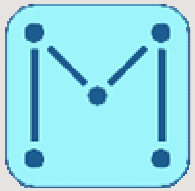



# *The MAGIC-5 CAD System for Lung Nodule Detection in Thorax CT Images*

**Giorgio De Nunzio**
**University of Salento & INFN (Italy)**
**on behalf of the MAGIC-5 Collaboration**

# *MAGIC5*
# Medical Application on a Grid Infrastructure Connection

The Project aims at developing a research plan to study models and algorithms for a distributed analysis of biomedical images, by making use of the GRID services.

**The main purposes are:**

1. **to support the radiologist's diagnosis by providing algorithms able to automatically detect pathological structures;**
2. **to improve computational speed, data accessibility and sharing of database of distributed images.**

# MAGIC-5

## (Medical Applications on a GRID Infrastructure Connection)

### Computer Assisted Detection (CAD)
### Distributed Computing Infrastructure (GRID)

The Project is funded by INFN - the Italian National Institute of Nuclear Physics - and coordinated with hospitals and Universities

6 Research Groups in Italy (Bari, Genova, Lecce, Napoli, Pisa, Torino, ~ 40 Researchers)

Medical (Imaging) Applications

- Analysis of Digital Images
  - **Mammography (breast cancer, 2002 -> 2006)**
  - **Lung CTs (nodules, 2004 ->)**
  - **Brain MRIs (Alzheimer's Disease, 2006 ->)**

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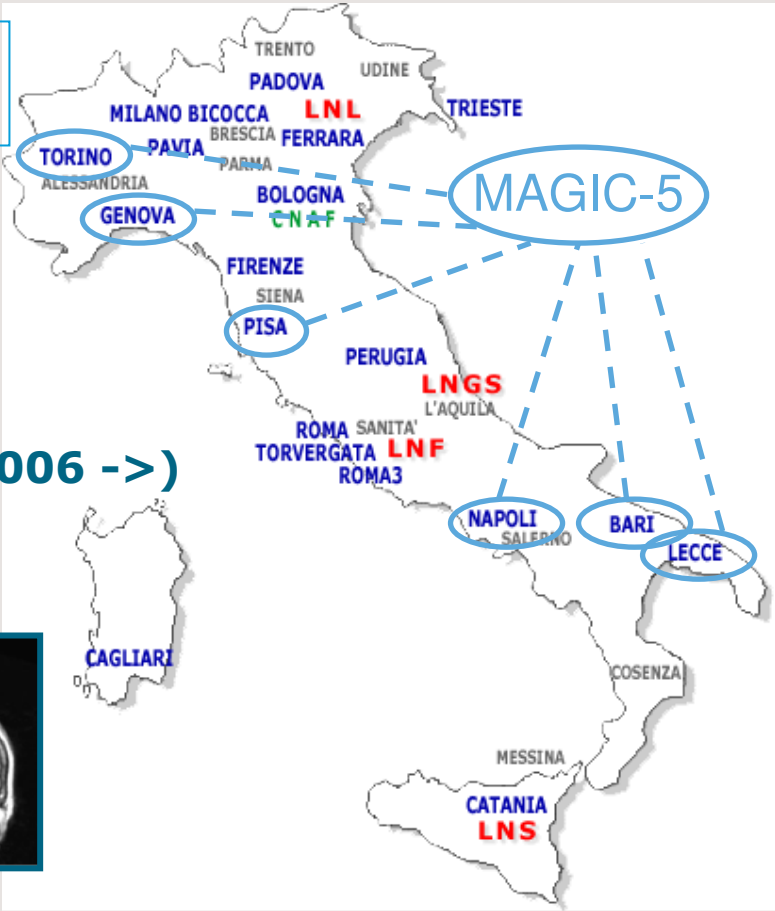
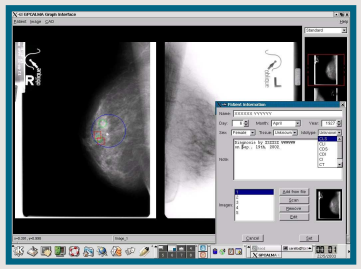
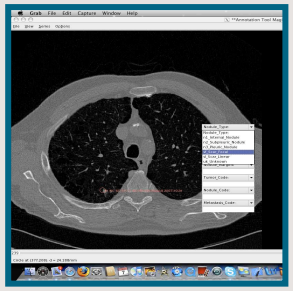
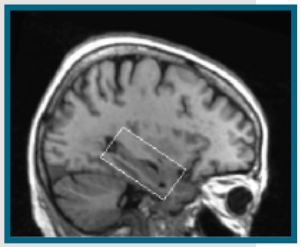
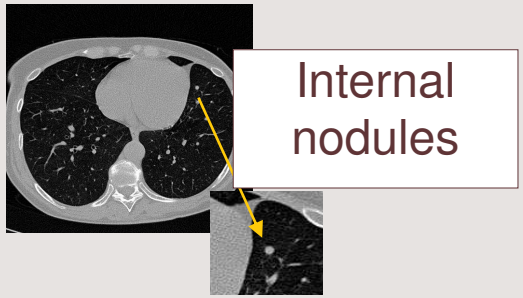


