

MAGIC-5 (2009-2011)

Linee di ricerca:

- lung CAD (screening per diagnosi precoce del tumore polmonare da immagini CT)
- analisi di neuroimmagini (diagnosi precoce del morbo di Alzheimer da immagini NMR)

Sezioni INFN: Bari (neuro, lung), Genova (neuro), Lecce (lung, neuro), Napoli (neuro), Pisa (lung, neuro), Torino (lung, neuro).

Collaborazioni: Ospedali [Cuneo (lung), Genova (neuro), Lecce (lung), Milano (lung), Perugia (neuro), Pisa (lung, AOUP e UNI), Roma (lung)], Bracco Imaging SpA (lung).

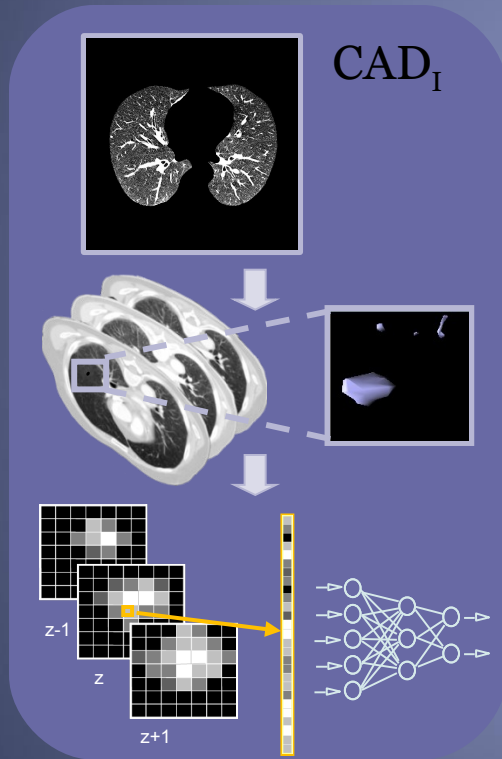
Contatti: GE.

2012: solo INFNMED per la parte lung e nuovo esperimento (PANDIS, MINDED, EDEN?) per la parte neuroimmagini?

OUTLINE

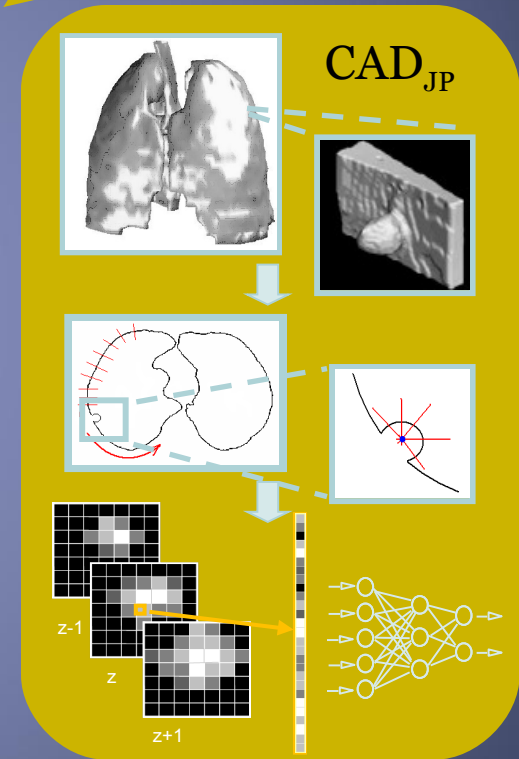
- **Situazione**
 - Lung CAD VBNA
 - Lung CAD MAGIC-5 comboCAD
 - OsiriX plugin
 - Framework radiologico
 - Lavori “lung CAD x lung screening” in corso
 - MAGIC-5 expertise in ambiente radiologico
 - Altre applicazioni e prospettive lung
 - Analisi di neuroimmagini
- **2012@PISA**
 - Disponibilità di manpower.
 - Necessità economiche e di servizi.

