The
Clay Research Group

RESEARCH AREAS

Climate Change : Data Analysis : Electrical Resistivity Tomography
Time Domain Reflectometry : BioSciences : Ground Movement
Soil Testing Techniques : Telemetry : Numerical Modelling
Ground Remediation Techniques : Risk Analysis
Mapping : Software Analysis Tools
Electrokinesis Osmosis
Intelligent Systems

Edition 130

March 2016

The Clay Research Group

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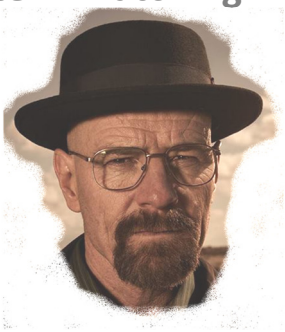
Edition 130, March, 2016

Pattern Matching Walt



Walt, the lead character in the television series Breaking Bad, has had a major role in the development of our pattern matching application. More inside.

THE CLAY RESEARCH GROUP
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Aston Conference

22nd June, 2016

ASTON UNIVERSITY

The annual CPD accredited subsidence conference is an excellent opportunity to keep up with current developments and meet colleagues. If you would like to present a paper on a subsidence related topic covering a technical or business issue, please send a short outline to clayresearchgroup@gmail.com.

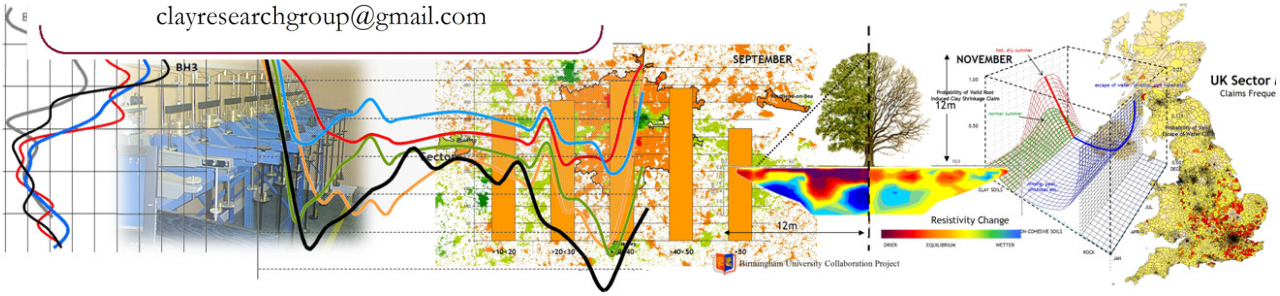
Pattern Recognition

Last month's newsletter looked at the knowledge base of our AI system. What is known about domestic subsidence from our extensive database? This edition explores the pattern matching aspect. If the system knows something, how does it recognise it?

Briefly, the approach has been to analyse several claim databases and make associations to derive probabilities. A good text describing the maths is provided in Ripley's "Pattern Recognition and Neural Networks" published by Cambridge University Press (1996).

Next Month

Do certain trees actually pollute the atmosphere? Can the smell of new mown grass harm us? What are Volatile Organic Compounds and will we ever see a headline saying “City Trees that pose a Threat to Human Health”?



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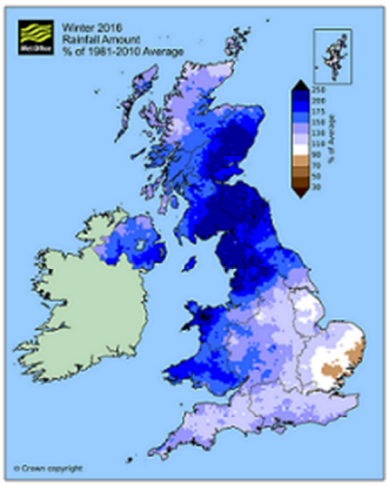
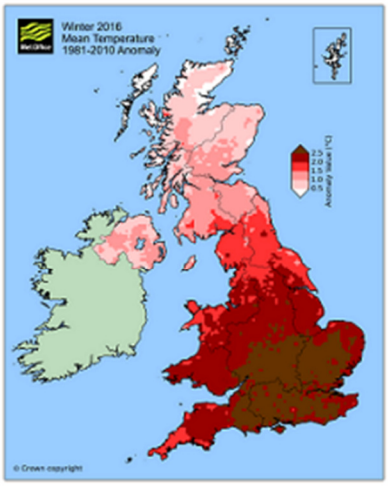
A Record Breaking Winter

http://www.metoffice.gov.uk/news/releases/2016/winter-statistics



Rainfall Winter 2015/16



Mean Temp Winter 2015/16

For meteorologists, spring commenced on the 1st March. Winter 2015/16 was the warmest and wettest on record.

"The latest end of month statistics show it was provisionally the warmest winter for England and Wales since the record series began in 1910, while it was the third-warmest for the UK as a whole. The warmth has been most notable in the south of the UK with mean temperatures across much of the area more than 2°C above average"

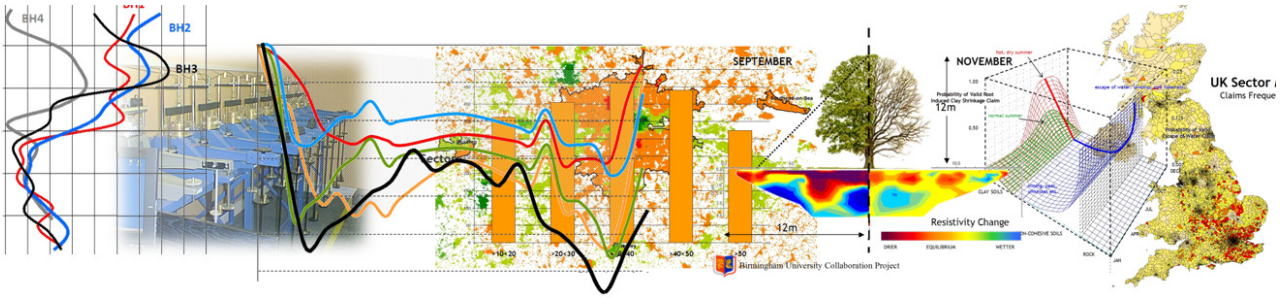
"It has also been the wettest in the record series for Wales, Scotland and Northern Ireland and the second-wettest for the UK as a whole just behind the winter of 2013/2014."

Ash Die Back Disease

Bartlett Tree Experts been working on a way to reduce the effect of Ash Die Back Disease and have developed an "enriched biochar", which combines a purified form of charcoal with fungi, seaweed and worm casts.

A study by the company's research labs on 2,000 established ash trees over three years in Essex found that while a third of the established trees monitored have become infected with Chalara, none of the 20 trees which had enriched biochar applied to their roots were hit.

Dr Glynn Percival, head plant physiologist at the Bartlett Tree Research Laboratory, said: "While we cannot claim this to be a cure for ash dieback, we are clear that it has a beneficial impact".



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The Role of Pattern Recognition in an A.I. Application

What role does pattern recognition have in resolving a subsidence claim?

The adoption of AI seems inevitable with the rise of Big Data and current interest in intelligent systems in our industry.

