Optimizing

Building a design matrix:

making regressors from event onsets

filtering steps

What's the best design?

Depends on what you're interested in.

Signal detection: Block

Estimating HRF parameters: ER

What if:

you want to do both detection and HRF est.?

you can't use a block design for psychological reasons?

you want to isolate particular processes of interest that you can't isolate by comparing blocks?

you're interested in the time course / temporal resolution of activity?

How to optimize a design

Selective averaging: counterbalance design. no confounding of conditions.

Linear model

set timing parameters

block duration (block)

jitter trial timing (ER)

lengthen scan duration

change TR

change event order (ER only)

The event-related linear model

What are we interested in? t = est / SE

var(est) = residual error * 1/variability of pred * correlation of pred.

Fourier transforms

describes variability as a f of frequency

can represent any timeseries as a sum of cosines + sines of different frequencies. (fft)

power spectrum is variability at each frequency

- ***draw sine wave and power spectrum***
- ***draw others***

Now we consider variability and correlation of predictors in turn.

Variability (energy)

Regression needs a range of scores on which to operate.

regression of age on test score: need a range of ages.

Bad: using only subjects 46-47 years old.

This is the same as changing variability in the first term of our equation

This is also the same as having a larger diagonal element in XtX.

Diagonals of XtX = variability

Off-diagonals = correlation

residual error * inv(XtX)ii = var(est)

How to increase variability

More trials (but spacing matters!)

Spacing issues

* draw canonical HRF function

allow HRF to return to baseline

space closely sometimes to get signal summation

But watch out for nonlinearity/signal saturation

Draw power spectrum of unfiltered and filtered design and noise

Colinearity

What is colinearity?

Draw bivariate scatterplot with correlated predictors

Why is colinearity bad?

t or F accounts for EXTRA variation, above that explained by other columns

Colinearity between columns of interest

* draw complementary columns design

Colinearity between columns of interest and drift

* draw slow on-off design

Impact of Non-white (colored) noise

also called autocorrelation of errors

more noise at lower frequencies (1/f)

high-pass filtering to eliminate low freq. noise

we don't want experimental energy at low frequencies.

there's a lot more noise than signal, so it helps to separate signal and noise.

if signal and noise are at different frequencies, we can reduce noise by filtering at certain frequencies.

paradigm should be designed to avoid energy at low frequencies (what you're going to filter out.)

low-pass / temporal smoothing to give robust autocorrelation estimates

if you ignore autocorrelation, error variance will be lower than it should be, and the false positive rate will be inflated.

don't put design power in the space affected by smoothing.

Student participation:

we draw delta functions and parameters

students draw regressors and power spectra