Equitable Thresholding And Clustering (ETAC) in AFNI

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TL;DR: Equity and Balance reduce arbitrariness in FMRl thresholding while maintaining FPR control (globally and locally) and improving detection power

Equity and Balance:
- Use **multiple plausible methods** to form and threshold clusters of “significant” voxels.
- Choose thresholding parameter(s) in each method to give all individual methods the same global False Positive Rate (FPR) \( \alpha_0 \) methods are balanced (equitable)
- Accept as “active” (or “globally significant”) the union over all methods of their resulting supra-threshold maps
- Union FPR \( \alpha_U \) will be > \( \alpha_0 \); adjust \( \alpha_0 \) to get desired \( \alpha_U = 5\% \) global FPR

Multiple Plausible Methods:
1. Voxel-wise thresholding at several p-values, followed by cluster-FOM thresholding
   - Potential to detect small intense clusters and large weak clusters equitably
2. Multiple cases of spatial blurring in one analysis
3. Cluster-FOM = cluster-size and/or sum of cluster z-scores squared
4. Use different cluster-FOM thresholds in different brain regions – to balance FPR across space
   - treating different regions equitably in FPR

Software:
- Implemented in AFNI program 3dttest++, with help from new codes 3dxC1ust5Sim and 3DMultiThresh
- Resampled t-tests to assess \( \alpha_0 \) for each sub-method
  - No parametric model for spatial smoothness
- Build cluster collections using each sub-method
  - Iteratively adjust \( \alpha_0 \) for each sub-method to get to global union FPR=5% (or chosen FPR goal)
- Inputs: user chooses \( p \) thresholds, FOM parameters, blurring cases
  - Plus 1- or 2-sided-ness of t-test
  - Plus NN clustering level (1 or 2 or 3)
- Multiple ETAC input sets can be run at once, saving time by reusing resampling simulations
- Output = mask of voxels that survive at least one sub-method’s thresholding

Example of how equity tradeoff works with multiple thresholding methods

Spatial equity in ETAC makes False Positive Rate more uniform (top) than using a global cluster threshold (bottom)

FPR density from 20000 2-sample 1-sided t-tests:
(top) ETAC method; (bottom) fixed cluster-size threshold ETAC is more spatially uniform at same global FPR

ETAC global FPR with 4 distinct pseudo-task timings applied to resting state data (1000 simulations each): FPR is reasonably controlled at nominal 5%

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