

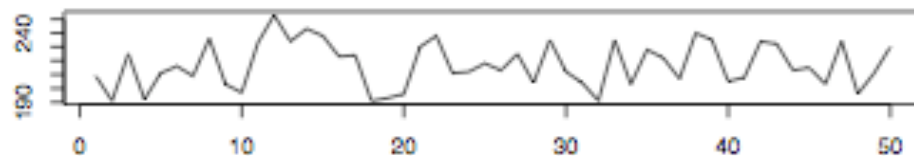
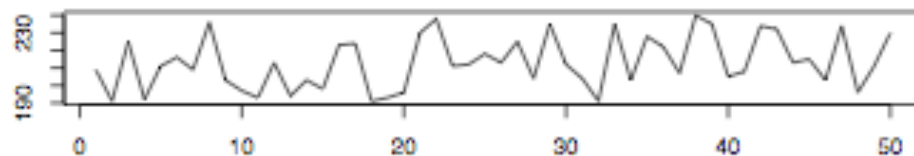
Feature Detection Aided by Comodulated Noise

- "Multiple Scale and Multimodal Data and Information Fusion in Human Sensory Discrimination", BBSRC
- University of Birmingham and Royal Holloway, University of London
- Glyn Humphreys and Fionn Murtagh, Roberta Roberts, Dimitri Zervas

Linkage with: comodulation, copula, stochastic resonance

- **Comodulation**: faint feature detection is enhanced by the presence of noise that is correlated in amplitude across the frequency spectrum.
- Used in aural feature detection.
- **Copula**: 2D density field such that marginals are the cumulative probability densities of two signals.
- Used in financial signal processing.
- **Stochastic resonance**: addition of noise to jump out of local less than optimal solutions.

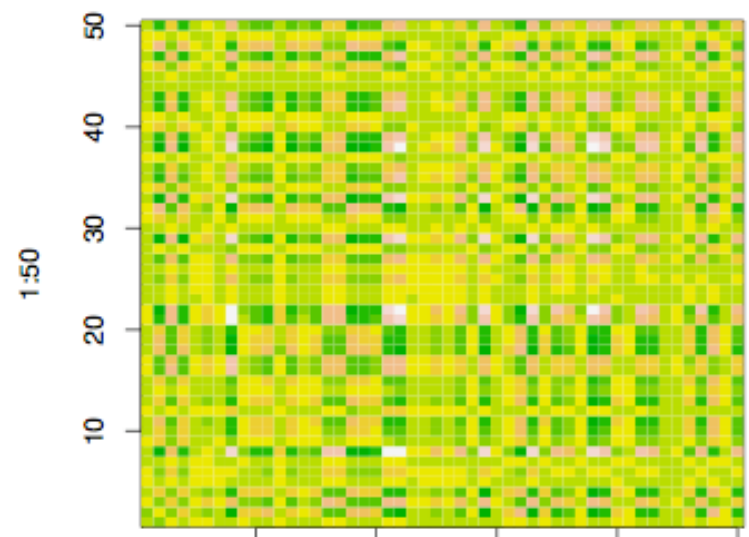
Pattern 5, without then with feature; and difference



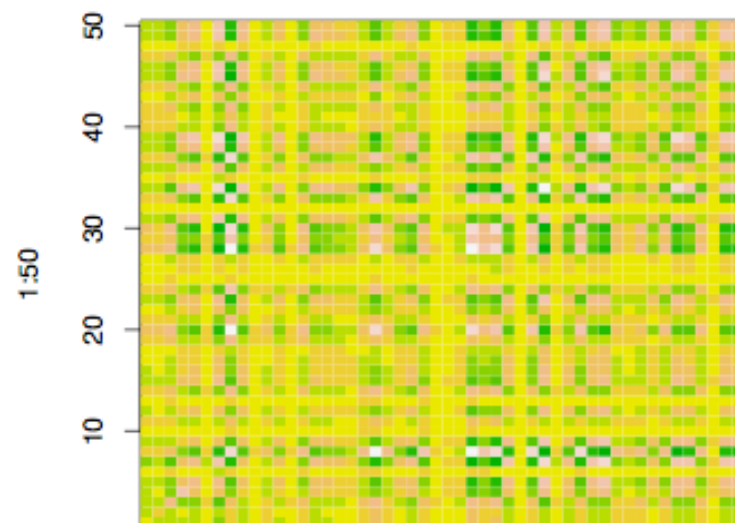
2D Visualization of Pairs of Signals

- For pairs of patterns, i.e. noisy signals, with - randomly - a feature added to one of these patterns (naming convention in the following slides: “w” added), do:
 - Form 2D field, an “expanding front”, using correlation and cross-correlation.
 - This visualization (i) respects the temporal flow of the two signals; (ii) takes memory into account.