The CRG objectives are to (a) broaden the offering to the homeowner in terms of registering and viewing their claim (b) deliver background (claims history, peril etc.) and specialist information (geology, weather) to everyone involved (c) improve triage using probabilities to assist in predicting whether a claim is likely to be valid, (d) if so, the most likely operating peril, (e) interpret data gathered in the course of investigations and (f) improve the efficiency of the claims handling process.

Practitioners in the field of domestic subsidence remain suspicious when a computer model suggests that an oak tree, 20m tall and 12mtrs from a house built in 1910 on a highly shrinkable soils can be linked to damage defined by the root zone in a hot and dry summer.

Modelling the degree of movement that might take place, the probable location of damage and the extent of desiccation is viewed sceptically.

Consensus between specialists can be further confounded when they come from different fields of expertise. Arboriculturalists aren't geotechnicians and vice versa. This is an area of rich pickings when debating causation that can delay claim settlements whilst the homeowner sits on the sidelines watching the ball go back and forth.

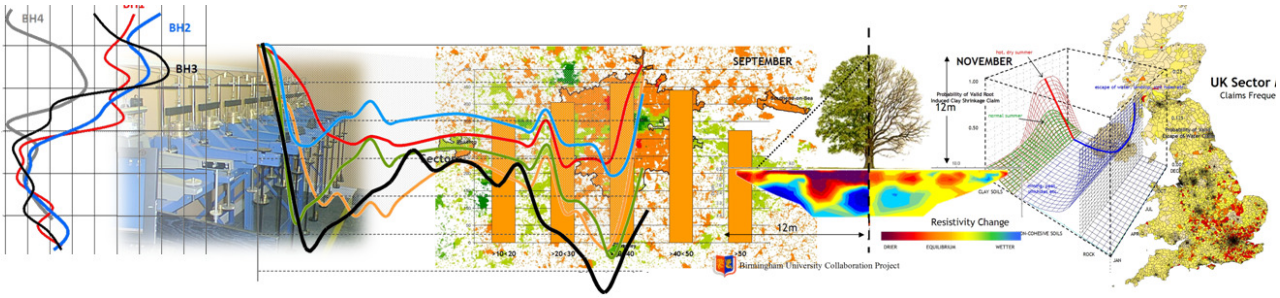
It also goes some way to explaining why the industry has been slow to adopt modelled solutions even though they are an everyday activity for most engineers, meteorologists and plant physiologists.

In some cases, the technical issues could be resolved at the press of a button. The counter argument is that sometimes (some might say often) trees are blamed for causing damage when the real cause lies elsewhere.

Applications can easily resolve sometimes complex monitoring data, distinguishing between a range of causes and handling input from both crack and level monitoring.

There is a similar application to report on vegetation and soils. Using data from claim records the system rates the risk of soils by shrinkability and trees by species and understands the metrics often associated with subsidence.

Homeowners can participate in the process viewing progress via a web based application taking assurance from the objective, engineering based interpretation.



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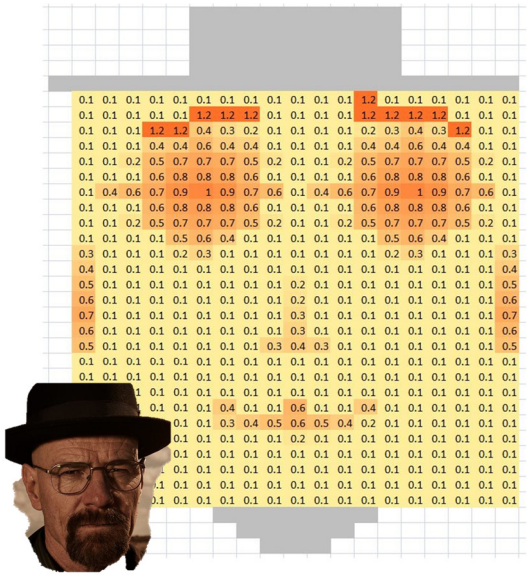
Pattern Matching for A.I. Application

Identifying shapes and patterns using digital information.

What does a valid, root induced clay shrinkage claim look like? We're not talking about crack patterns. This is about data analysis carried out by a computer as part of the AI application.

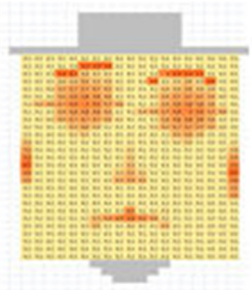


Probably nothing like Walt, above, from Breaking Bad. However, the image does help to explain what we mean by 'pattern recognition' and machine learning.

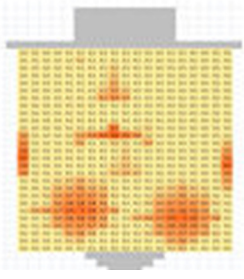
If we can build a system that recognises digital (rather than visual) patterns and match them to known claim outcomes - valid, declined, operating peril etc., - then we have a system that can start to think for itself.

If the system can recognise patterns then it can learn by building the template of a 'valid, root induced clay shrinkage claim' by looking at the database. What do they look like?

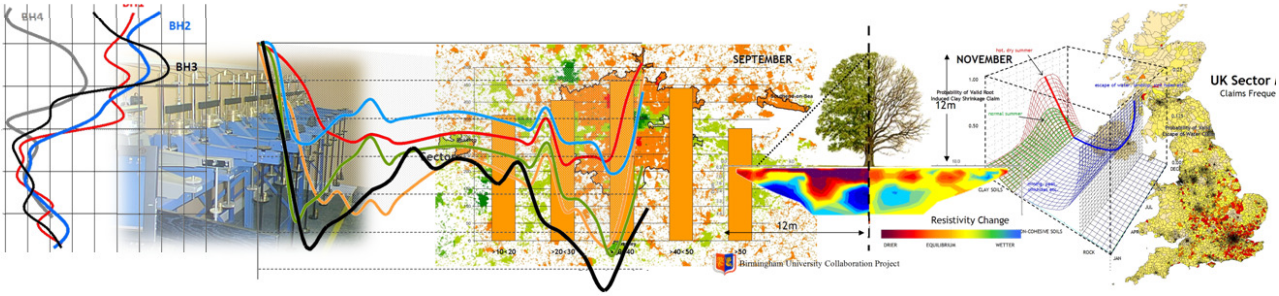
The eyebrows, nose and mouth are a perfect match. The face is recognised by the application and scores +1.



The system has spotted a frown and the right eyebrow is a little different. This pattern scores +0.76.



No eyebrows and upside down. It doesn't get much worse. This pattern has a negative score of -0.07.



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Detecting Differences

Imagine that the eyebrows record the tree species and metrics - height and distance etc. The nose the geology, with scores in the range 0 - 1 and where 0 = rock and 1 = clay. We know there are considerable variations in terms of risk amongst the clay series.

Perhaps the eye reflects variations in risk related to the property age, implied depth of foundations, use of lime mortar and so forth.

The ears might reflect the time of year the claim was notified and the cheeks the weather. Investigations, monitoring and soils results might shape the chin.

By carrying out a statistical analysis the application will arrive at a figure reflecting the current probability of the claim being valid or otherwise, and the operating peril.

