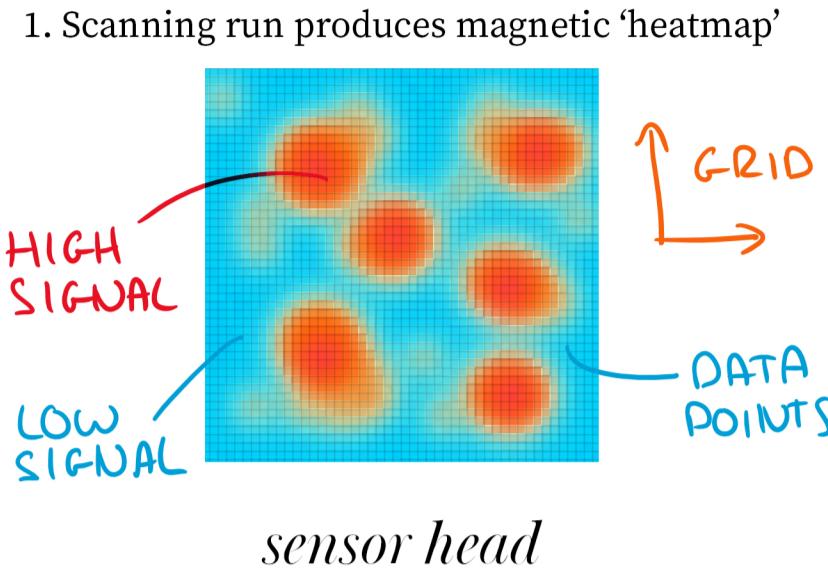
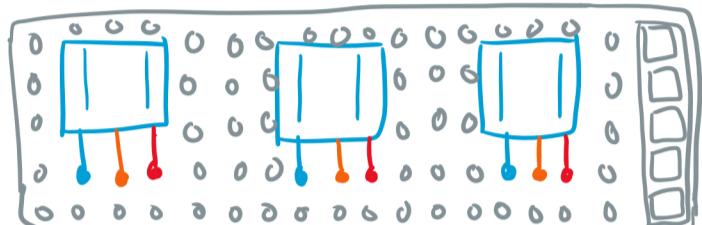


# sensing & data processing



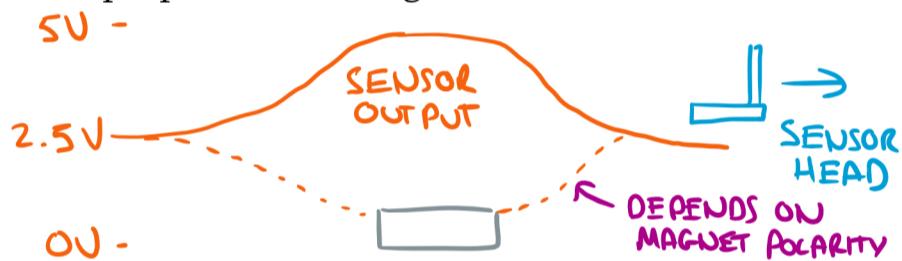
Made from three hall effect sensors in a line



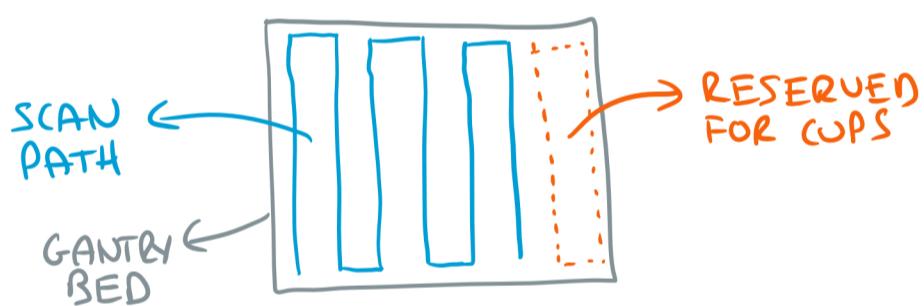
This allows three columns of data to be gathered in a single sweep



