

CANARY Segmentation of Lung Adenocarcinoma

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Abstract

Computer-Aided Nodule Assessment and Risk Yield (CANARY) is a novel computed tomography (CT) tool developed at Mayo Clinic (Rochester, MN) that characterizes early lung adenocarcinoma by detecting nine distinct voxel classes, representing a spectrum of lepidic to invasive growth, within an adenocarcinoma. CANARY characterization has been shown to correlate with ADC histology and patient outcomes.

This protocol provides basic instructions for segmentation of lung adenocarcinoma on CT imaging. CANARY has been validated in lung adenocarcinomas less than 3cm in diameter

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Protocol

Finding the nodule

Step 1.

Scroll up and down in axial view to identify the pulmonary nodule. Scroll through the entirety of the lungs to ensure you are not missing a nodule. (Keep the CT image in “lung view”, i.e. Do not change the image view to “soft tissue” if trying to differentiate between solid and sub-solid tissue).

Finding the nodule

Step 2.

Click the axis tool (defined below) and place it over the nodule so that you can see it in all three views (axial, sagittal, and coronal).

Finding the nodule

Step 3.

Click the nodule, and a box will be placed around it with the rest of the screen in red.

Finding the nodule

Step 4.

Ensure the entirety of the nodule is enclosed within the box in all three views. Adjust the box dimensions by clicking and dragging the border to the desired location.

Establishing the nodule perimeter

Step 5.

If the nodule abuts the pleura or mediastinal structures, exclude these tissues as much as possible from within the box. You can expand the nodule perimeter after it has been established by the software, but it can take a great deal of time to erase tissue that you do not want included in the analysis.

Establishing the nodule perimeter

Step 6.

The Wall function may also be used to exclude tissue from the chest wall. Draw a line along the chest wall, clicking once to create distinct points along the line. At the last point, double click to finish the line. Scroll through the CT slices that involve the lung nodule. Adjust the line by moving its distinct points to ensure that the chest wall is appropriately excluded.

Establishing the nodule perimeter

Step 7.

Click "Get nodule mask".

Establishing the nodule perimeter

Step 8.

A red ROI will appear around the perimeter of the nodule. (Pressing the letter "T" will toggle the mask on and off from the screen, but not permanently remove it.)

Establishing the nodule perimeter

Step 9.

Scroll through the slices and adjust the mask with the tools below.

Establishing the nodule perimeter

Step 10.

Use the "Nudge" function under the REFINE tab to adjust the perimeter of the nodule.

- i. Holding down the middle mouse key will enable you to change the size of the Nudge tool.
- ii. If the cursor is within the mask when you begin to nudge, it will EXPAND the mask.
- iii. If the cursor is outside of the mask when you begin to nudge, it will SHRINK the mask.
- d. The Trace function can be used to include tissue of interest into the mask. Draw a line around the tissue, connecting the start and end points of the line to the original mask.

Establishing the nodule perimeter

Step 11.

Once finished with all adjustments of ROI, click "Classify nodule".

Establishing the nodule perimeter

Step 12.

Once nodule has been classified for the first time, the "edit nodule" & "delete nodule" buttons can be

used to adjust the ROI.

Tools

Step 13.



Tools

Step 14.

Camera tool: Will take a screen shot of the CT scan and import the image to the final report generated for each nodule.

Tools

Step 15.

Ruler tool: measure structures using cursor.

Tools

Step 16.

Note tool: Enables you to label structures with a small yellow “sticky note” using the cursor. Right click for options on using the note.

Tools

Step 17.

Axis tool: Locks axial, sagittal, and coronal views so that you can scroll through the images in a coordinated fashion.

Data Extraction

Step 18.

Clicking "Classify" will save the CANARY data every time in the same Excel file.

Data Extraction

Step 19.

The Excel data file can be found by opening the C drive: Temp folder: CANARY-Plus folder: “CANARY-PlusTumorStats”.

Data Extraction

Step 20.

Data from each CT case is listed in a row.

Data Extraction

Step 21.

Seed, X, Y, Z columns indicate the position of the cursor when the nodule mask was set.

Data Extraction

Step 22.

Letters V (violet), I (indigo), B (blue), G (green), Y (yellow), O (orange), R (red), C (cyan), and P (pink) represent the 9 colors shown in the “Classify nodule” analysis wheel. The numbers in these columns represent the volume (mm³) of the nodule that is assigned to each color classification.

Data Extraction

Step 23.

Ensure that the CANARY-PlusTumorStats file is closed whenever segmentation is being performed. Otherwise, new data will not import into the Excel file.