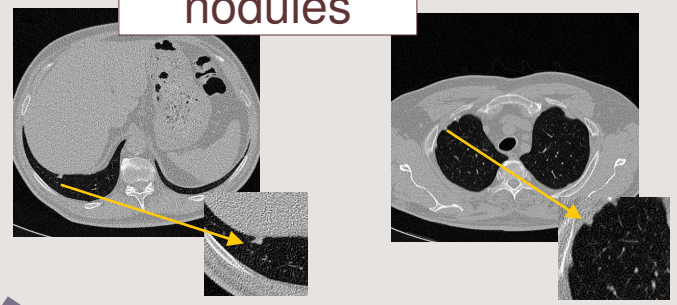




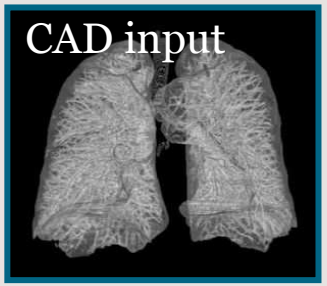
# Lung CAD Systems: the goal



Internal nodules

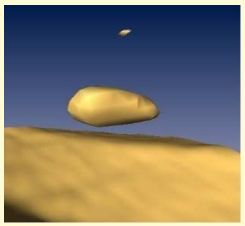


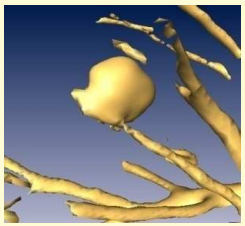
Juxtapleural nodules



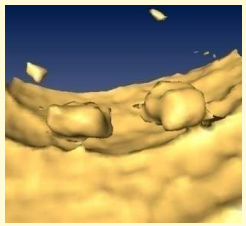
CAD input

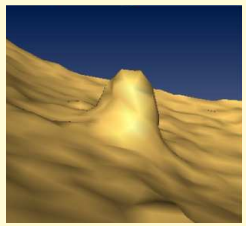
**internal nodule detection**

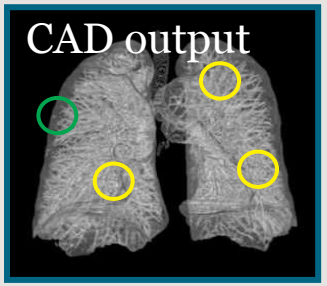




**juxtapleural nodule detection**







CAD output

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# The general strategy

- CT scan databases:
  - Low-dose helical multi-slice CT: slice-thickness <= 1.25 mm
  - Annotation by 1 or more radiologists (up to 4)
    - Nodules of radius > 3, 4, 5 mm according to the different protocols
    - Agreement sometimes ~ 60% between radiologists
- Lung Segmentation
  -> Lung Volume
- Nodule-Candidate Detection (4 parallel developments)
  -> list of ROIs
- Feature Extraction, and Classification
  -> list of ROIs with probabilities
- Results and Validation