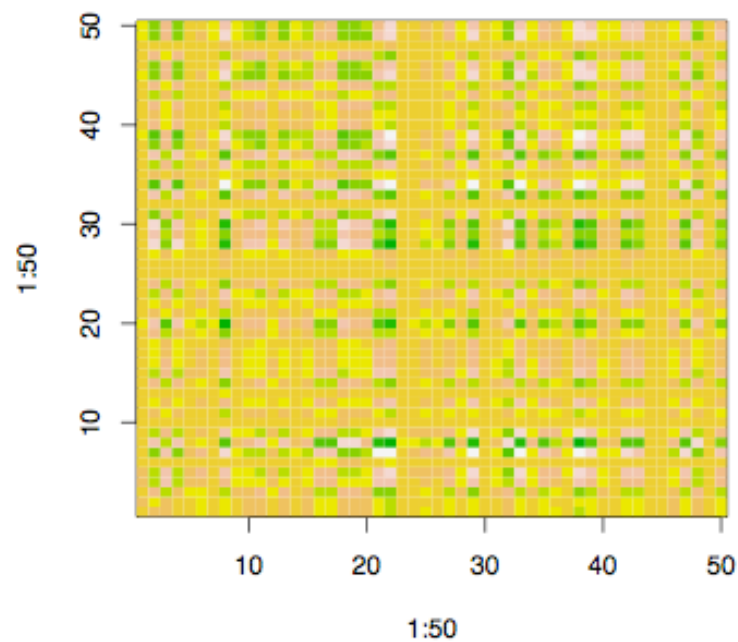
Expanding 2D field. Horiz.: p5 Vert: p5



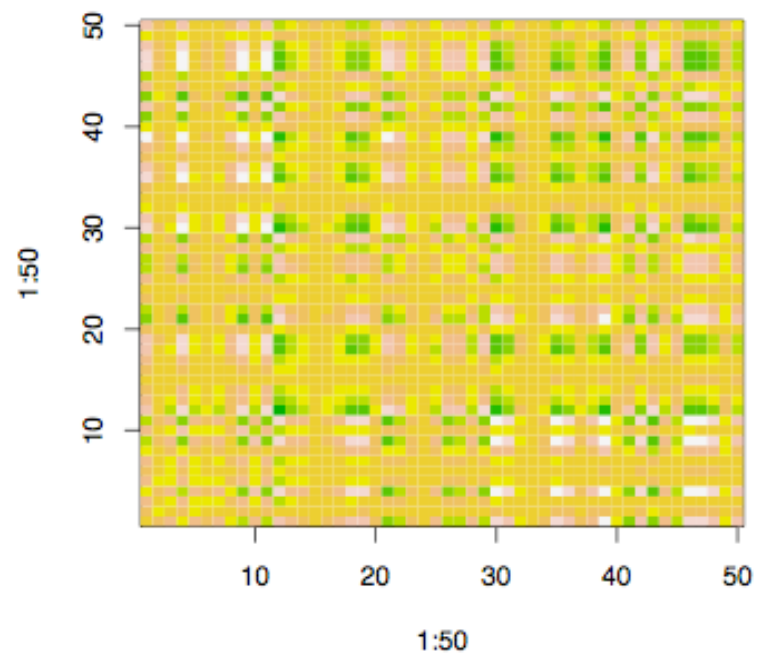
Expanding 2D field. Horiz.: p7 Vert: p7



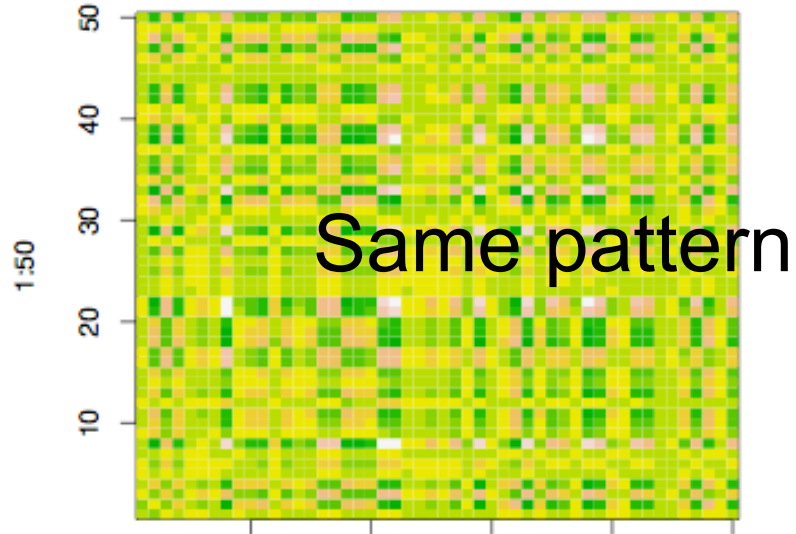