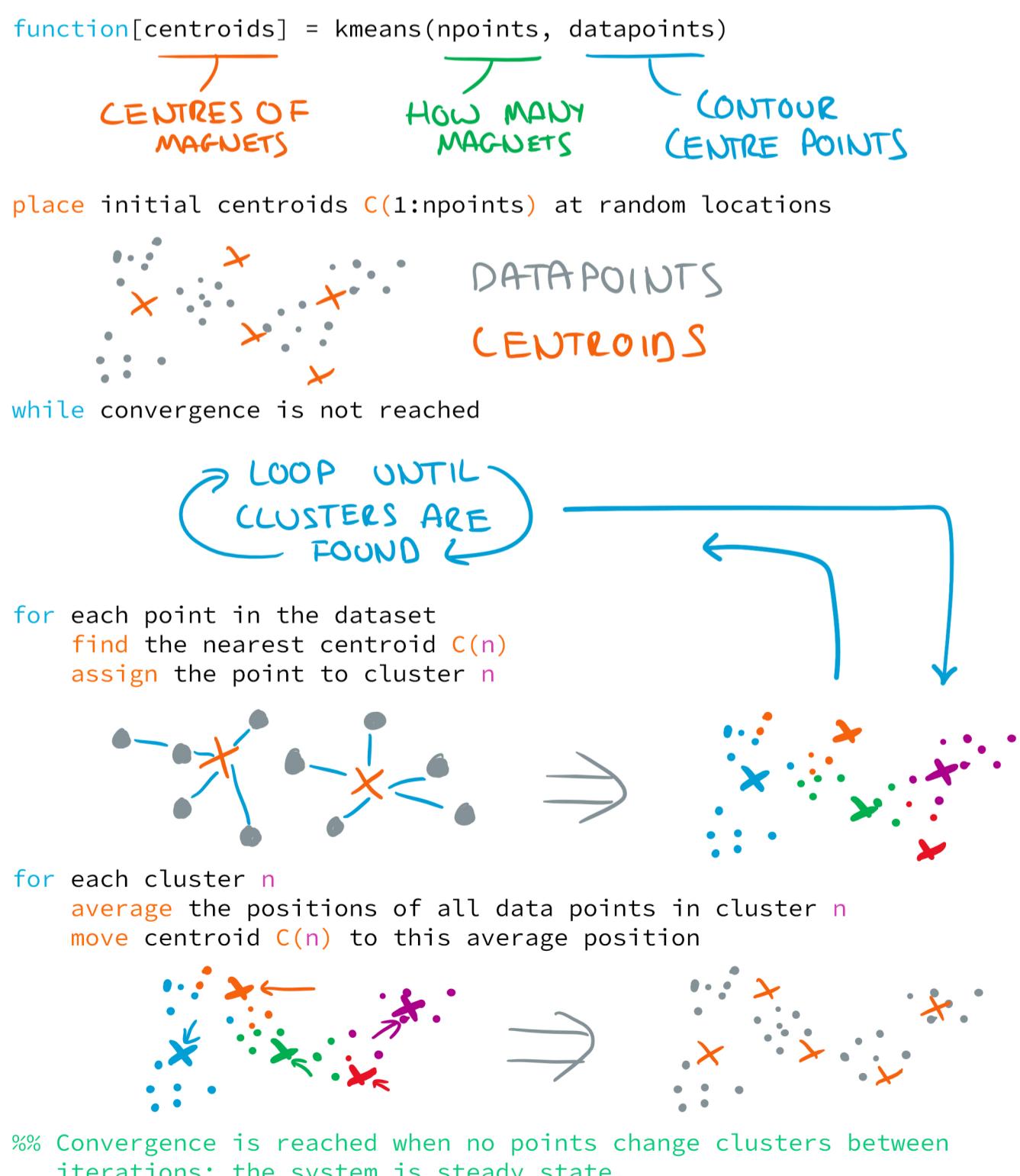
As the magnetic field changes, the sensors output a proportional voltage from 0 to 5 volts



