**Single-Session Analysis**

**Preprocessed data**
- FMRI data
- Motion correction
- High-pass filtering
- Spatial smoothing

**Voxel-wise single-subject analysis**
- Design matrix
- Stimulus/task timings

**Voxel time-series data**
- GLM

**Effect size statistics**
- Contrast

**Statistic Image**
- Thresholding

**Significant voxels/clusters**
FMRI Modelling and Statistics

- An example experiment
- Multiple regression (GLM)
- T and F Contrasts
- Null hypothesis testing
- The residuals
- Thresholding: multiple comparison correction
Under null hypothesis, $\beta=0$, $t$ is $t$-distributed

(what are the chances of that?)
Null Hypothesis Testing

Under null hypothesis, $\beta = 0$,
t is t-distributed

$t = \frac{\hat{\beta}}{std(\beta)}$

Small P-Value = null hypothesis unlikely
If P-Value < P-threshold then voxel is “active”
P-threshold corresponds to False Positive Rate (FPR)
FEAT performs spatial inference on z statistic maps.
Therefore, we convert t statistics to z statistics by equating probabilities under the tails of the distributions (\(t' \rightarrow p \rightarrow z'\)).
FMRI Modelling and Statistics

- An example experiment
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Choosing High-Pass Filter Cut-off

• Can use the tool `cutoffcalc` to determine a good cut-off value

Remember that MJ mentioned highpass filtering?

- Removes low frequency signals, including linear trend
- Must choose cutoff frequency carefully (lower than frequencies of interest = longer period)
Choosing High-Pass Filter Cut-off

- Can use the tool `cutoffcalc` to determine a good cut-off value
  **OR**
- Set by hand, but make sure model is not badly affected

**Example: Boxcar EV with period 100s**
- Cut-off=100s
- Negligible effect on EV, so use cut-off of 100s

**Example: Boxcar with period 250s**
- Cut-off=100s
- Substantial effect on EV, so need longer cut-off

- Cut-off=250s
- Negligible effect on EV, so use cut-off of 250s
Non-independent/Autocorrelation/Coloured FMRI noise

Uncorrected, this causes:

- biased stats (increased false positives)
- decreased sensitivity

FSL fixes it for you in FEAT!

Cannot use randomise (see later) because of autocorrelation
FMRI Modelling and Statistics

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What happens when we apply “standard” statistical testing to imaging data?

z-map where each voxel $\sim N$.
Null-hypothesis true everywhere, i.e.
NO ACTIVATIONS

16 clusters
288 voxels
$\sim 5.5\%$ of the voxels

That’s a LOT of false positives
What we really want

Let’s say we perform a series of identical studies

Each z-map is the end result of a study

Let us further say that the null-hypothesis is true

We want to threshold the data so that only once in 20 studies do we find a voxel above this threshold

There will be a whole talk on how to find such a threshold
Summary

• We test for an effect through a null-hypothesis, that we might reject.
• The null-hypothesis is rejected if the observed statistic is “too unlikely”.
• When thresholding the number of false positives needs to be controlled across the entire brain

That's all folks