CAD VBNA



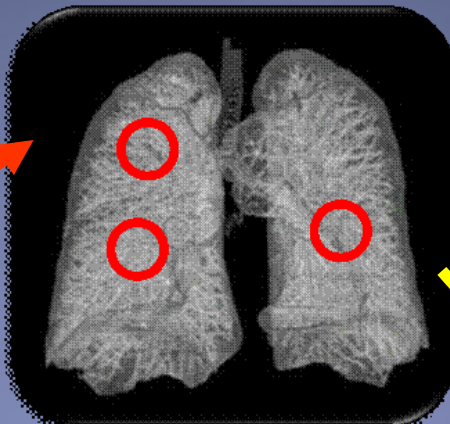
VBNA CAD architecture:

1. Lung segmentation
1. ROI identification
1. ROI classification

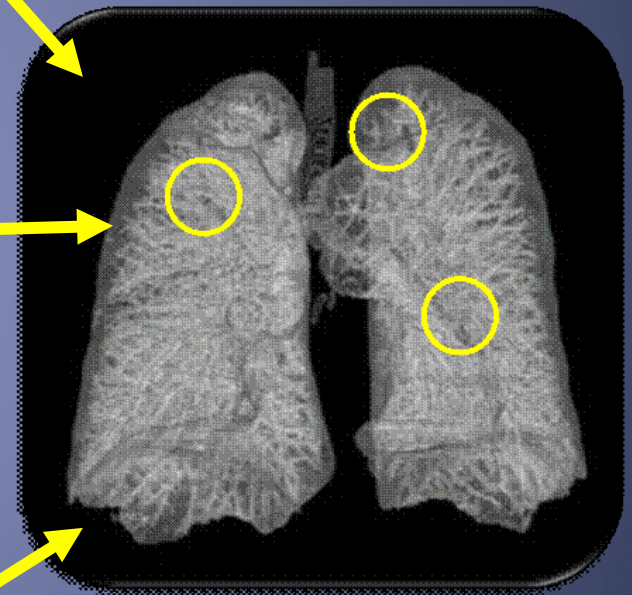


MAGIC-5 comboCAD

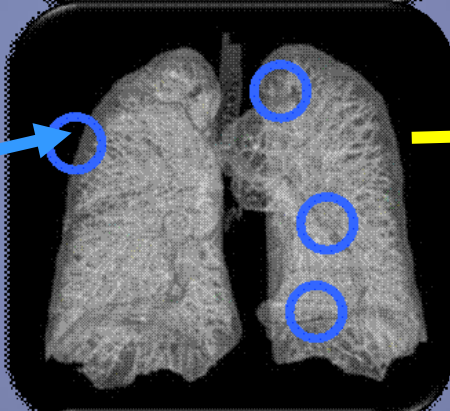
Analisi
CAD CAM



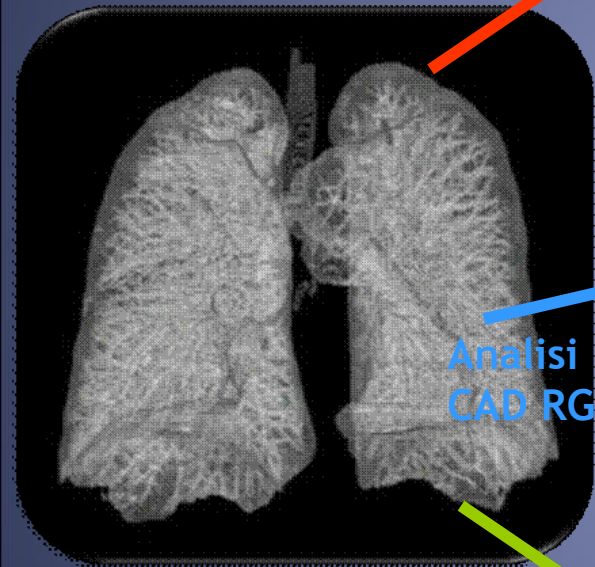
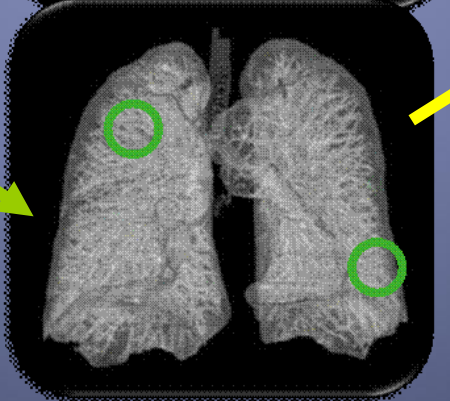
Combinazione delle
3 analisi



Analisi
CAD RGVP



Analisi
CAD VBNA



MAGIC-5 comboCAD

Combination procedure (from B. van Ginneken):

The findings of each CAD are considered in terms of their degree of suspicion p , which corresponds to the final output of the procedure of candidate nodules classification. These probabilities are normalized by associating to each p of a value $f(p)$:

$$f(p) = \frac{TP}{FP + TP + 1}$$

TP (FP): number of true (false) positives obtained by considering all the CAD findings with $p_i \geq p$ as positive.

