

M5L Lung: a WEB- and Cloud-based Computer Aided Detection (CAD) system for the automatic detection of pulmonary nodules

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1. The algorithms

M5L is the combination of two independent CAD sub-systems: the Channeler Ant Model (lungCAM) and the Voxel-Based Neural Approach (VBNA). These two algorithms have a common starting point, which is the parenchymal volume, obtained with a 3D region growing segmentation algorithm, that also excludes the trachea and separates the two lungs [1]. The CAD system has been trained using 67 scans from the LIDC data-set.

1.1 The Lung CAM

This algorithm is based on the reproduction of the life-cycle of colonies of virtual ants [2], released from an anthill with the capability to move along the 3D space determined by the lung volume in the CT. The motion is accompanied by the release of pheromone traces along the ant path. The CT voxel intensity is interpreted as the amount of food available to the ants and is progressively reduced by the ant feeding. The evolution of the colony is determined by a set of rules, which define how ants move, the released amount of pheromone and the cycles of reproduction and death. The algorithm ends when all the ants in the colony have died. The output of this stage is a pheromone map, a collection of segmented objects, which are classified by means of a feed-forward artificial neural network with 13 input features. The lungCAM algorithm detects both pleural and internal nodules.

1.2 The VBNA CAD

This algorithm makes use of two different procedures to detect nodules inside the lung parenchyma (CADI) [3][4] and nodules attached to the pleura (CADJP) [5]. The former method models nodules as spheres with a 3 Gaussian profile, where the center of the sphere is chosen to be corresponding to a local maximum in the voxel intensity. The CADJP method builds normals to the pleura surface and each voxel gets a score depending on the number of normals crossing it. Before combining the

CADI and CADJP results, nodule candidates are separately classified by a Support Vector Machine (SVM) using more than 100 voxel-based input features, that include information about grey levels and morphology.

2. The M5L on-demand system

In order to make M5L easily available to radiologists without any requirement on their hardware and software tools, a web-based interface has been designed and implemented. Furthermore, in order to guarantee flexible access to computational resources, a Cloud Computing facility was setup. The preliminary concept version, presented for the first time at the demo session of the CARS 2011 Conference [6], then evolved into the M5L on-demand system (<http://m5l.to.infn.it>), which is composed by the following modules:

- The Web front-end, designed to provide radiologists with the functionality to exchange imaging studies and compare diagnoses on the same studies, handles the CT submission, the on-line insertion of the medical review and the access to CAD results.
- The cloud computing back-end, conceived to guarantee flexibility in the access to the available computing resources (i.e. virtual machines) according to the user requests, handles the algorithms execution.

A similar concept was also recently proposed as possible future development [7].

References

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