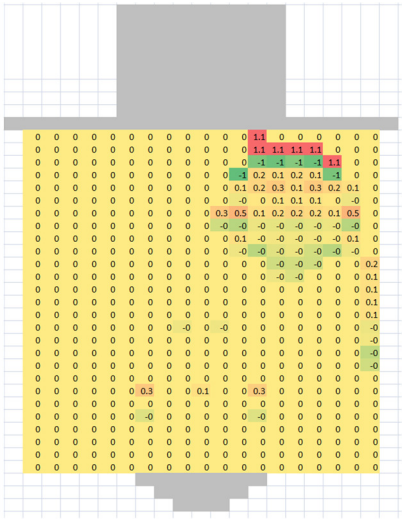
Let's say a score greater than 0.7 means a high probability of the claim being valid. We don't have to concern ourselves because the system can carry out the analysis using the historic claims database together with any prevailing factors - 'is it a surge year' for example.

One of the benefits is the capability to undertake analysis from a variety of directions with differing focal points.

For example, we can use one layer to check for a particular peril and another for validity.

The system can then produce exception reports that might suggest 'check geology - BGS map records sand and our records from a borehole sunk at No. 18 suggest shrinkable clay'.

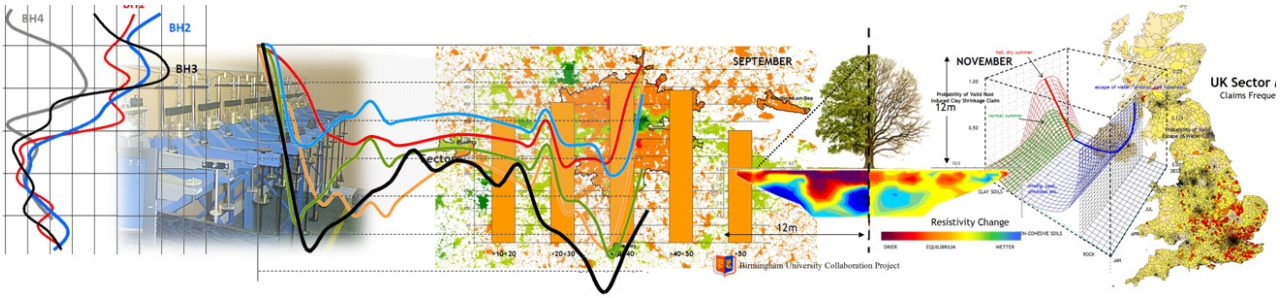
The plot below reveals the differences between the template from the previous page and the second image down from the top.



Where differences exist, the application can identify them and more importantly, ascribe a value to that difference.

Not only can it detect patterns when they match, but also where they differ and by how much. In this case, the difference between Walt and the second face down is 0.24.

That difference is the right eyebrow, eye, ear and mouth which differ slightly. When things don't stack up, the application knows where and by how much.



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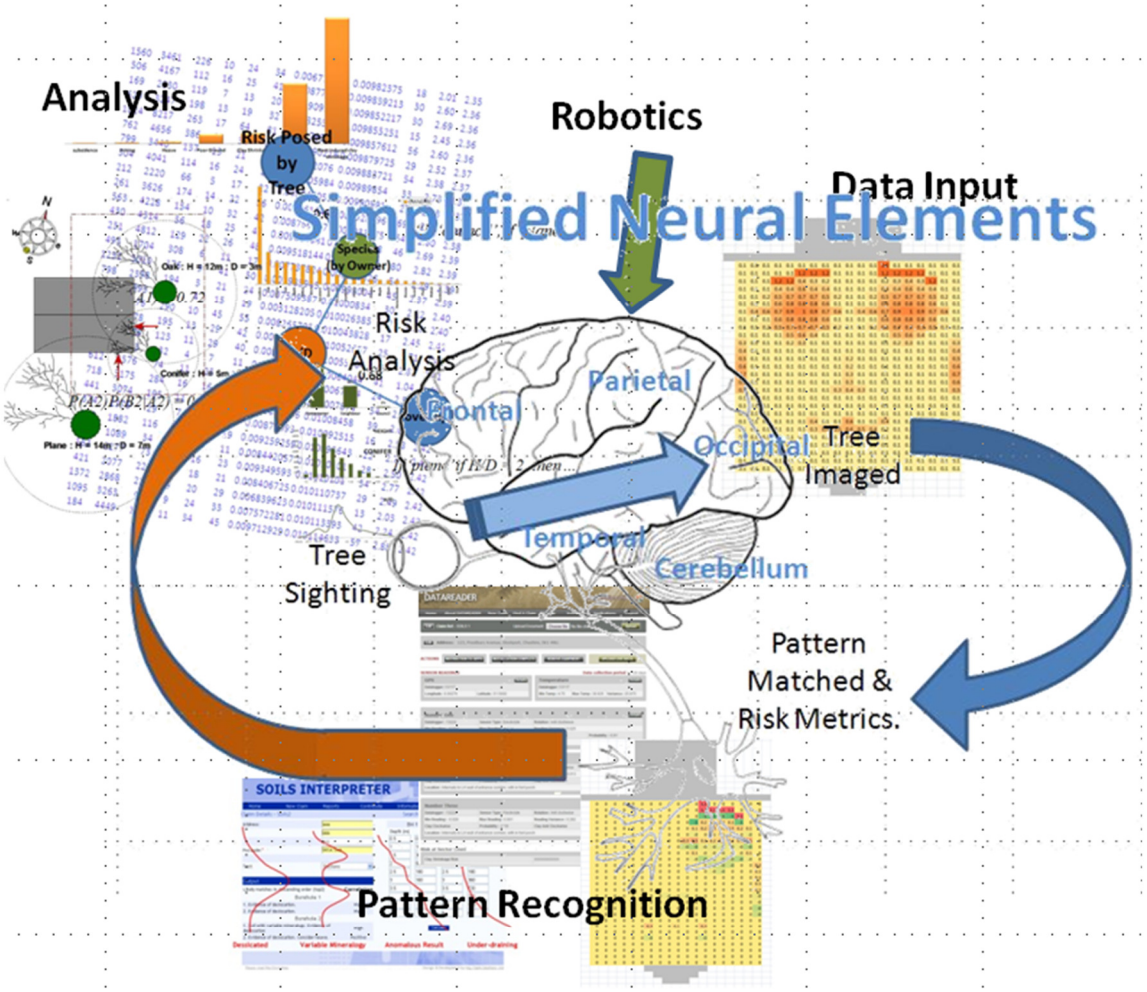
As an aside - just how 'neural' are we?

Pattern recognition and AI have become fashionable but just how close are the architectures of brains and computer systems? The much simplified illustration below shows how and where the various elements sit. The AI applications are of course trivial in comparison even with the brain of an ant (no disrespect to ants) but a starting point.



Data enters the system and has to be registered somewhere. Databases for us, and the occipital lobe for brains. Do we recognise it? Pattern match it to see if it corresponds with anything in our memory/database (or temporal lobe) before passing on to our AI system (frontal lobes) for action. Next generation will involve robot control (parietal lobes). It all fits together - sort of.