Expanding 2D field. Horiz.: p5 Vert: p7



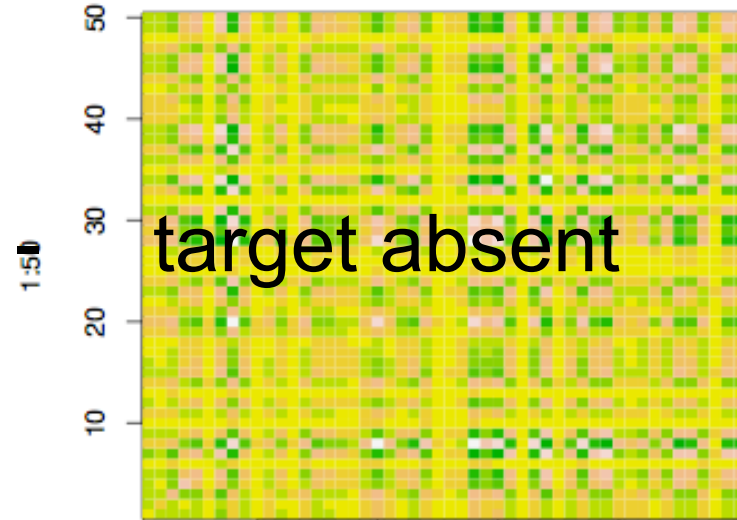
Expanding 2D field. Horiz.: p8 Vert: p3



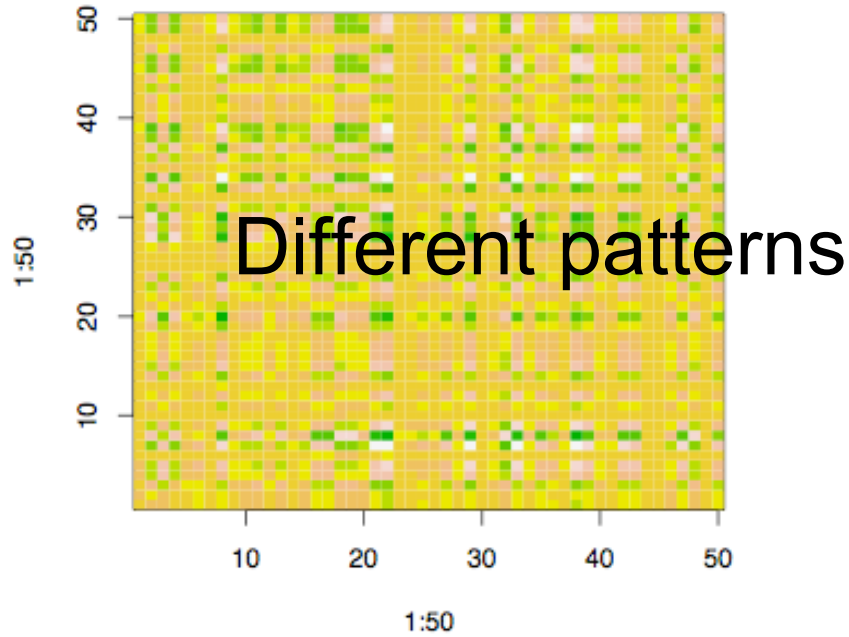
Expanding 2D field. Horiz.: p5 Vert: p5