The $f(p)$ values can be considered as the probability that a finding in the validation set with likelihood p or higher represents a true nodule.

$f(p)$ is computed for every finding from every sub-system.

All findings are then sorted so that $f_i, i=1 \dots n$ and $f_i \geq f_j$ if $i < j$.

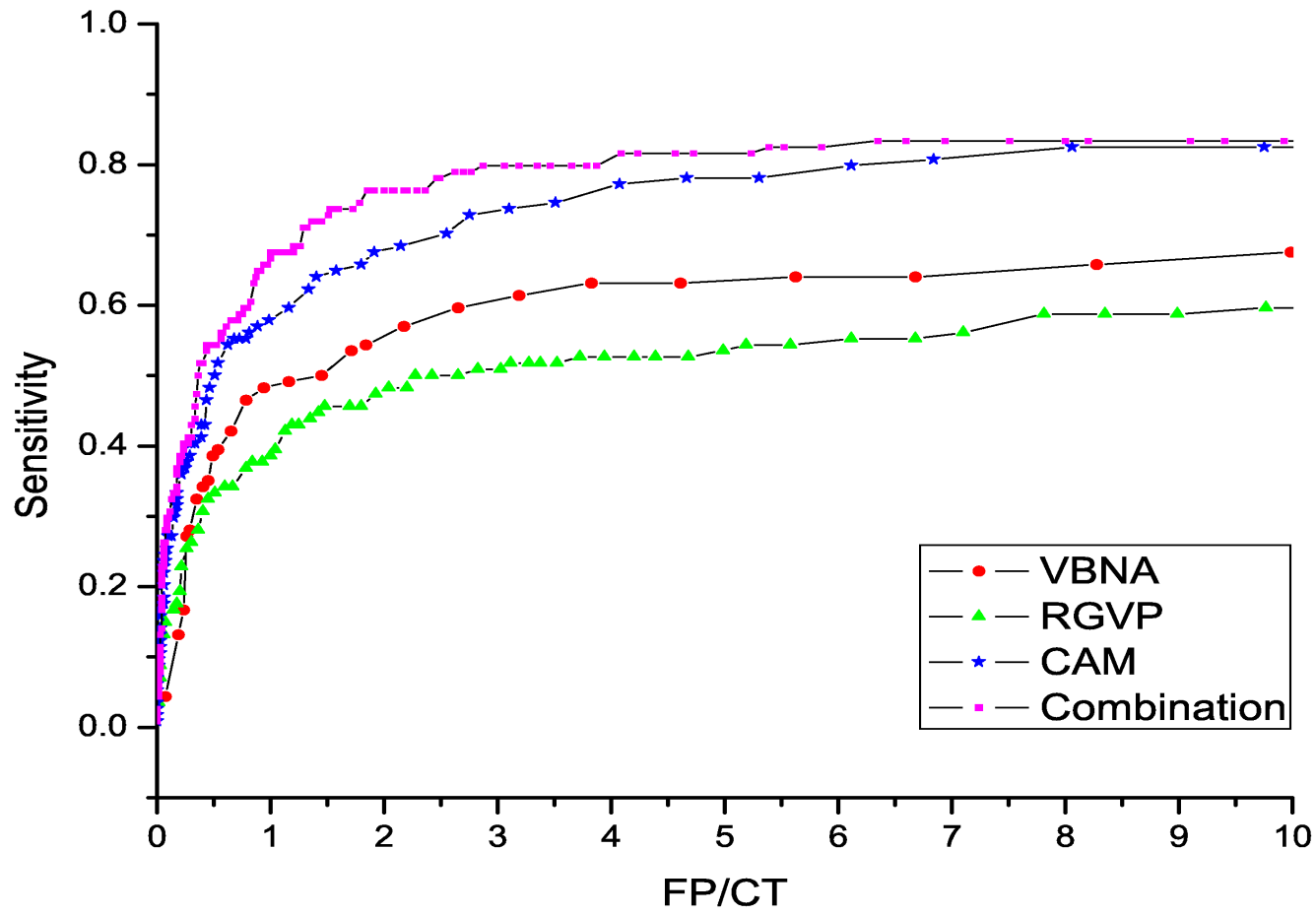
Starting at f_i with $i=1$, all findings f_j , $j = i + 1 \dots n$ are checked against a “matching condition” defined by the clustering distance (1.5 times the radius).

