Lung Nodule Annotation

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Diagnostic decision-making in medical imaging by radiologists has been augmented by computer-aided diagnosis (CAD) systems. Several CAD systems have been developed to help estimate the probability of lung cancer based on nodule characteristics and some clinical information. We study the relationships between radiologists' subjective assessments for nodule characteristics and image features computed from the region of interest with the final goal of integrating these relationships in the CAD systems.

Goals:

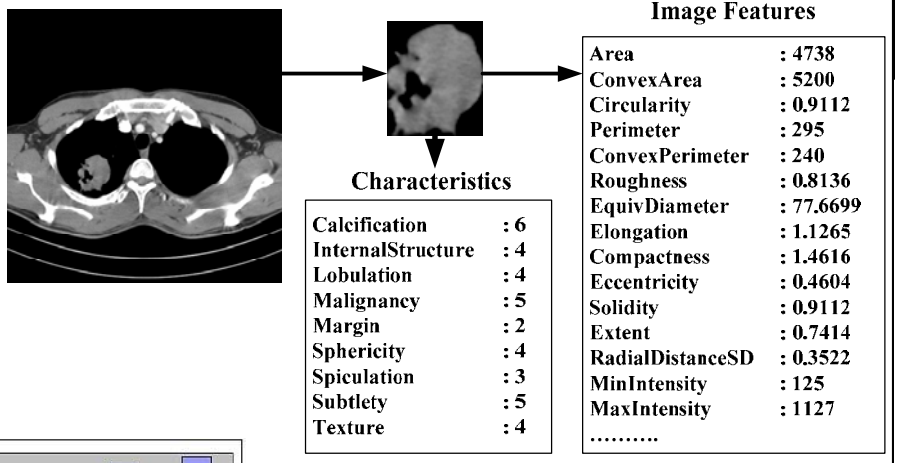
- Determine the relationship between physical nodule characteristics and their annotations.
- Understand how radiologists rate nodules.
- Create content and semantic-based image retrieval systems to help educate future radiologists.

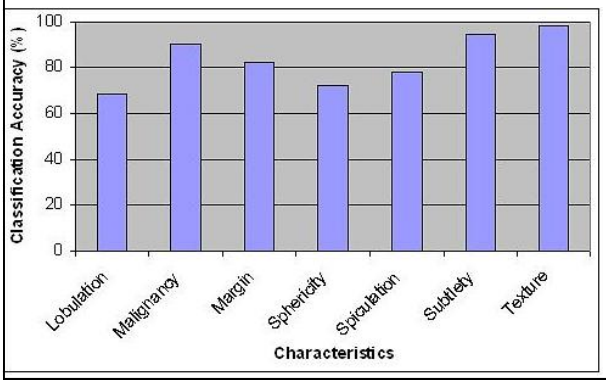
System Characteristics:

- Provide probabilistic annotation for lung nodule semantics based on low-level image features
- Increase radiologists' ability to interpret lung nodules efficiently
- Reduce interpretation variability among observers

Example of nodule characteristics assigned by a radiologist and low-level features.

Nine nodule characteristics were provided by each radiologist and 64 image features were computed from each segmented nodule image.





Accuracy Results

From prediction rules learned from decision trees, we can accurately predict the rating of Malignancy, Margin, Subtlety, and Texture with accuracies greater than 80%. Lobulation, Sphericity, and Spiculation are all based off of the nodule's shape and boundary which were not captured well by our morphological shape features.

Applications:

As shown in the table to the right, using a set of rules governed by a complete lung nodule ontology, one can accurately classify nodule characteristics. This framework can be applied to other soft tissues to help radiologists determine a tumor's malignancy.

How you can contribute:

- If you are a trained radiologist we would like you to look at our results and provide feedback.
- We could use people who have experience with or are willing to learn about active learning classifiers.
- We need software engineers and programmers to implement a practical system from this prototype.

Selected publications:

- W. Horsthemke, E. Varutbangkul, D.S. Raicu, and J.D. Furst, "Predictive Data Mining for Lung Nodule Interpretation", The 7th IEEE ICDM'07 Workshop on Data Mining in Medicine, Ohmaha, NE, USA, Oct. 28-31, 2007.
- M. Lam, T. Disney, D. Raicu, J. Furst, D.S. Channin, "BRISC—An Open source Pulmonary Nodule Image Retrieval Framework", Journal of Digital Imaging, 2007.
- W. Horsthemke, D.S. Raicu, and J.D. Furst, "Task-Oriented Medical Image Retrieval", MICCAI'07 Content-based Image Retrieval Workshop, Brisbane, Australia, October 2007.
- M. Muhammad, D. Raicu, J. Furst, E. Varutbangkul, "Texture versus Shape Analysis for Lung Nodule Similarity in Computed Tomography Studies", SPIE Medical Imaging Conference, San Diego, CA, February 2008.

Table 1:
Predicting rules for Subtlety along with possible ratings and their probabilities

Ratings	Rules
1 (Extremely Subtle)	IF both the minor axis length and the maximum intensity are small THEN subtlety = 1 Pr (1) = 1.00
4 (Moderately Obvious)	IF the minor axis length is low but the maximum intensity is high THEN subtlety = 4 Pr (4) = 0.94 Pr (5) = 0.06
5 (Obvious)	IF the minor axis length is high THEN subtlety = 5 Pr (5) = 0.99 Pr (4) = 0.01

* *Minor axis length* is the length of the minor axes of the ellipse that has the same normalized second central moments as the segmented nodule image
* *Maximum intensity* is the maximum value of the gray-level intensity in the segmented nodule image

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http://facweb.cs.depaul.edu/research/vc
e-mail our advisors,
Dr. Raicu (DStan@cti.depaul.edu) and
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Or attend one of our visual computing seminars, held every other Friday,
starting January 11th from 2:30-3:30 in room 610 (CTI)

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