Square wave sweep pattern covers the whole board



## k-means algorithm



## sensing overview

2. Data is processed into more usable form

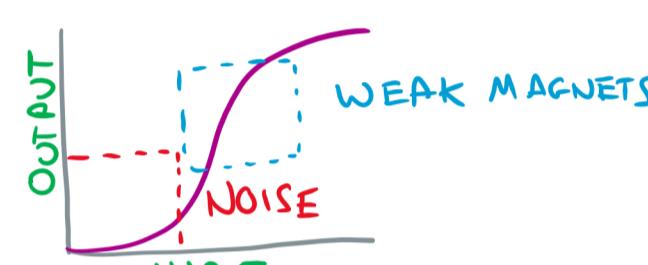


## processing steps

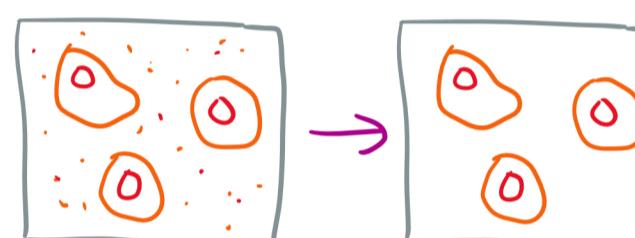
Sensor input is normalised at 0 volts



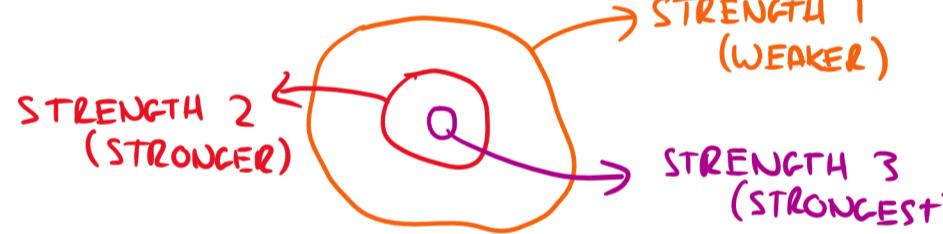
An S curve filter removes weak signals and boosts strong signals, without clipping



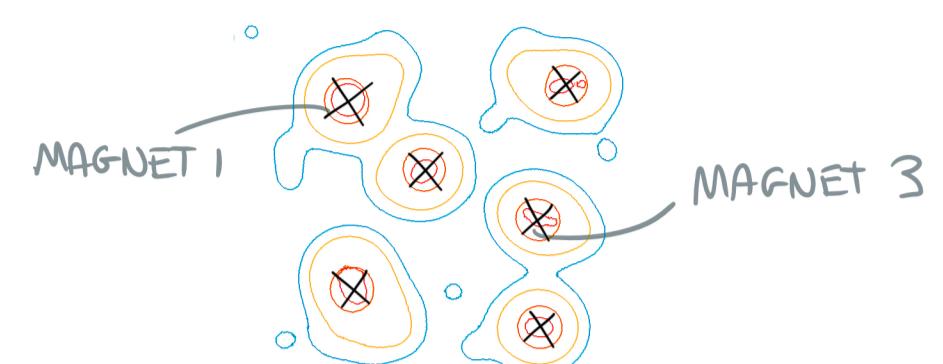
Wiener filter removes any remaining noise



Contour plot of data values shows boundaries between sensor levels



3. Algorithms determine centre points of magnets



## centre point detection

For each contour outline, the centre point is found by averaging x and averaging y points



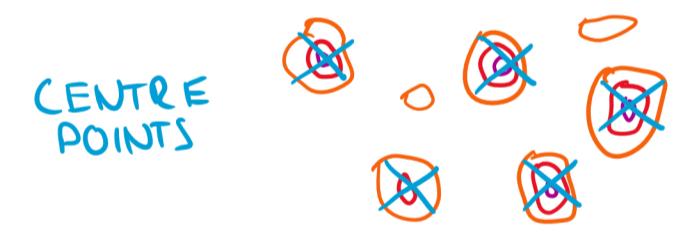
Points are weighted based on their signal strength

