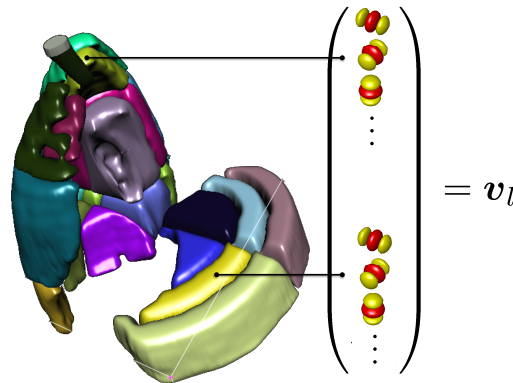
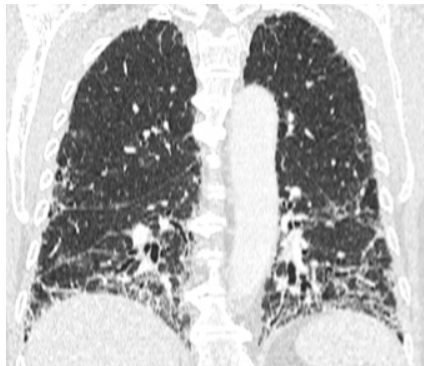


A computerized score for the automated differentiation of usual interstitial pneumonia from regional volumetric texture analysis

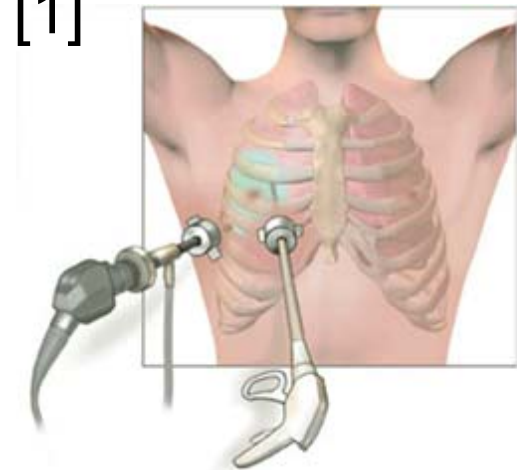
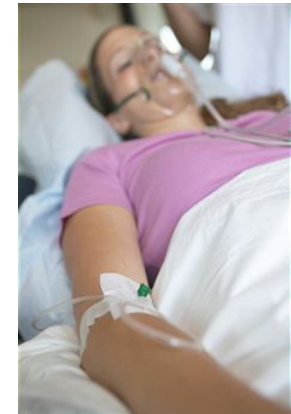
Adrien Depeursinge, Anne S. Chin, Ann N. Leung, Glenn Rosen, Daniel L. Rubin



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Idiopathic pulmonary fibrosis (IPF)

- Most **common** type of interstitial lung disease (ILD)
- Confounding diagnoses of ILDs: >150!
 - Sarcoidosis, non-specific interstitial pneumonia, ...
- **Multidisciplinary** approach between experts in pulmonology, pathology and chest radiology [1]
- Often requires a surgical **biopsy**
 - Costly, invasive and risky:
 - *Hemorrhage, lung collapse*
 - *Acute **exacerbation** of the lungs [2]*



[1] Raghu et al. An official ATS/ERS/JRS/ALAT statement: Idiopathic pulmonary fibrosis: Evidence-based guidelines for diagnosis and management. American Journal of Respiratory and Critical Care Medicine, 183(6):788–824, 2011.

[2] Lynch et al., Usual interstitial pneumonia: Typical and atypical high-resolution computed tomography features, Seminars in ultra-sound, CT, and MR, 35(1):12–23, 2014.