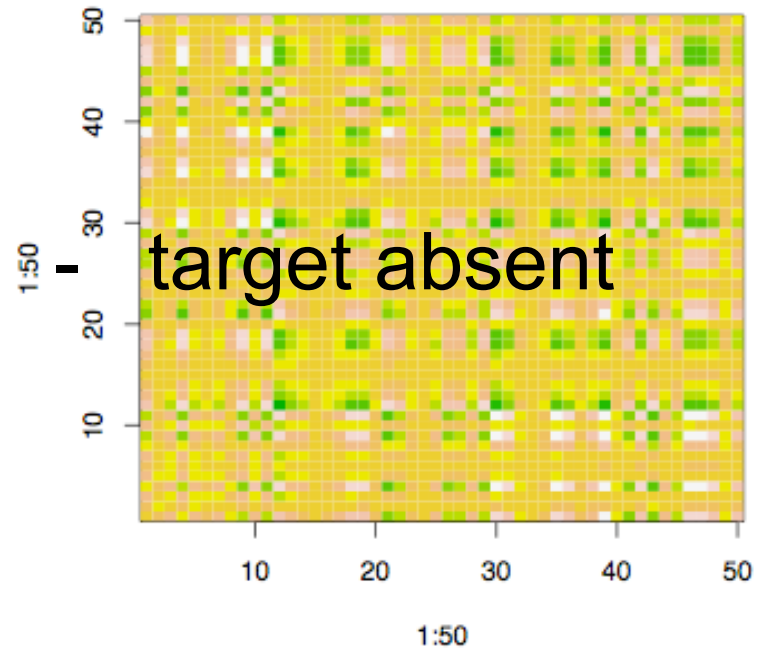
Expanding 2D field. Horiz.: p7 Vert: p7



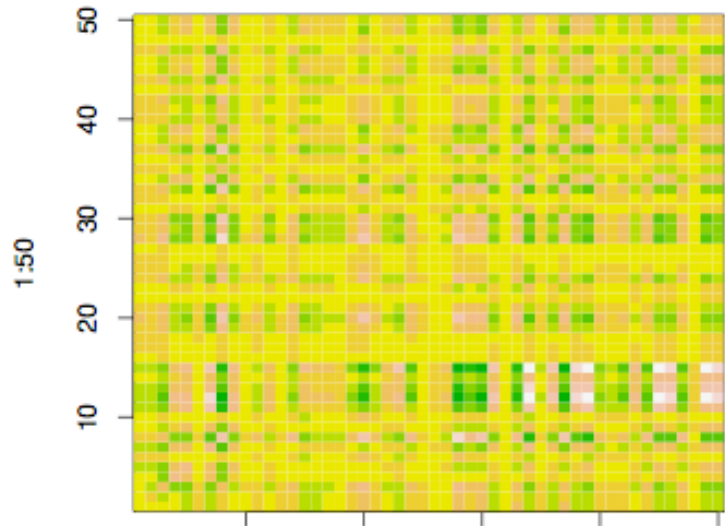
Expanding 2D field. Horiz.: p5 Vert: p7



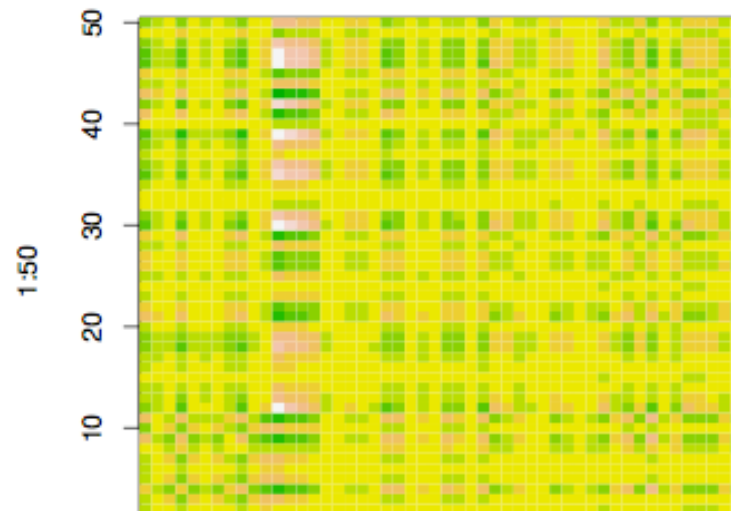
