

MIC @ MICCAI: past, present and future

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Motivation

Intervention



Diagnosis/prognosis



Basic research

Top 9

Percent of papers that claim the organ in the title in 2017 (1998)

Brain 20 (25)

Heart 11 (4)

Vessels 5 (4)

Lung 4 (2)

Ortho 2 (7)

Prostate 3 (2)

Breast 3 (2)

Pancreas 3 (2)

Liver 2 (2)

Key Technical Problems

Segmentation

Registration/tracking

Biomechanical modeling

Statistical modeling

“Signal” imaging: d/fMRI, M/EEG, ECG

- Analysis coupled with imaging
- Sophisticated statistics

Methodological Evolution

- Physics-motivated models coupled with optimization
- Statistics and geometry of manifolds
- Generative probabilistic models
- Machine learning

People



Diversity of Thought

- Lie groups and statistics on manifolds
- Large-scale software packages
- Surgical navigation systems
- Robots

Open Problems

- Algorithms do not generalize
 - across acquisition parameters or patients
- Much more emphasis on average performance than patient-specific results
 - great for population studies and MICCAI papers but useless for interventions and prediction
- Missing connection to acquisition
 - opportunity to improve analysis and opportunities for cool math

What we *can* do today

- Research brain images with diffuse atrophy: registration, segmentation
- 3D heart image series, even with infarct: segmentation, stress/strain estimation
- Lesion detection: cancer, stroke, TBI, MS
- What else is there?

What we *want* to do today

- Clinical brain images with an infiltrating tumor: accurate multimodal fusion
- 3D heart with congenital pathologies: segmentation, stress/strain estimation
- Moving and deforming organs, sparse sampling, non-standard anatomy

Wrap Up

- Amazing progress
 - Medical image computing is used in clinical research
 - Many image-guided procedures use some analysis
- Impossible challenges
 - We cannot handle variability of real patients
 - Acquisition is a foe instead of a friend
 - Existing solutions do not generalize to new applications
- Fantastic opportunities
 - Time to handle patient-specific case