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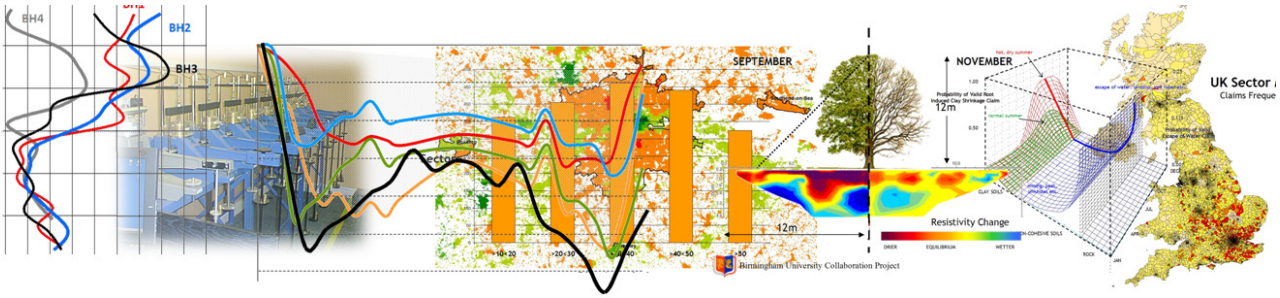

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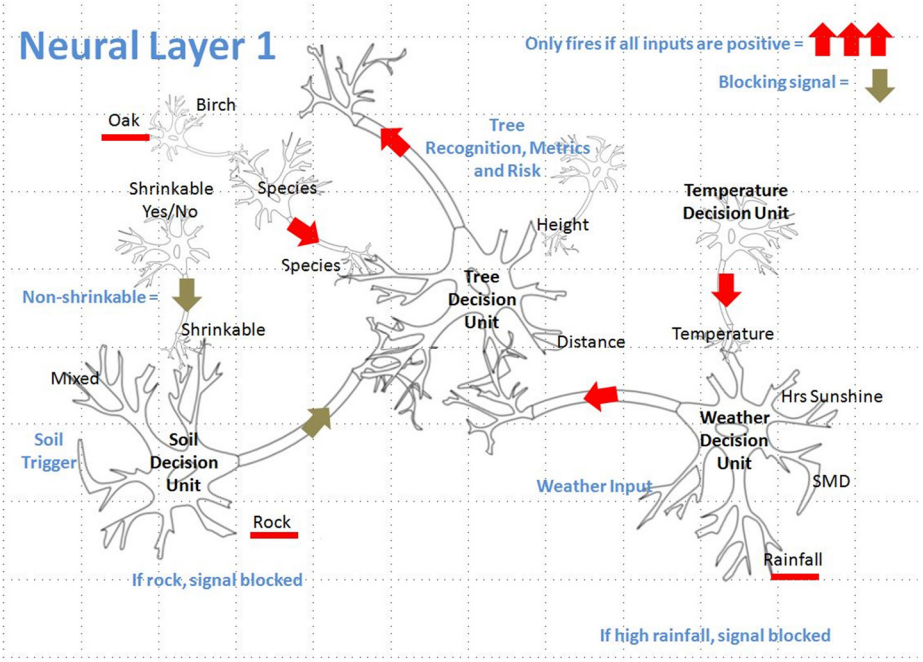
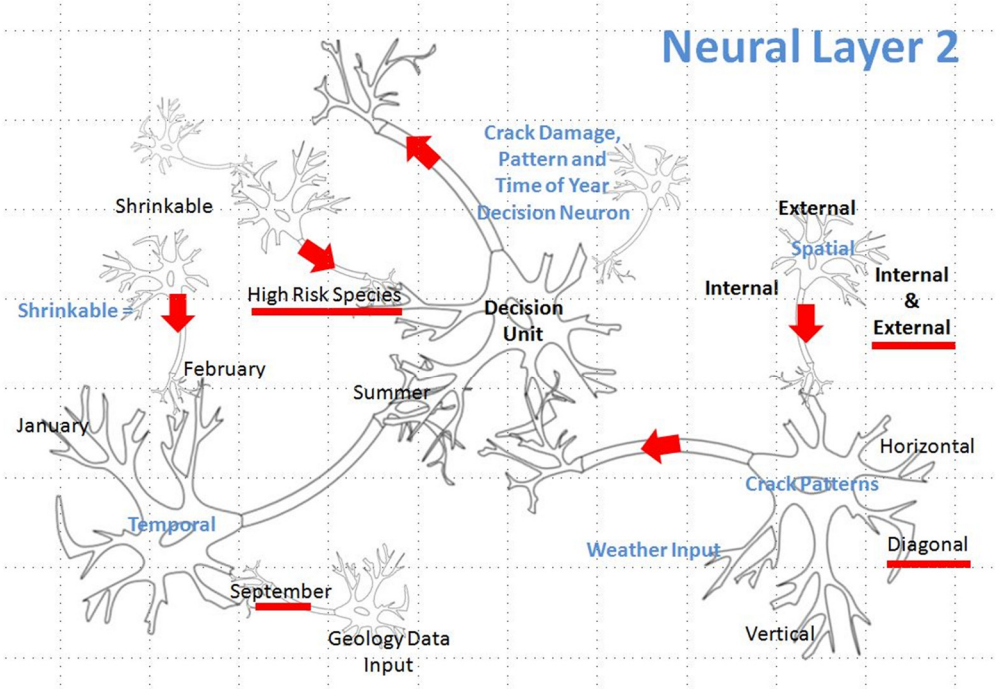
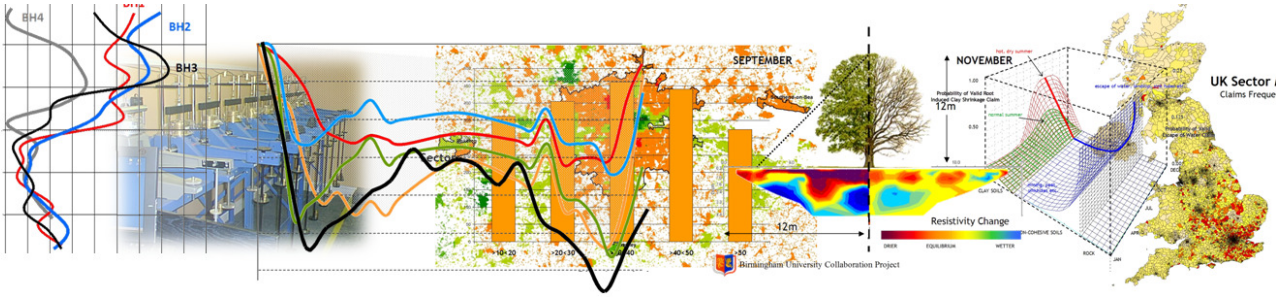


In the above example, the 'is it clay shrinkage' option is blocked due to the presence of rock and heavy rainfall. One blocked pathway stops the signal going forward.



Temporal data include time on risk, date of notification and periodic signatures from monitoring. Patterns of damage are taken in to account as well as location to add another layer to the decision making matrix. 'Neural Layer 2' supports a valid claim.



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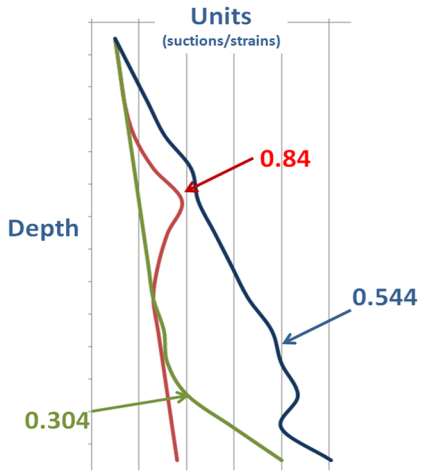
Example of Pattern Matching using Soil Test Results



Using the pattern matching application to assess whether soils are desiccated, the above profiles and outputs suggest that the red plot is the closest to a desiccated profile with a score of 0.84 on a scale of 0 - 1.