If two findings f_i and f_j match, $f_i = f_i + f_j$, is set and f_j is removed from the list of findings.

LIDC selected database

- Total: 138 CT scans from LIDC database.
 - Slice thickness: 0.5 mm - 2.0 mm.
 - Tube voltage: 120 kVp.
 - Tube current: 40 mA - 172 mA.
 - Pixel spacing: 0.434 mm - 0.762 mm.
 - Slices number: 154 - 730.
- Provided annotations:
 - From 4 independent radiologists in a two phase (blinded + unblinded) annotation procedure.
 - Nodules with diameter > 3 mm, non nodules (i.e. “false positives”) with diameter > 3 mm, nodules with diameter < 3 mm.
- MAGIC-5 chosen Gold Standard and datasets:
 - Nodules with diameter > 3 mm annotated by at least 2 radiologists.
 - Train dataset: 69 CTs containing 138 (96 internal and 42 juxtapleural) nodules.
 - Validation dataset: 69 CTs containing 114 (95 internal and 15 juxtapleural) nodules.

MAGIC-5 comboCAD



OsiriX plugin

Mode: MIP - Max Intens
11
Thick Slab
Movie Export
Sync
Propagate
Browse
Rate
3D Panel
iChat

Loop 10.0 im/s

412551 (74 y, 68 y)
LungLowDose — LungLowDose 1.25 B50f
305
3

150
-600
-1350

Zoom: 142% Angle: 0
Im: 275/347 S (I -> S)
Uncompressed
Thickness: 1.25 mm Location: -52.00 mm

P

1/5/06 9:50:14 AM
Made In OsiriX

CAD VBNA		CAD RGVP		CAD CAM		RAD findings		Combined CAD	
Number	ROI Prob	Number	ROI Prob	Number	ROI Prob	Number	Category	Number	ROI Prob
1	0.514...	1	0.735...	1	0.71895	1	Nodule	1	0.471...
2	0.62963	2	0.58728	2	0.762...	2	Nodule	2	0.618...
3	0.4	3	0.631...	3	0.681...	3	Irrelevant	3	0.518...
4	0.5	4	0.701...	4	0.607...	4	Irrelevant	4	0.447...
5	0.424...	5	0.545...	5	0.578...	5	Nodule	5	0.719...
6	0.583...	6	0.636...	6	0.769...	6	Irrelevant	6	0.416...
7	0.403...	7	0.545...	7	0.778...	7	Irrelevant	7	0.402...
8	0.871...	8	0.792...	8	0.786...	8	Irrelevant	8	0.638...
9	0.529...	9	0.530...						
10	0.530...	10	0.791...						
11	0.857...	11	0.963...						
12	0.409...	12	0.555...						
13	0.457...	13	0.585...						
14	0.478...	14	0.770...						

Hide CAD VBNA Hide CAD RGVP Hide CAD CAM Hide RAD Hide combined CAD

Framework radiologico: lung screening trials

Novembre 2010

U.S. National Lung Screening Trial (NLST) - più di 53000 soggetti

Lung cancer trial results show mortality benefit with low-dose CT

Twenty percent fewer lung cancer deaths seen among those who were screened with low-dose spiral CT than with chest X-ray

NLST trial

- 33 centers
- Low dose CT versus RX
- 55 - 74 y
- > 30 pack/y
- 53456 participants randomized by sex, age, place
- 20% overall mortality reduction

Framework radiologico: lung screening trials

Italian trials



Pisa, ottobre 2010 - 2011

Lo screening per il tumore del polmone: stato dell'arte.
Consensus meeting Italiano

Pisa, 3 marzo 2011

Azienda Ospedaliero-Universitaria Pisana
Dipartimento Cardiotoracico e Vascolare
Edificio 10, 2° piano, Aula Dipartimentale, percorso 5
Via Paradisa, 2



Studio italiano sullo screening per il cancro del polmone con tomografia computerizzata

- ITALUNG (2FI, PI, PT)
- DANTE (MI, Humanitas)
- MILD (MI, Istituto Tumori)
- COSMOS (MI, IEO, Giulia Veronesi)
- I-ELCAP (RO, Regina Elena, Salvatore Giunta, also with CAD)