Radiology: usual interstitial pneumonia (UIP)

- Lung biopsy can be **obviated** when the clinical and **radiographic** (CT) impression are clearly suggestive of UIP [1]

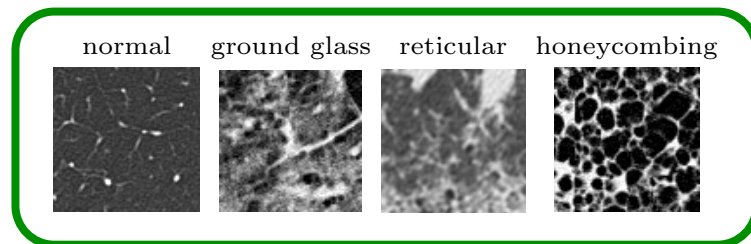
Classic UIP (all required)

- Peripheral, basal predominance
- Reticular abnormality
- Honeycombing with or without traction bronchiectasis
- Absence of features listed as inconsistent with UIP pattern

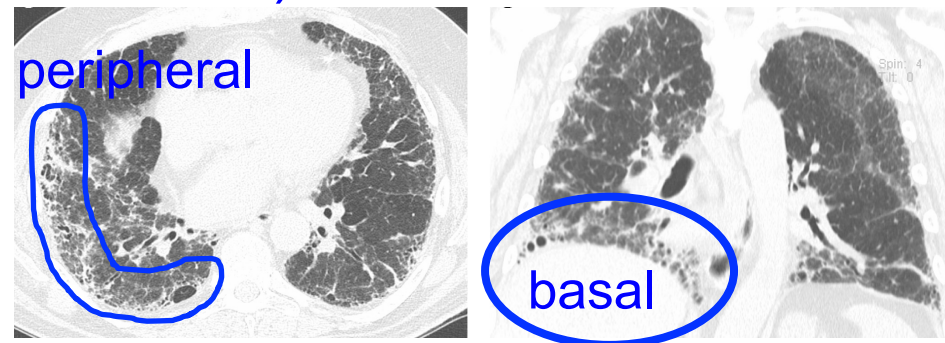
Inconsistent with UIP (any)

- Upper or mid-lung predominance
- Peribronchovascular predominance
- Extensive ground glass abnormality (extent > reticular abnormality)
- Profuse micronodules (bilateral, predominantly upper lobes)
- ...

A) tissue type



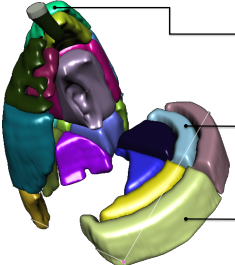
B) tissue location



[1] Raghu et al. An official ATS/ERS/JRS/ALAT statement: Idiopathic pulmonary fibrosis: Evidence-based guidelines for diagnosis and management. American Journal of Respiratory and Critical Care Medicine, 183(6):788–824, 2011.

Objectives and experimental setup

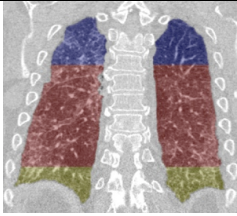

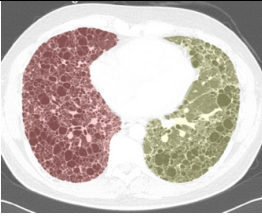



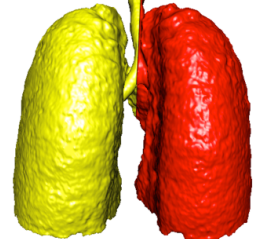

- **Computer-aided diagnosis** for **identifying classic UIPs**:
 - No biopsy required for them!
- Derive a **score** from **regional volumetric texture analysis**
 - 3-D texture analysis
 - Basic anatomical atlas
- **33** patients with biopsy proven IPF
- Volumetric multiple detector CT (MDCT)
 - Acquired within the year of the biopsy
- Gold standard: **consensus** of two thoracic radiologists with more than 15 years of experience with ILDs
 - **15** patients with **classic UIP** versus **18** patients with **atypical UIP**