The other soil test results (green and blue) deliver low scores when compared with the desiccation template, confirming that they are not desiccated.

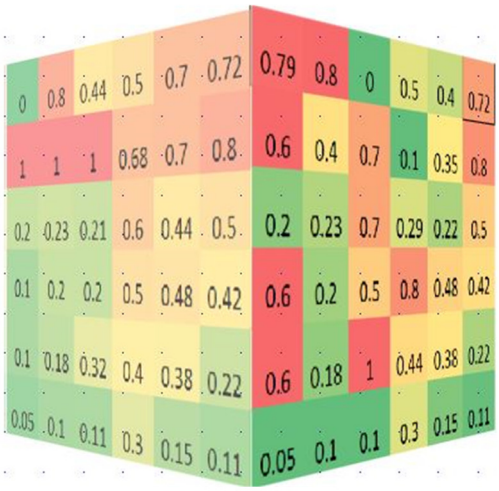
Maximum and minimum absolute values can be added to refine the decision making process of the application. For example, in the case of soil testing variations from the Ko line of say 50kPa might be coded to be ignored.

Developing the AI Cube

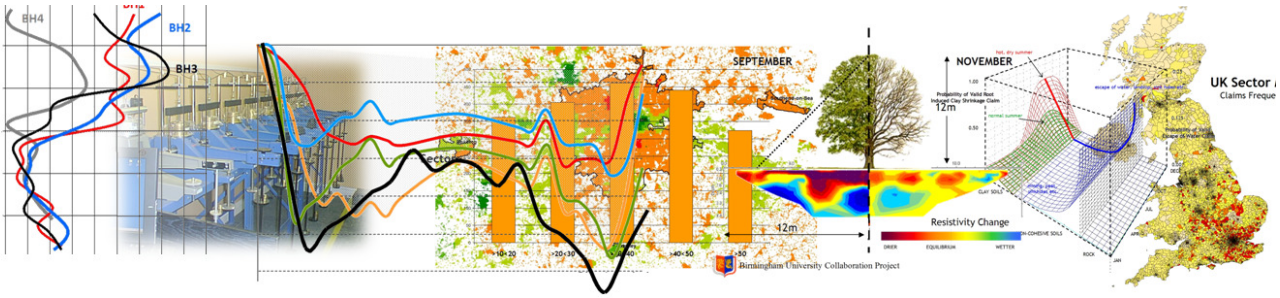
Walt's face has been useful in introducing the theme of how we use pattern matching to recognise differing outcomes.

The AI application uses a more formal (and less interesting) approach with the development of a cube. It has exactly the same purpose and input is from a series of specific applications that we touch on in the following page. The cube stores the outcomes.

As an example, let's assume that the top, left hand corner of the cube (below) contains the results of soil tests. There is a 0.79 probability that the soils are desiccated as a result of root activity.



The adjoining box comparing the monitoring results with a periodic signature scores 0.8.



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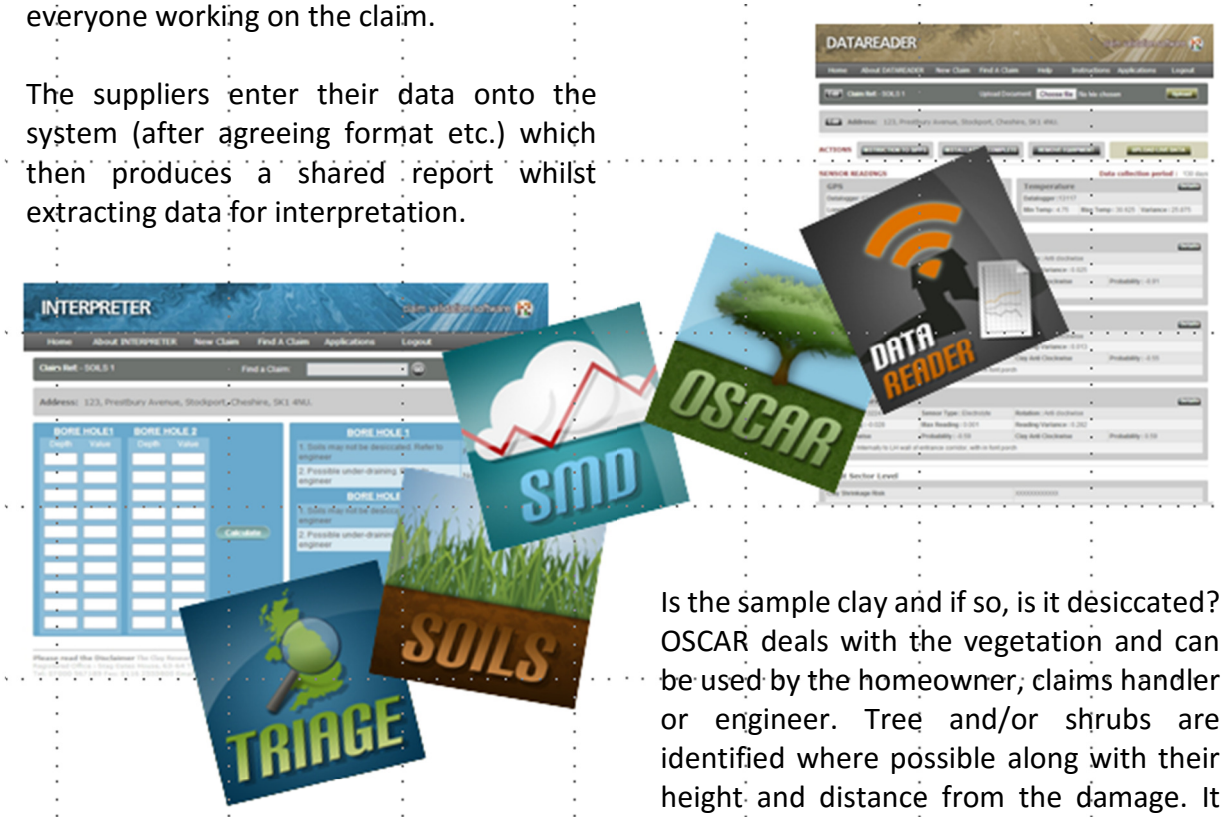
A.I. Modules & Suppliers

Instead of suppliers entering data onto their systems, producing reports in Excel, pasting into Word and then saving as pdf files, the application provides input screens for everyone working on the claim.

The suppliers enter their data onto the system (after agreeing format etc.) which then produces a shared report whilst extracting data for interpretation.



The system uses pattern recognition techniques to interpret the data using one of the above modules.

The Triage module assesses whether the claim is likely to be valid, determines whether a visit or a phone call is needed and if a visit is required, handles logistics to improve efficiency. It also provides some first line assessments based on location, time of year, geology and so forth.

The Soils module interprets results from the soils laboratory, where samples have been retrieved.

