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TFA Math

- Need to select a good template set, that captures systematics.
- Need to choose filter function. Simplest choice: linear combination of template LCs.
- How to get weights? A: assume all variation is systematics → O−C (least squares).
- What distortion does TFA cause? Design it to tackle two problems:
  1) Increase the detection probability by removing systematic trends.
  2) Restore the signal form by filtering trends iteratively from periodic signals, assuming the period is known.

Details:

Have template time-series $X_j(i)$ $\quad i=1,\ldots N \leftarrow$ data pts, $\quad j=1,\ldots M \leftarrow$ template #.

$$F(i) = \sum_{j=1}^{M} c_j X_j(i)$$ is the filter funcn.

Assume that $\sum_{i=1}^{N} X_j(i) = 0 \quad \forall j$ (zero-averaged timeseries).

The coefficients c_j are found by minimizing

$$D = \sum_{i=1}^{N} \left[y(i) - A(i) - F(i) \right]^2$$

for $y(i)$ the target time-series the ~~best~~ estimate of the detrended LC.
$A(i)$ the current

For application (1), "frequency analysis" (period-finding), no a priori knowledge about signal in LC. Therefore

$$A(i) = \langle y \rangle \equiv \frac{1}{N} \sum_{k=1}^{N} y(k) = \text{constant}.$$

In application (2), signal reconstruction, we have knowledge about a periodic signal in the data.

The phase-folded time-series can then be used to iteratively estimate $\{A(i)\}$. (the best estimate of the detrended LC).

Step 1:

- $A(i) = \langle y \rangle$

Step 2:

- phase-fold and bin $\hat{Y}(i) \equiv Y(i) - A(i)$, the filtered timeseries.
  Unfold, yielding new estimate of $A(i)$.

Step 3:

- Recompute c_i, using better $A(i)$ estimate

Step 4:

- Repeat 1–3 until c_i converge.

Requires:

- Number of bins (e.g. 100 for 3,000 data points).
- A convergence limit for stdev of residuals
  (e.g. $\sigma = 10^{-3} = 1$ mmag)