Expanding 2D field. Horiz.: p8 Vert: p3



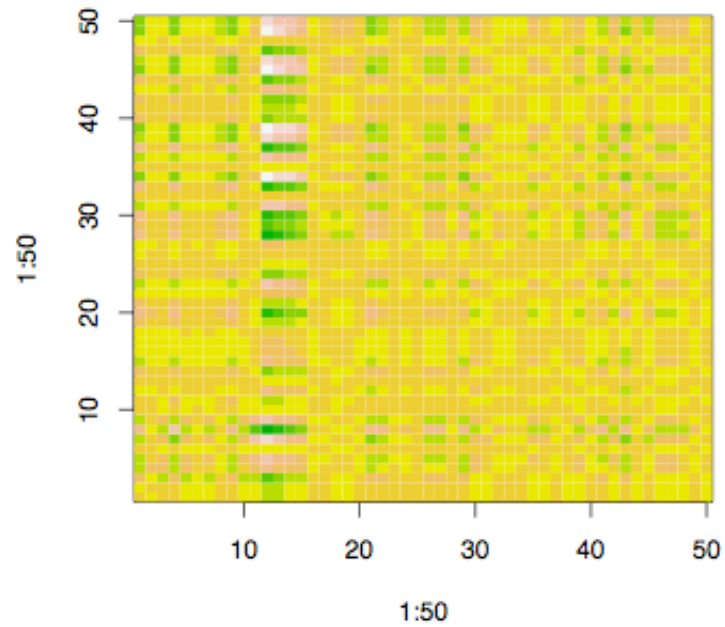
Expanding 2D field. Horiz.: p7 Vert: p7w



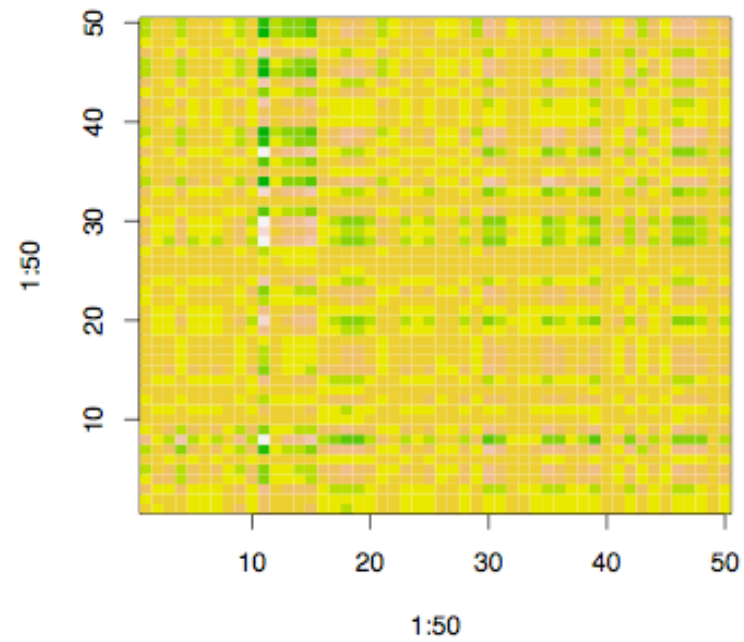
Expanding 2D field. Horiz.: p3w Vert: p3