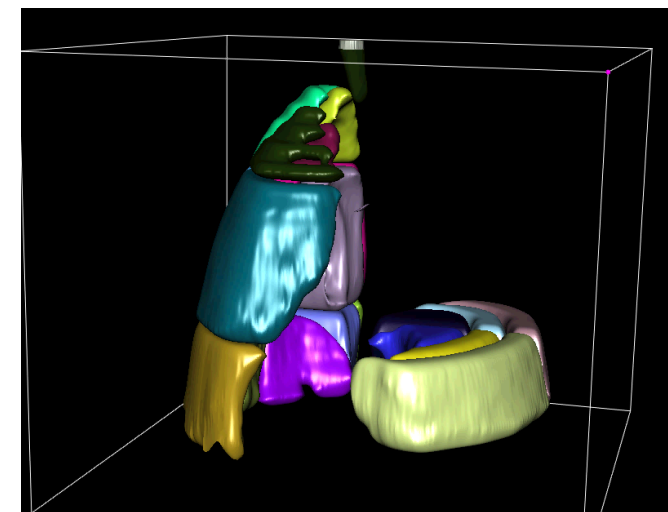
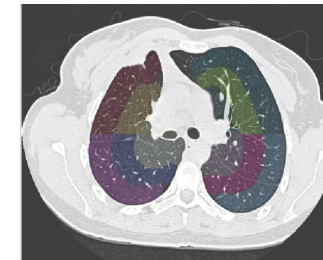
$$\left(\begin{array}{c} E \left(\mathcal{R}^{(n_1, n_2, n_3)} \{f\} (\mathbf{x}_1) \right)_{j=1, \dots, 4} \\ \vdots \\ E \left(\mathcal{R}^{(n_1, n_2, n_3)} \{f\} (\mathbf{x}_i) \right)_{j=1, \dots, 4} \\ \vdots \\ E \left(\mathcal{R}^{(n_1, n_2, n_3)} \{f\} (\mathbf{x}_{36}) \right)_{j=1, \dots, 4} \end{array} \right) = \mathbf{v}_l$$

Simple 3-D digital atlas of the lungs

- The lungs are **split** perpendicularly to 4 axes [3]

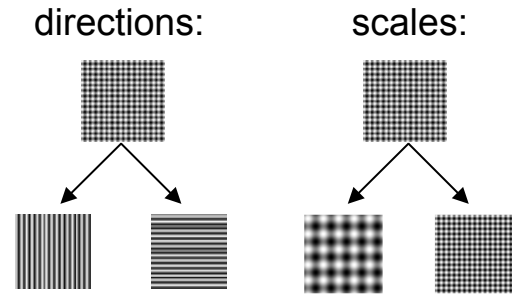
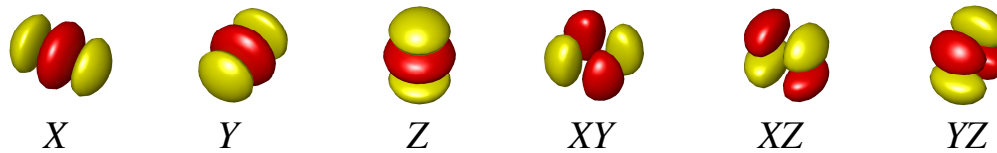
⊥ vertical	⊥ axial	⊥ coronal	⊥ sagittal
apical, central, basal	peripheral, middle, axial	left, right	anterior, posterior
			
			

intersections: **36 subregions**

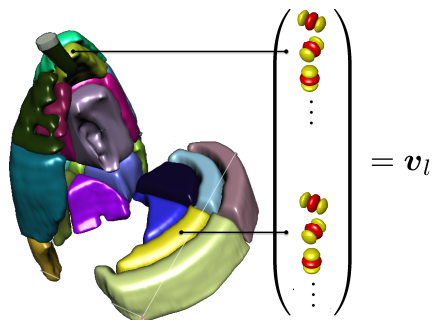


Regional features and **score**

- **Texture**: 3-D Riesz filters [4]
 - quantify the local amount of **directional** image patterns at multiple **scales**:

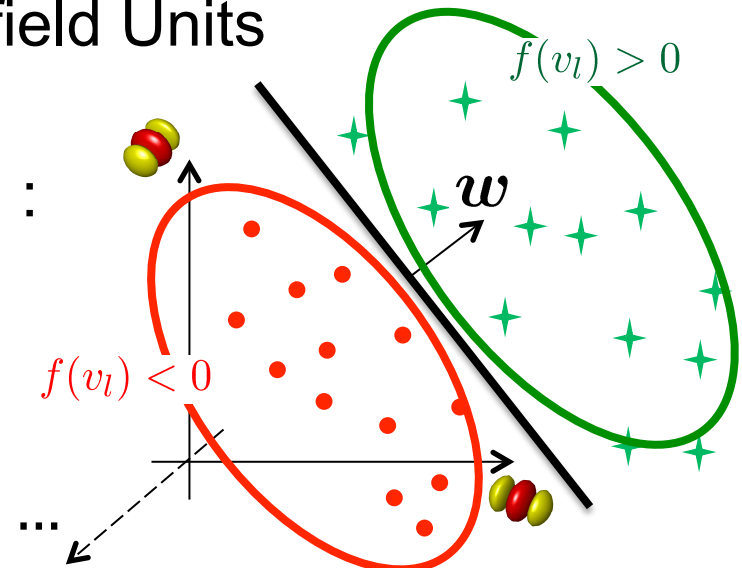


- **Intensity** hist. in $\{-1000; 600\}$ Hounsfield Units
 - 15 hist. bins
- Feature aggregation and **score** $f(v_l)$:



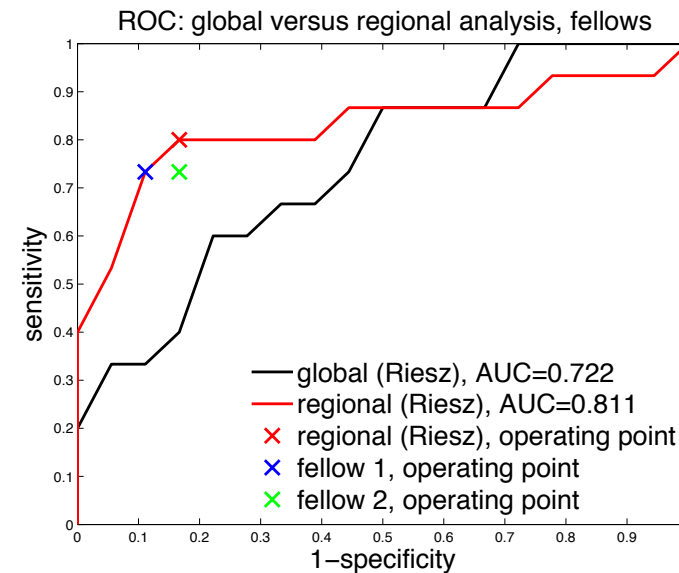
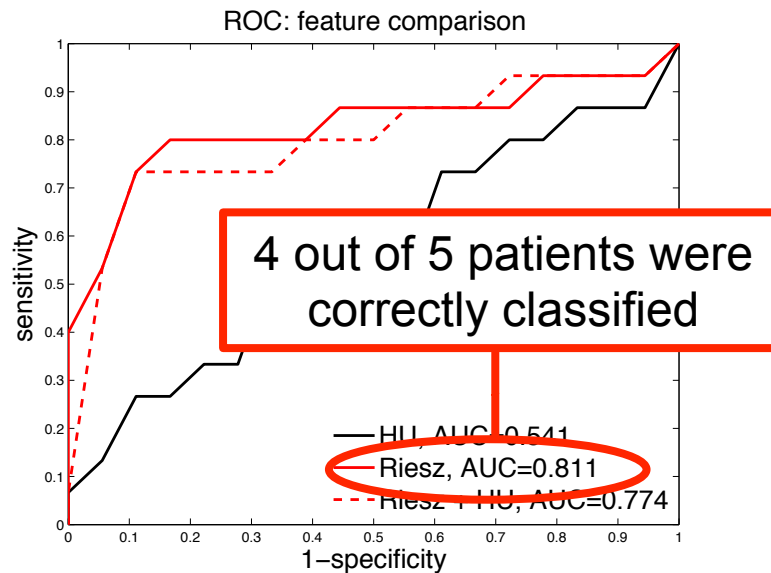
$$f(v_l) = \langle w, v_l \rangle + b$$

$f(v_l) > 0$: classic UIP
 $f(v_l) < 0$: atypical UIP



Results and discussion

- **ROC analysis** of the score and **comparison** with two fellows



- Importance of **regional** volumetric **texture** analysis
- the performance is **comparable** to cardiothoracic fellows with 1 year of specialization (computer score: 6 errors, fellows: 7 errors each)
- Demonstrate the potential benefits of our approach in centers without access to ILD experts to **avoid unnecessary biopsies**