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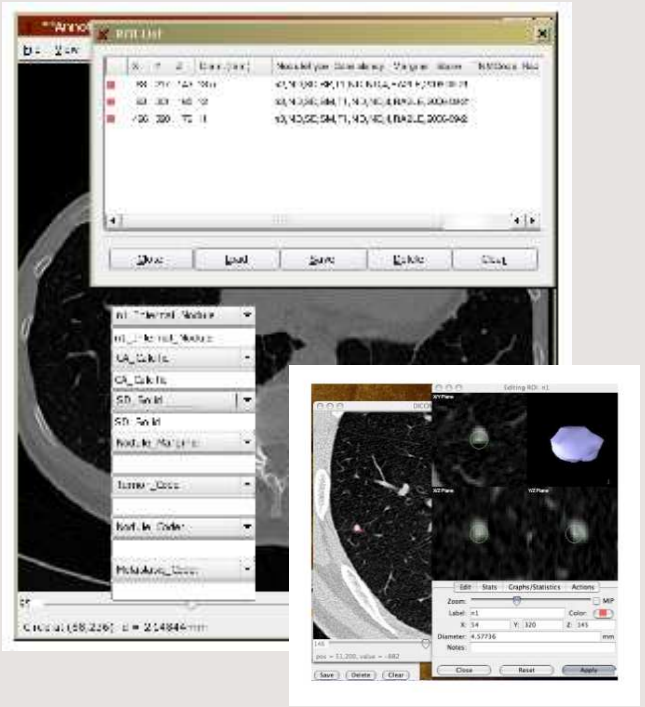
# Databases



- The MAGIC-5 database
  - 163 CT scans in DICOM format (~ 250-400 slices, 512x512x2 bytes each)
  - Lung Nodule Annotation (LUNA) tool developed
  - Annotation by 2 to 4 radiologists (nodules with diameter > 5 mm)
- LIDC
  - https://imaging.nci.nih.gov/ncia/login.jsf
  - hundreds of lung CT scans (rapidly increasing), with annotations by 1, 2, 3, 4, radiologists
  - nodules: > 3 mm diameter

NBIA National Biomedical Imaging Archive

- ANODE09
  - http://anode09.isi.uu.nl/
  - 5 (50) scans with (without) annotation
  - nodules > 4 mm diameter

ANODE09

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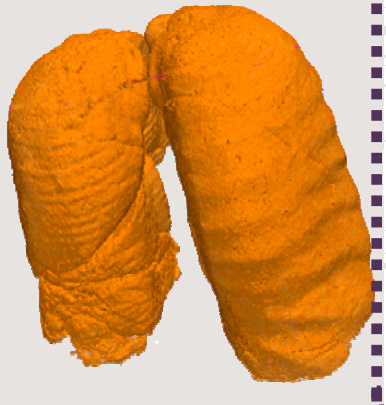
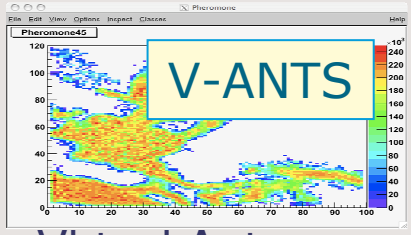
# MAGIC-5 Lung CAD Syntesis

Lung Segmentation → Nodule-Candidate identification → Nodule-candidate Feature extraction → Nodule-candidate Classification