Framework radiologico: lung screening trials



**International workshop on lung cancer
screening randomised trials.
State of the art in Europe after the early
stop of the US NLST trial**

Pisa (Italy), 4th March, 2011

University-Hospital of Pisa
Cardio-thoracic and Vascular Department
Building no. 10, 2nd floor, Conference Room, path no. 5
Via Paradisa no. 2



Italian lung cancer CT screening trial

European trials

- Nelson Study (The Netherlands)
- DLCST (Danish Lung Cancer Screening Trial)
- UK study
- German Study

Framework radiologico: lung screening trials

Verso un documento di consenso delle Società Scientifiche

Moderatori: B. Terracini, A. Cristaudo

14.30 Gli esposti ad amianto e i cancerogeni
occupazionali: quale prevenzione
secondaria?

B. Terracini, A. Cristaudo

14.55 Valutazione costi-benefici

M. Zappa

15.15 Prevenzione primaria e screening

G. Gorini, F. Pistelli

15.40 Proposta di Consenso Italiano

U. Pastorino

Implications of the NLST results for European trials and screening programs

Chairmen: A. Santoro, M. Mascalchi

15.55 New guidelines in US?

R. Smith

16.15 Who is at high risk?

O. Raji

16.35 Smoking cessation and screening

L. Carrozzi

16.55 Proposal for the European trials: how
to proceed

H.J. de Koning

17.15 Italian consensus

U. Pastorino

17.35 Discussion

Lavori “lung CAD x lung screening” in corso

- First test of different CAD trained and validated by means of the same datasets
 - Overall results very good: 80% of sensitivity at 3 FP/CT with GS at two radiologists.
 - Confirmed and enforced the ANODE09 results about CADs combination.
- Further investigations
 - Performance vs clustering distance (CAPESTRO condition too restrictive?).
 - Detailed analysis of the 2 CADs combinations and possible improvements.
 - Volumetric analysis.
 - Performance with other database (ANODE09 for RAD+CAD validation).
 - CAD + RAD validation.

MAGIC-5 expertise in ambiente radiologico

CAD in PUBMED 1980 - 2010:

U.S.A.: 547

Italia: 58.

MAGIC-5:2001: 1 mammo

2005: 3 mammo

2006: 1 mammo

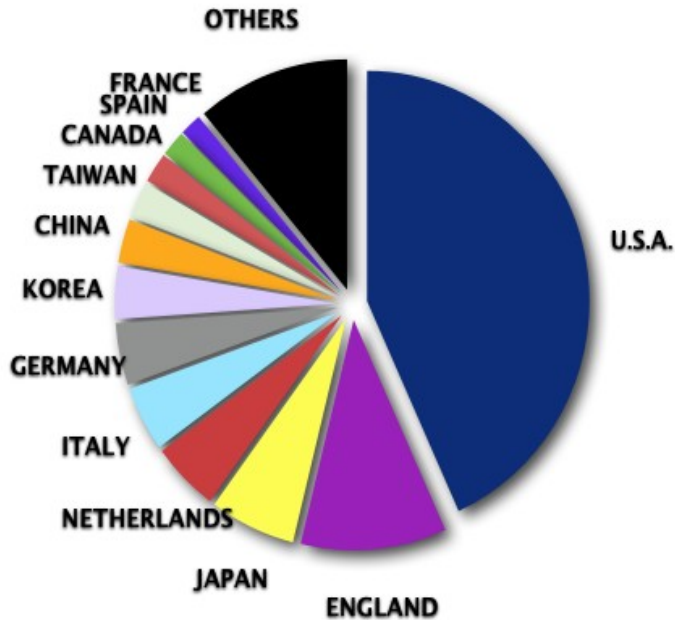
2007: 1 mammo, 1 lung

2008: 1 mammo, 1 lung

2009: 3 lung, 1 neuro

2010: 1 lung

- 2011 lung: 2 published non PUBMED, 1 accepted and 1 submitted PUBMED, 2 to be submitted PUBMED.



