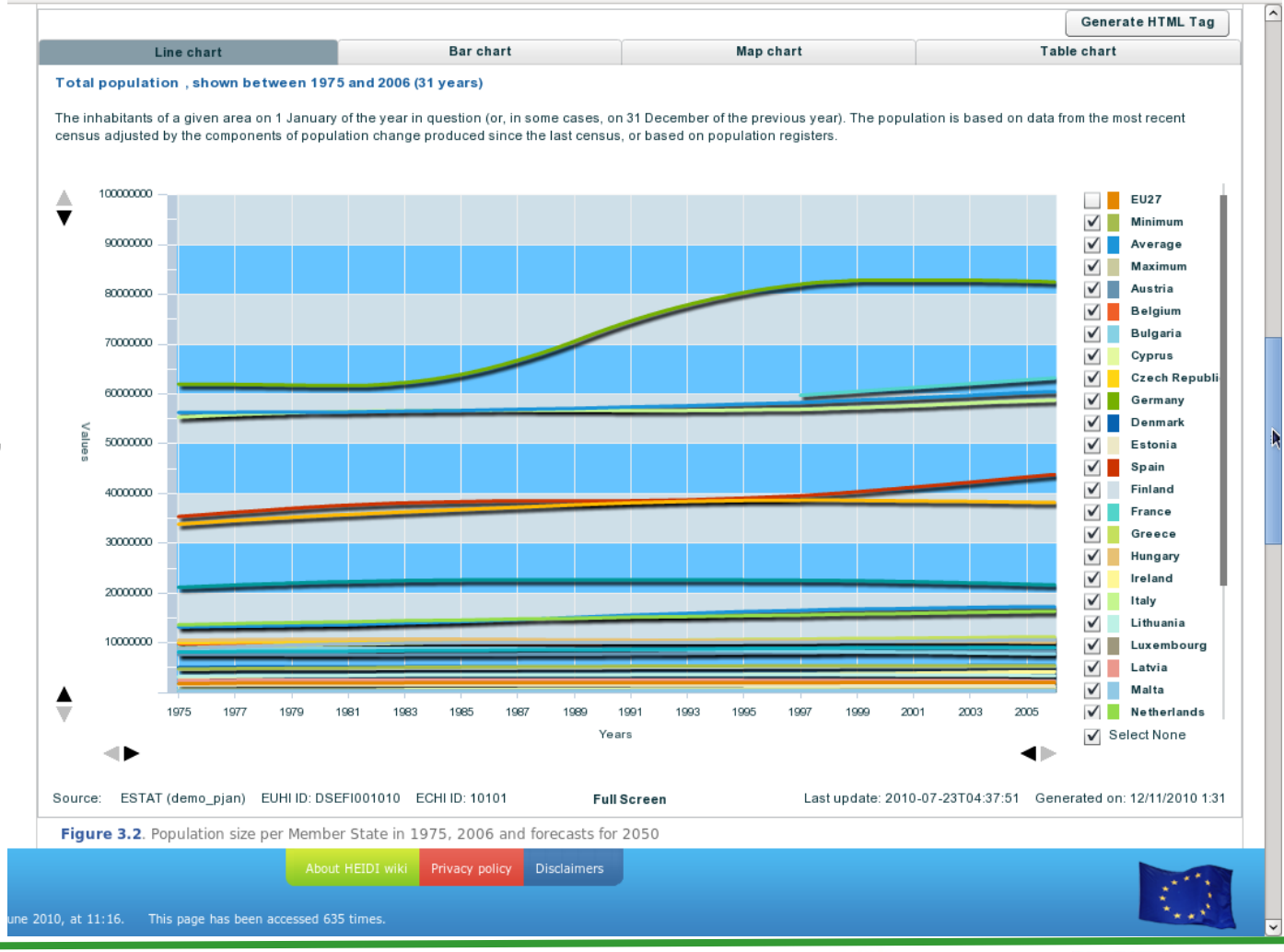
Perspectives
Connecting BIRO and HEIDI

HEIDI wiki:
"Health in Europe: Information and Data Interface"

BIRO .csv data outputs

=>

HEIDI SDMX data format



More Collaborative Frameworks needed!

"*Performance measurement is not something done to you by someone else but something done together, in partnership, to improve our ability at every level – local, state, regional, and national – to achieve our common goals*".

former USA Assistant Secretary for Health, Philip R. Lee