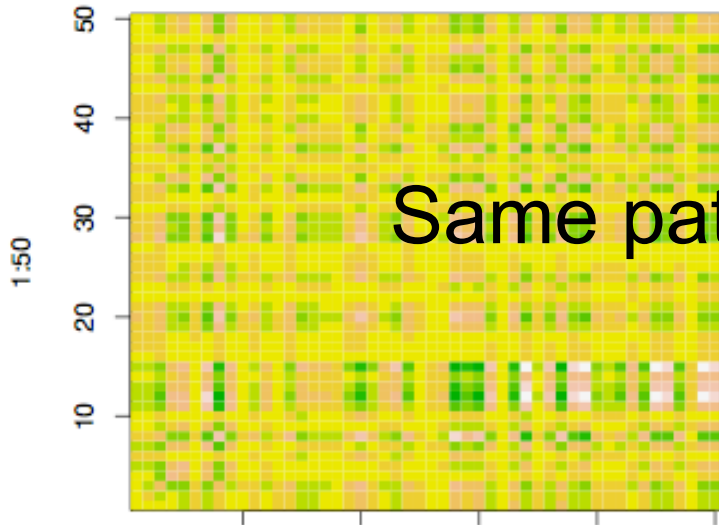
Expanding 2D field. Horiz.: p3w Vert: p7