Is the sample clay and if so, is it desiccated? OSCAR deals with the vegetation and can be used by the homeowner, claims handler or engineer. Tree and/or shrubs are identified where possible along with their height and distance from the damage. It cross-references with the Soils module and, using a database of risk, models likely ground movement and the likelihood of being implicated.

SMD module analyses the weather and also provides input into the OSCAR module. DataReader interprets soils and monitoring data including data gathered from remote sensing devices.

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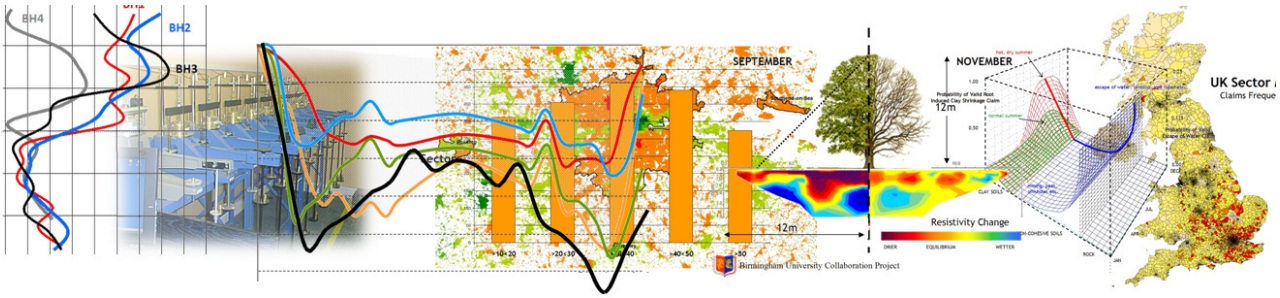

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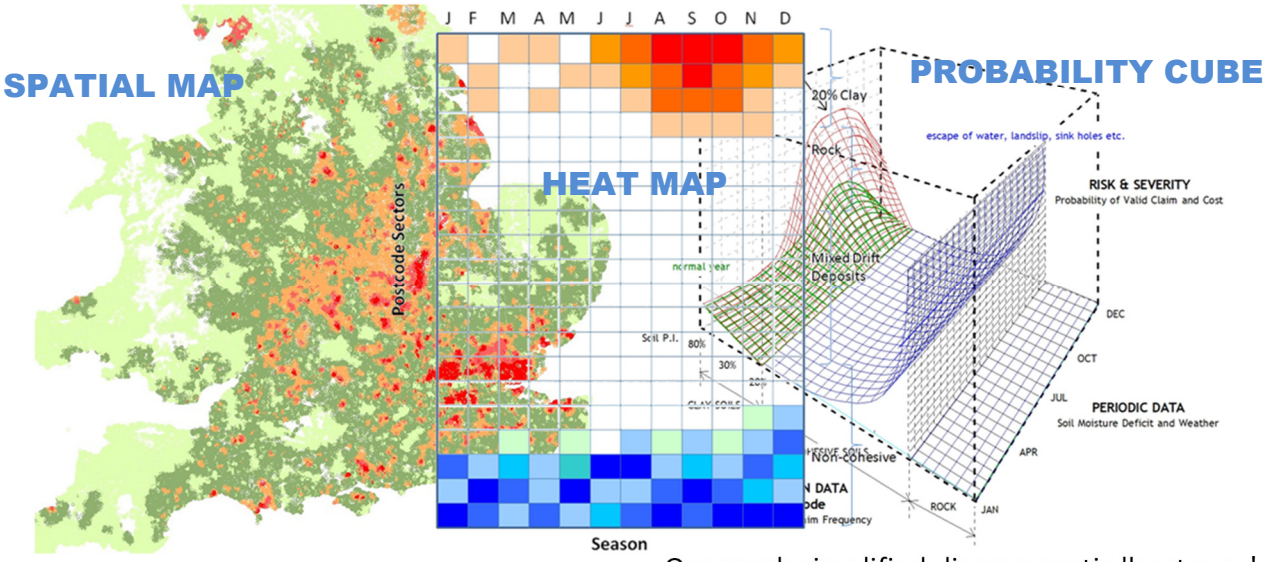
Data Sources

Different Representations

Claim databases provide an excellent source of information and reflect the portfolio of the insurer, taking into account local demographics, broker connections etc.

Other sources include the BGS, Met Office and of course claims data from the ABI etc. It's worth noting that ABI data relates to the status at time of notification and not outcomes.



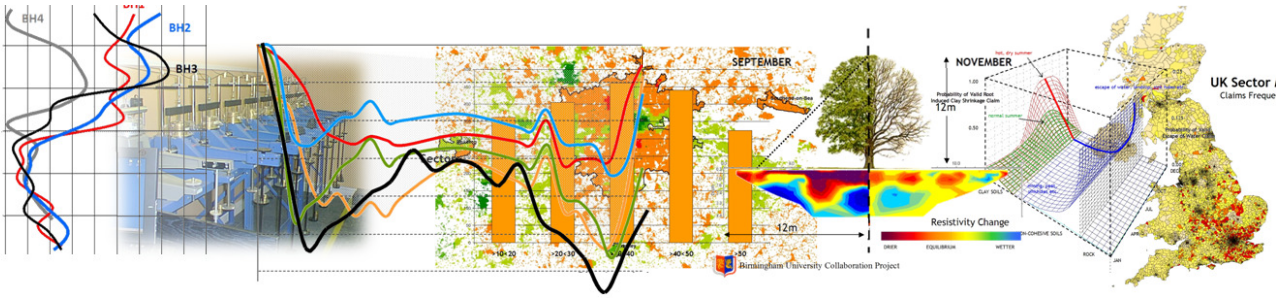
Supplementary sources include Census data which list details of house age, style and demographics relating to lifestyle of the occupants. The Census includes classes of ownership (owned, purchasing, housing association, Council etc.) and house style - semi-detached, terraced, flats etc.

The Census also provides information on age of householder, occupation, number of cars and age of children etc. This data has been used by academics to understand if there is a correlation between crime and deprivation.

Our much simplified diagrammatic 'heat map' (centre) of the UK illustrates the risk at postcode sector level. Top (in red) are sectors with a predominantly clay soil. Bottom, in blue, sectors that record predominantly water related subsidence claims.

The clay series becomes riskier the higher the shrink/swell characteristics (towards the top of the graph) and have a periodic signature with risk increasing in the summer months.

In contrast, water related claims do not exhibit any particular relationship to the weather and the risk is more scattered amongst the sectors.