WEAK  $\Rightarrow$  LOW WEIGHT  
MEDIUM  $\Rightarrow$  MEDIUM WEIGHT  
STRONG  $\Rightarrow$  HIGH WEIGHT

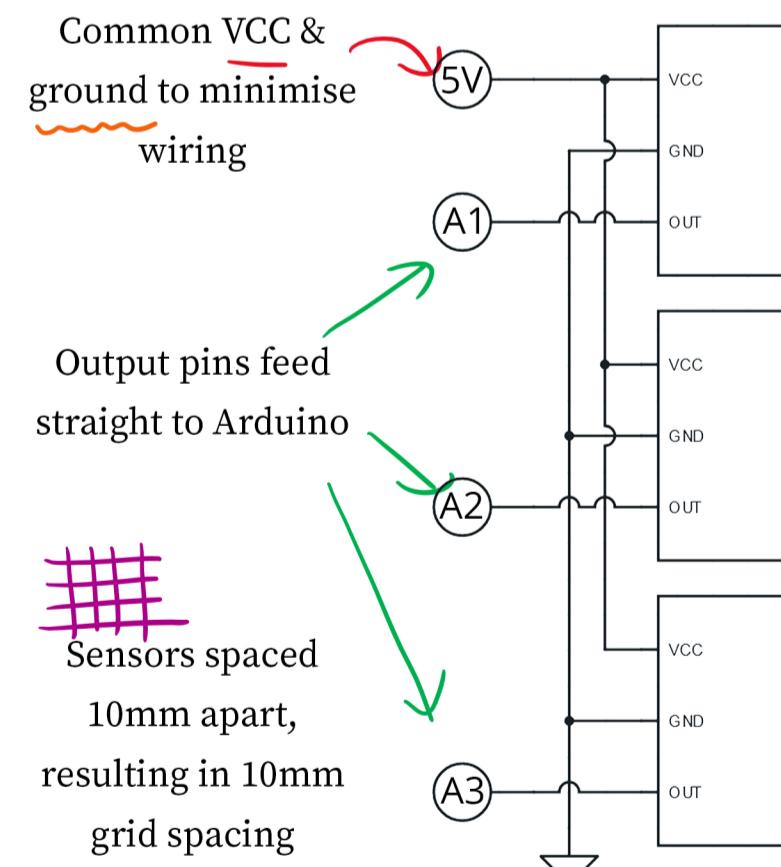
Davies-Bouldin Criterion estimates the number of magnets present, N



k-means clustering groups data points into N collections, and outputs their centroids

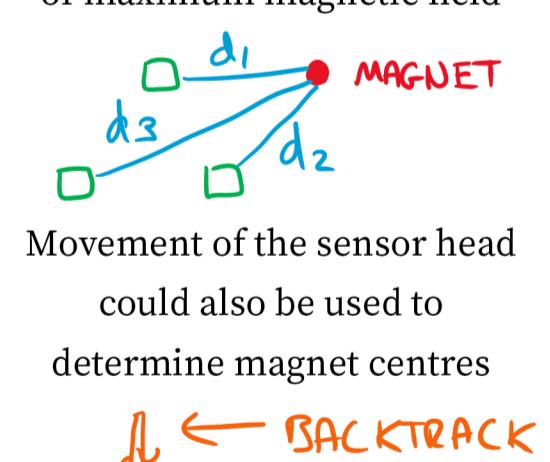


## sensor head layout



## design evolution

Original concepts included triangulation of three sensor values to determine location of maximum magnetic field



Movement of the sensor head could also be used to determine magnet centres

## algorithm selection process

A general process was followed in algorithm selection for signal processing and centre point detection:

1. Research to determine if there is an existing popular algorithm

2. Determine if any of these algorithms are available in MATLAB / addons

3. Test the algorithms using generated data and varying parameters, and compare results  $\rightarrow A \parallel B$

%% Convergence is reached when no points change clusters between iterations; the system is steady state.