Expanding 2D field. Horiz.: p8w Vert: p2

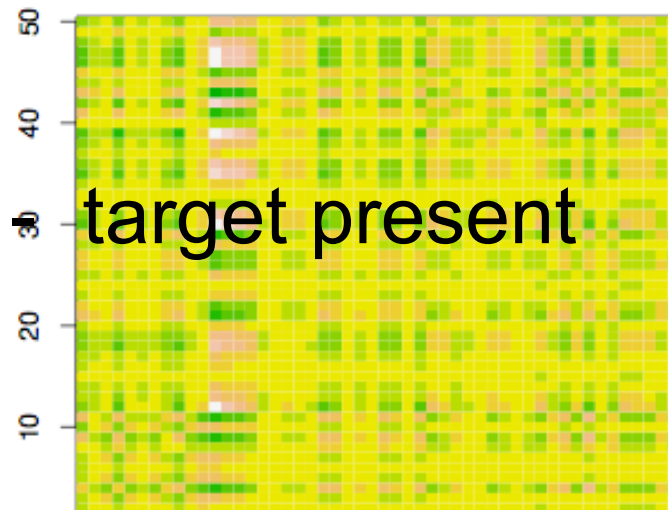


Expanding 2D field. Horiz.: p7 Vert: p7w



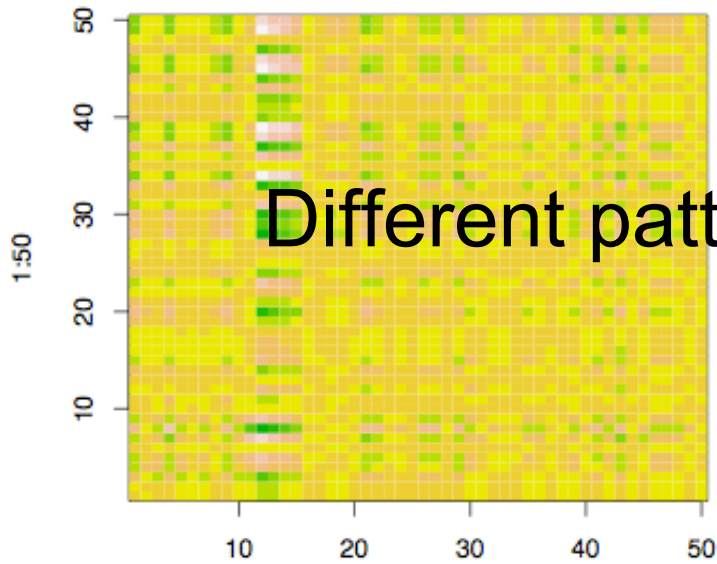
Same pattern

Expanding 2D field. Horiz.: p3w Vert: p3



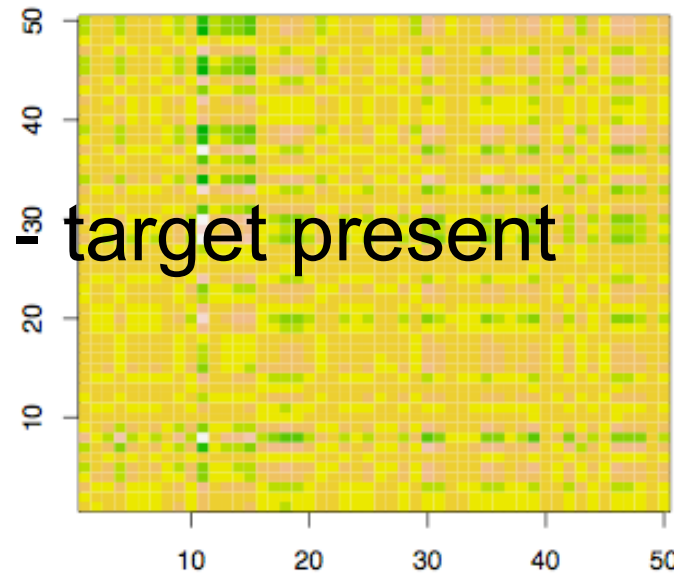
target present

Expanding 2D field. Horiz.: p3w Vert: p7



Different patterns

Expanding 2D field. Horiz.: p8w Vert: p2

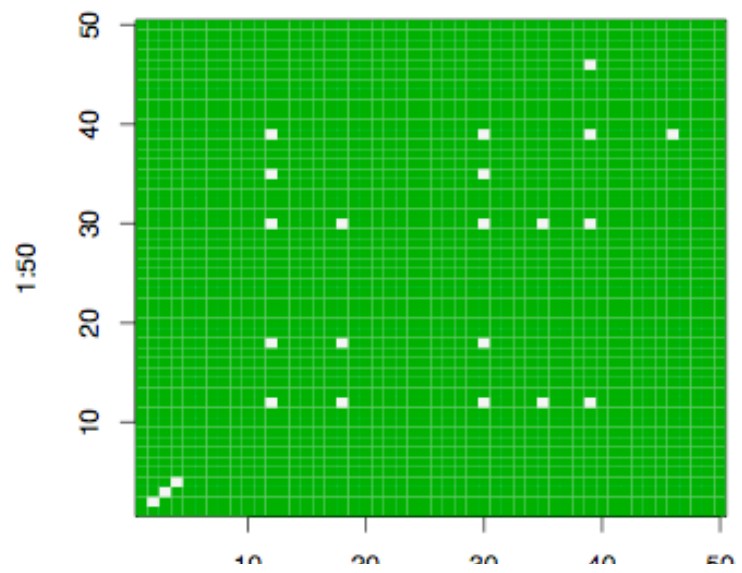


target present

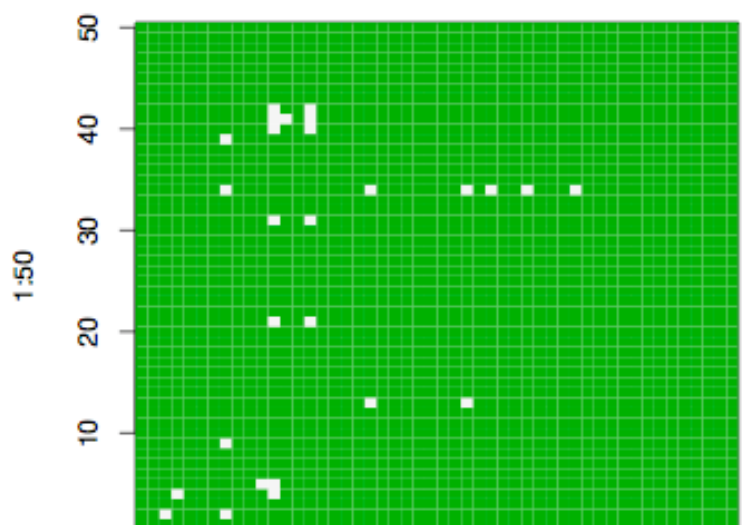
Threshold visualization to automatically detect presence or absence of feature

- 99th percentile used to threshold visualization i.e. correlations and cross-correlations.
- Presence of more than (initially 50% and now:) 20% of thresholded correlations and cross-correlations in the region where the feature is placed: implies feature detected.