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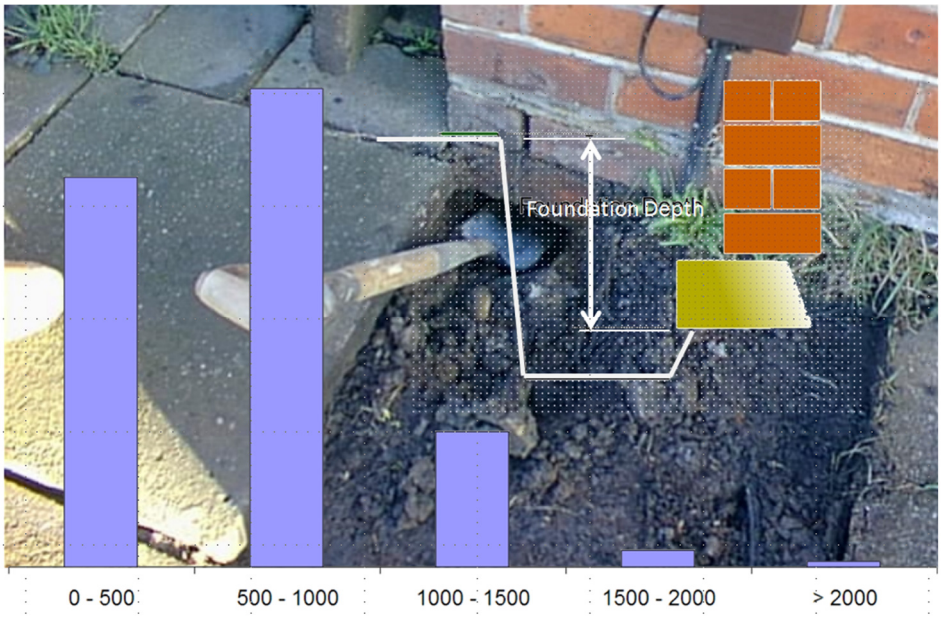
Foundation Depths



From a sample of valid claims where investigations have been undertaken, the range of foundations depths expressed as a percentage. 56% were less than 600mm deep (above graph is in 500mm divisions), typically belonging to older houses and pre-dating modern Building Regulations.

The deeper foundations may have included a small number of claims where underpinning had already been carried out and further damage reported.

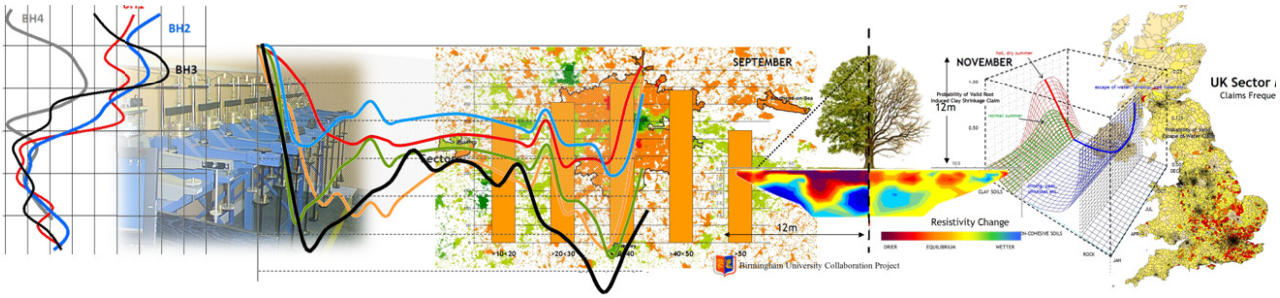
Mike Crilly carried out a study whilst at the Building Research Establishment and came to the following view in his paper "Analysis of a Database of Subsidence Damage" published in Volume 19 of Structural Survey, 2001. "Overall, about 5.5 per cent of cases (where information was provided) had been previously underpinned and suffered a recurrence of damage."

Family Fun Day

British Geological Survey

The BGS are holding a Family Fun Day at their Keyworth site in Nottingham on Saturday, 19th March and everyone is invited. Hands-on activities for children, talks and demonstrations. Free admission and opens from 10am to 4pm.

If around 5% of valid claims are underpinned and 5% of those return, the number re-opening in a normal year is around 30-40.



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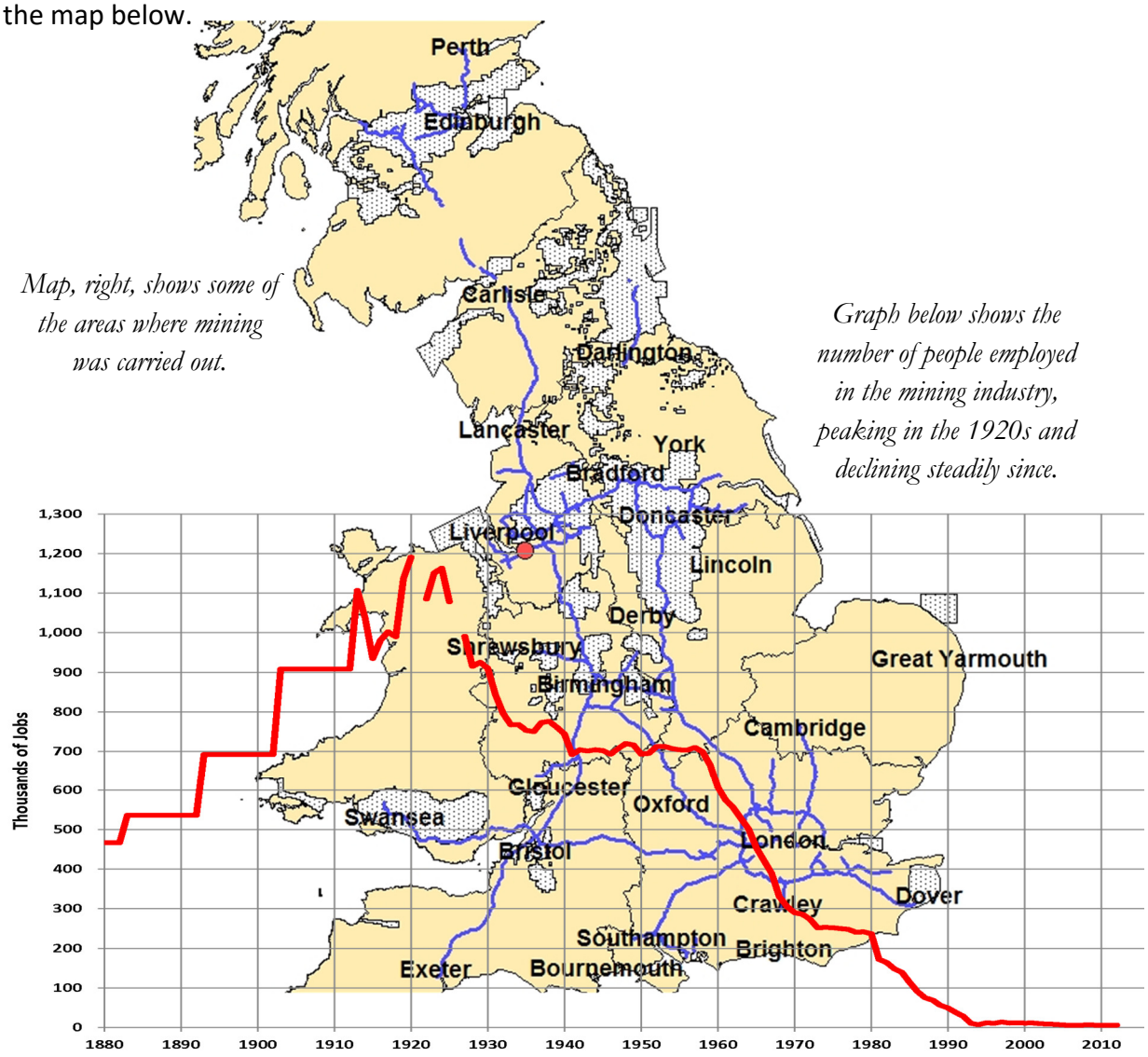
Mining Compensation Areas