MAGIC-5 expertise in ambiente radiologico

Best results in ANODE09 competition

ANODE09 <http://anode09.isi.uu.nl>

Comparing and combining algorithms for computer-aided detection of pulmonary nodules in computed tomography scans: the ANODE09 study

Bram van Ginneken¹, Samuel G. Armato III², Bartjan de Hoop³, Saskia van de Vorst³, Thomas Duindam¹, Meindert Niemeijer¹, Keelin Murphy¹, Arnold Schilham¹, Alessandra Retico⁴, Maria Evelina Fantacci^{4,5}, Ilaria Gori⁶, Shoji Okura⁷, Takuya Tomida⁷, Hiroshi Fujita⁷, R. Bellotti⁸, F. De Carlo⁸, Bruno Golosio⁹, L. Bolaños¹⁰, Piergiorgio Cerello¹⁰, E. Lopez Torres¹¹, Mathias Prokop³

CARS (Computer Assisted Radiology and Surgery):

- **Berlino 1985** : prima edizione.
- **Ginevra 2010** : 12000 iscritti da 45 nazioni, più' di 600 abstract, selezionati 190 oral (1 MAGIC-5) e 150 poster, 9 demo su invito (1 MAGIC-5).

Berlino 2011 : 1 oral, 1 poster, 1 demo MAGIC-5.

2012: CARS @ Pisa

CARS 2009



SPIE 2010

Certificato
Di merito



Altre applicazioni e prospettive lung

“Oncological screening”

- Search for lung metastasis in oncological patients: comboCAD?
- Full dose CTs already available from Pisa and Roma and preliminary tests done with VBNA-CAD.

New efforts in lung cancer screening

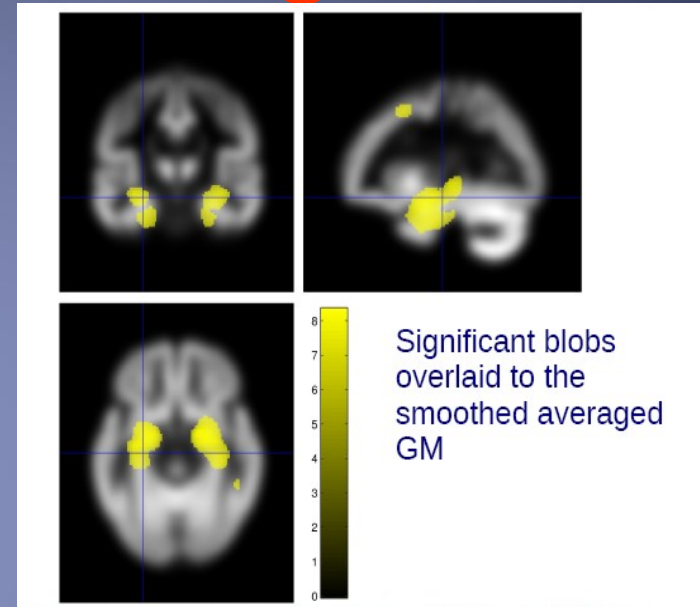
- Tomosynthesis for lung cancer screening with lower dose: new approach?
- Service “CAD on demand” in the new screening protocols?

Other applications

- Automatic segmentation for ARDS (Acute Respiratory Distress Syndrome), images already available from Milan and Pisa and preliminary tests done.
- Silicosis (multiple micronodule analysis in dust exposed people), collaboration with Nijmegen University, work almost finished.

Analisi di neuroimmagini

VBM (Voxel Based Morphometry) preliminar analysis of 30 AD (Alzheimer's Disease), 30 MCI (Mild Cognitive Impairment), 30 HC (Healthy Controls) subjects to identify significant local GM (Grey Matter) differences by means of a SPM (Statistical Parametric Map) in MRI images from ADNI database.



Complete study (VBM analysis + Support Vector Machines-Recursive Feature Elimination classification) of morphometric alterations in structural MRI of children with autism spectrum disorder.

2011: application of the same approach to the whole ADNI database already studied with other methods by MAGIC-5 researchers.

Manpower e necessità 2012 @ PISA

- **Manpower:**

- M. Barattini (spec. UNIFI)
- S. Delle Canne (Fis. San. Fbf-it) (?)
- M.E. Fantacci (ric. UNIFI)
- I. Gori (dip. Bracco Imaging SpA)
- A. Retico (ric. INFN)
- 2011: F. Bagagli e S. Trombella (laureandi)

- **Necessità economiche per il 2012:**

- **MI: 3 keuro** (riunioni e contatti con gli ospedali, conference fee per il CARS 2012).
- **ME: 2 keuro** (Ginevra e Nijmegen).
- **Consumo: 1 keuro** (metabolismo).

- **Spazio:** per noi e per i nostri computers.
- **Servizi:** calcolo (a livello ticket).