Region Growing




Virtual Ants


3D Multiscale Gaussian Filter

≈ 15 discriminating features

Volume,

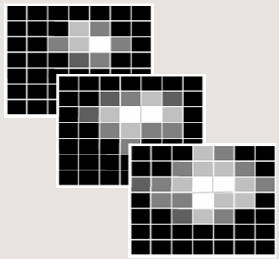
Sfericity,

Ellipticity,

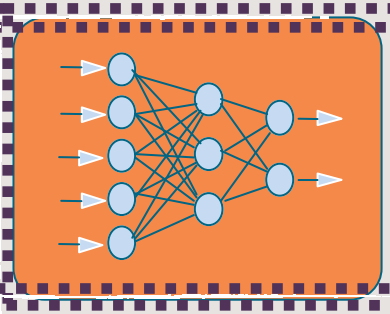
Compactness,

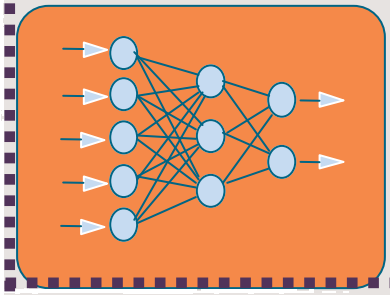
Shannon's Entropy,

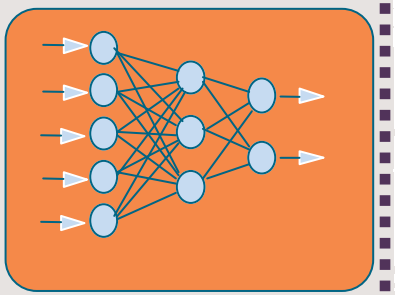
…



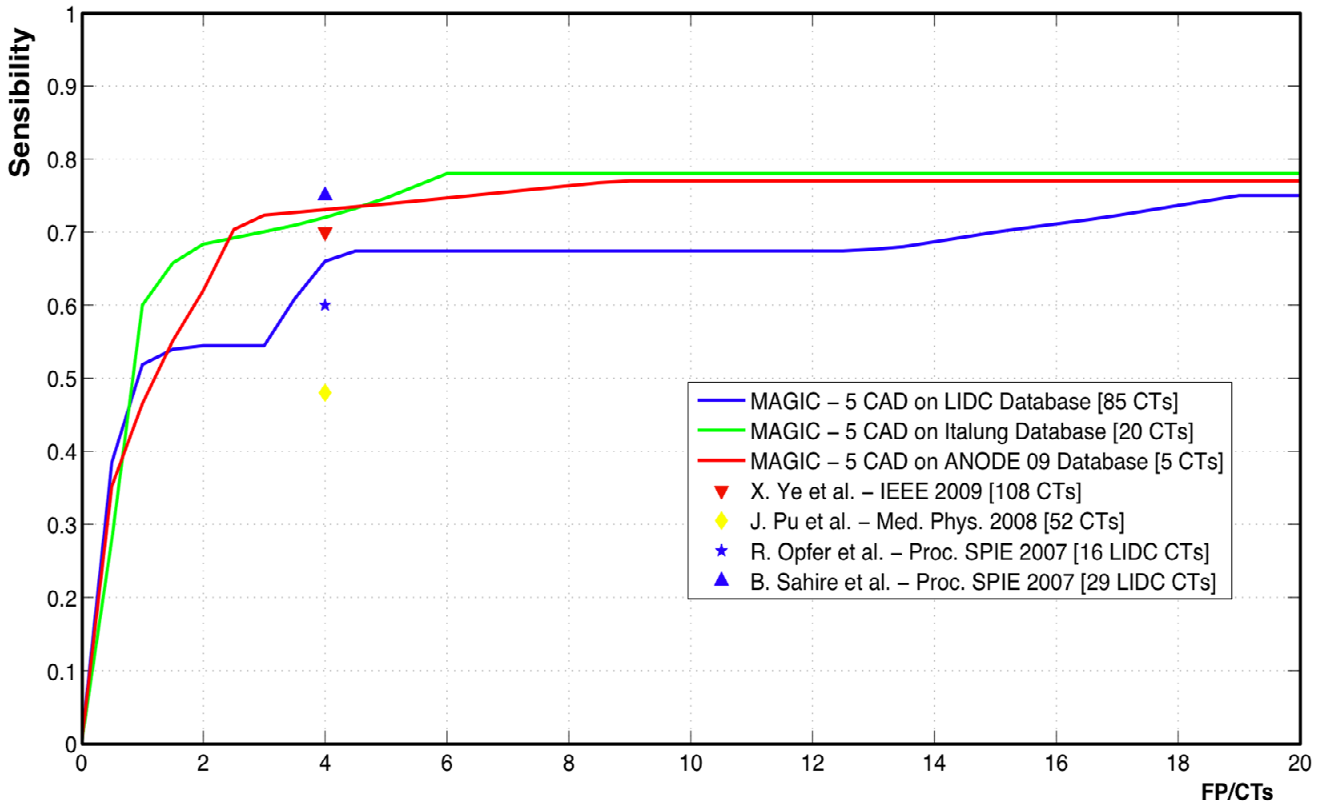
Voxel Based Analysis







# Best results




Three parallel approaches to lung nodule detection

CADs can be combined (work in progress, with good results)

The ANODE09 challenge showed that they are competitive

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[3] Retico A, Delogu P, Fantacci ME, Gori I, Preite Martinez A. Lung nodule detection in low-dose and thin-slice computed tomography, Comput Biol Med. 2008 Apr;38(4):525-34

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[6] Cerello P, Cheran SC, Bagnasco S, Bellotti R, Bolanos L, Catanzariti E, De Nunzio G, Fantacci ME, Fiorina E, Gargano G, Gemme G, Torres EL, Masala GL, Peroni C, Santoro M,., 3-D Object Segmentation using Ant Colonies, Pattern Recognition (2009), doi:10.1016/j.patcog.2009.10.007