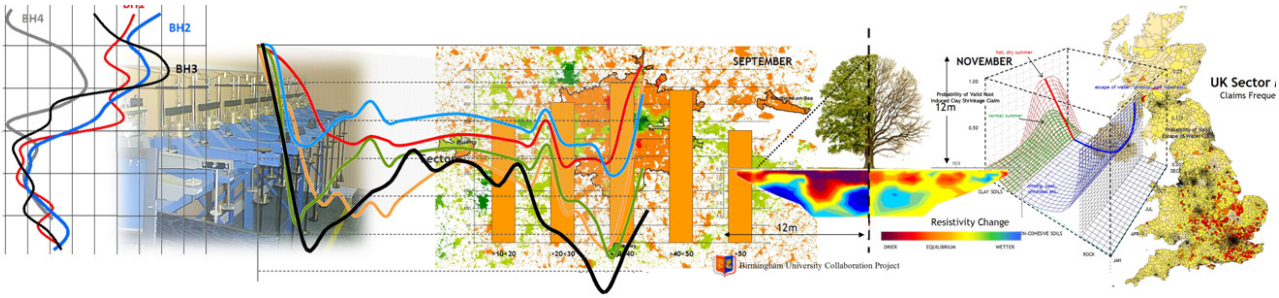
Damage resulting from the collapse or settlement of old working have diminished over the last 20 years or so, and follow the profile of employment in the mining industry (bottom graph). As we know, compensation is payable by the Coal Authority for such damage and they are responsible for carrying out investigations to determine causation.

Benefits for the homeowner include (a) no policy excess, (b) recovering costs of surveyor/engineer if claim is proven. The address for notification is The Coal Authority, 200 Lichfield Lane, Mansfield, Nottingham, NG18 4RG. Some mining areas are shown on the map below.

Map, right, shows some of the areas where mining was carried out.



Graph below shows the number of people employed in the mining industry, peaking in the 1920s and declining steadily since.



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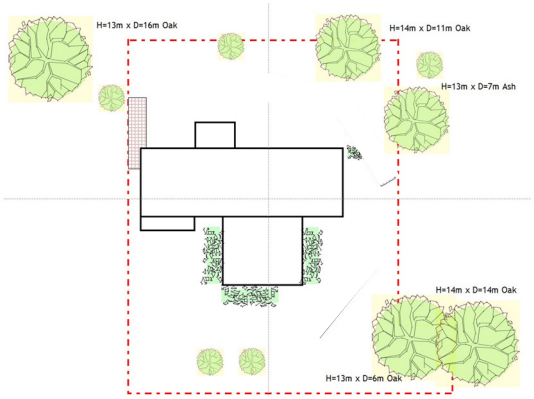
Intervening

Monitoring Update - Intervention Technique



Above, site plan of one of the first properties treated (early 2007) using the Intervention Technique.

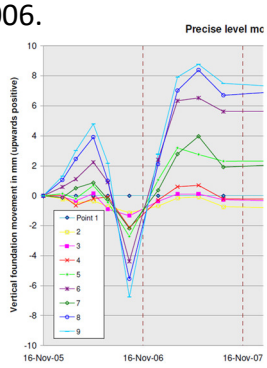
The soil is Mercia mudstone with a PI of around 30%. Not as troublesome as some found elsewhere in the UK but causing recurrent damage to this detached property under the influence of several mature oak trees, the most troublesome of which is 13mtrs tall and 6m distant from the building.

The homeowner was keen to retain the trees and underpinning/piling seemed excessive for the level of damage. Nonetheless, something had to be done and after lengthy discussions with the homeowner it was agreed that the intervention technique be used and the house monitored using precise levels.

Recovery took place shortly after the teatment was applied.

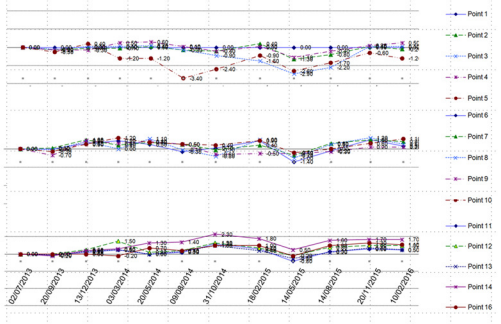
Background - a claim for recurrent damage was notified in 2005 and downward movement exceeding 10mm was recorded in 2006.

Level monitoring from November 2005 through to November 2007 revealed seasonal movement followed by recovery.

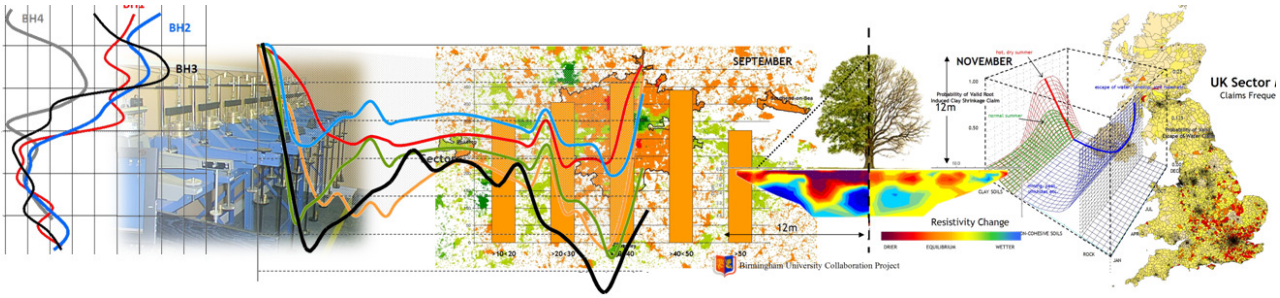


The Intervention Technique was installed early in 2007 and the building responded well by recovering 14mm.

Subsequent monitoring has shown stability with movement at the station nearest to the most influential of the oak trees (point 6) limited to 3.4mm.



The treatment has yet to be tested through a dry summer but the approach has been welcomed by the homeowner. In fact, when a neighbour had a similar claim a few years ago, they requested the same repair.



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Trees, the environment, and Sheffield Council

Sheffield Council have felled 3,000 trees, replacing them with saplings (below, right). The before -and-after pictures below tell the story. Campaigners are concerned that 75% of the council controlled tree stock is under threat.

The Council explained that dead, dying and diseased trees have been cut down, along with trees that might be damaging roads or causing an obstruction to pavements. The council dismissed criticism of mass felling, saying many of the trees have been replaced with saplings. A spokesman said an independent study a decade ago found that 75 per cent of roadside trees were approaching the end of their natural life.

Campaigners raised money using crowd sourcing and took the matter to court. They persuaded Mr Justice Dove to halt the chainsaws on the grounds there had not been a 'proper and fair consultation' about the felling policy. His ruling was made 'pending further investigation' and could remain in force for three months.

The injunction reads: "The Defendant (i.e. SCC) and the Interested Party shall not, whether by themselves, their servants, agents or otherwise, fell any street tree in the City of Sheffield under the Sheffield Streets Ahead Project unless an appropriately qualified independent arboricultural expert has produced a written report stating that the tree presents an immediate danger to the public and must be felled."

Met Office Supercomputer Project

A supercomputer has been installed at Exeter Science Park as part of their High Performance Computing Project (HPC). The collaboration between the Met Office and Exeter University offer opportunities for both academics and businesses.