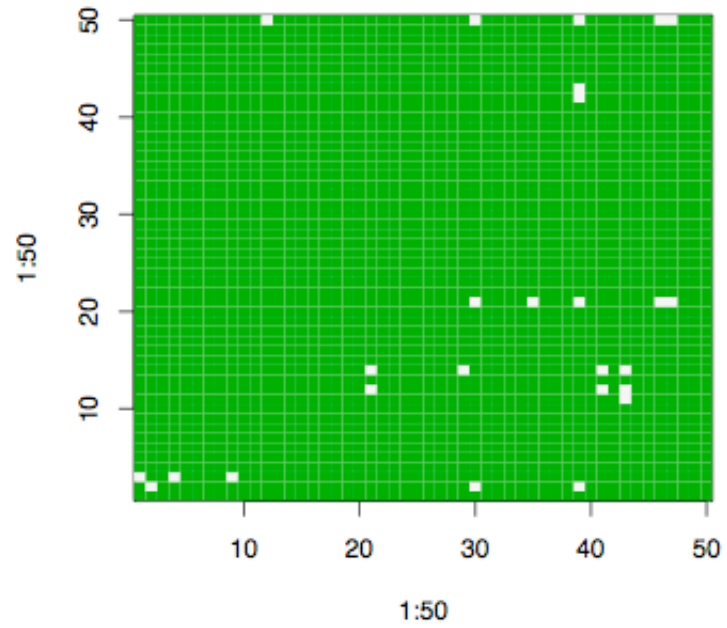
Thresholded. Horiz.: p8 Vert: p8



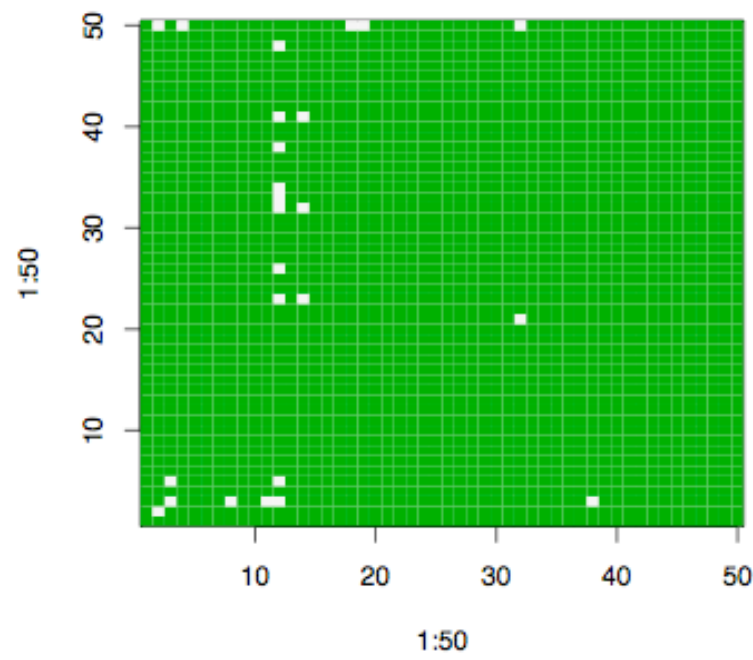
Thresholded. Horiz.: p7w Vert: p4



Thresholded. Horiz.: p8 Vert: p6w



Thresholded. Horiz.: p5w Vert: p6



Assessing subjects against our automated system: latter superior

	(a)	(b)	(c)	(d)
amv	267	11	93	3
exs	214	23	52	1
gxv	279	49	57	11
mxk	285	31	58	7
pxr	261	62	55	12
sxa	0	0	1	0
axc	301	27	62	2
gwh	208	7	86	0
mxd2	220	14	49	1
njd	268	39	63	9
rdr	194	51	53	9
uyx	271	41	59	8

Table 1: Left column: test subject. (a) = the subject was correct, our system was correct. (b) = the subject was correct, our system was wrong. (c) = the subject was wrong, our system was correct. (d) = both subject and our system were wrong.

Conclusions and Next Steps

- **Conclusions: Powerful visualization technique. Effective for investigation of the supportive role of noise in faint feature (below noise level!) finding.**
- Investigation of experiments with lag in the target (feature).
- Check evidence for form of target, especially its temporal duration.