Introducing
Philip Sallis

- Undergraduate degrees in NZ. PhD in London, England
- Academic positions in UK, Australia, NZ
- Visiting and Adjunct Professorships in UK, HK, USA and Chile
- Research in geophysics and geo spatial systems, software engineering, computational linguistics
- Joined AUT in 1999 as DVC (Pro Chancellor)
- From today
  - Director Geoinformatics Research Centre
  - Pro Vice Chancellor (Innovation and Enterprise)

AUT

Auckland University of Technology

- 140 years old but established as a university in Jan 2000
- 26,000 students (4000 international students)
- 15% postgraduate (Masters, PhDs, some PG Diploma)
- 4 Faculties on three campuses:
  - Business and Law
  - Design and Creative Technologies
  - Health and Environmental Sciences
  - Humanities
- 12 Research Institutes and 10 Research Centres
- Technology Park
  - Business Innovation and Enterprise
  - Research Commercialisation

The
Geoinformatics Research Centre

www.geomaticsresearch.org

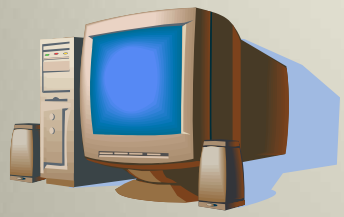
Professor Philip Sallis
Director

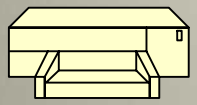
School of Computing and Mathematical Sciences
Auckland University of Technology
New Zealand

www.aut.ac.nz

GRC Profile

established August 2007





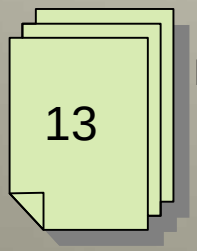
Server, computers,
printers, cameras
sensors, analysers

8 more scientists
in 5 countries

AUT 3 full-time
+ 3 associates
+ 1 administrator
+ 2 interns

2+5 PhD
students

Electrical tools and
lab equipment



Publications

6 vineyards
in 4 countries

Expertise

- Mathematics and Statistics
- Computer Science & Software Engineering
- Electrical Engineering
- Biology and Zoology
- Forestry and Environmental Science
- Geodetic Science and Geocomputation
- Oenology (*enology*)...wine science
- Viticulture
- Climatology

Current GRC projects
staff and students

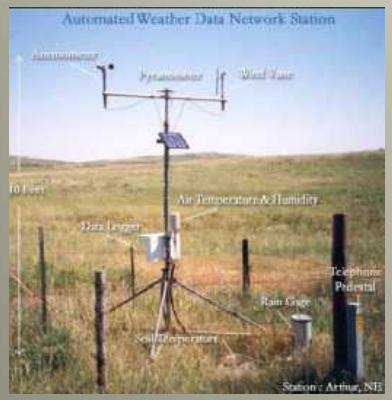
- **Data mining – wine quality influence factors**
  - climate and atmospheric data processing with neural networks
  - data relationship depiction and result visualisation methods
- **Text and Audio Mining**
  - taxonomy construction from wine characteristic descriptions (text)
  - coincidence of verbal tasting keyword descriptions of wine with expert database of terms (audio)
  - analysis of discourse relating to wine quality (comparative study in Spanish and English)
- **Geocomputation**
  - spatial DB construction
  - Remote sensing, image rendering and processing
  - Image processing method with spectrum analysis of fruit colour and taste
  - sensor construction, data logging, signal processing and wireless communications technologies
  - prototype construction of robotic multi-sensor device
  - real-time data ingestion infrastructure design and operation
- **Geometrics** – equations and algorithms for geo-spatial measurement & modelling
- **Geographic Information Systems applications**
  - forestry management
  - health service delivery
  - tourism provision

The Main Project

'Eno-Humanas'

Modelling and Prediction

Data Acquisition



Sensor technology

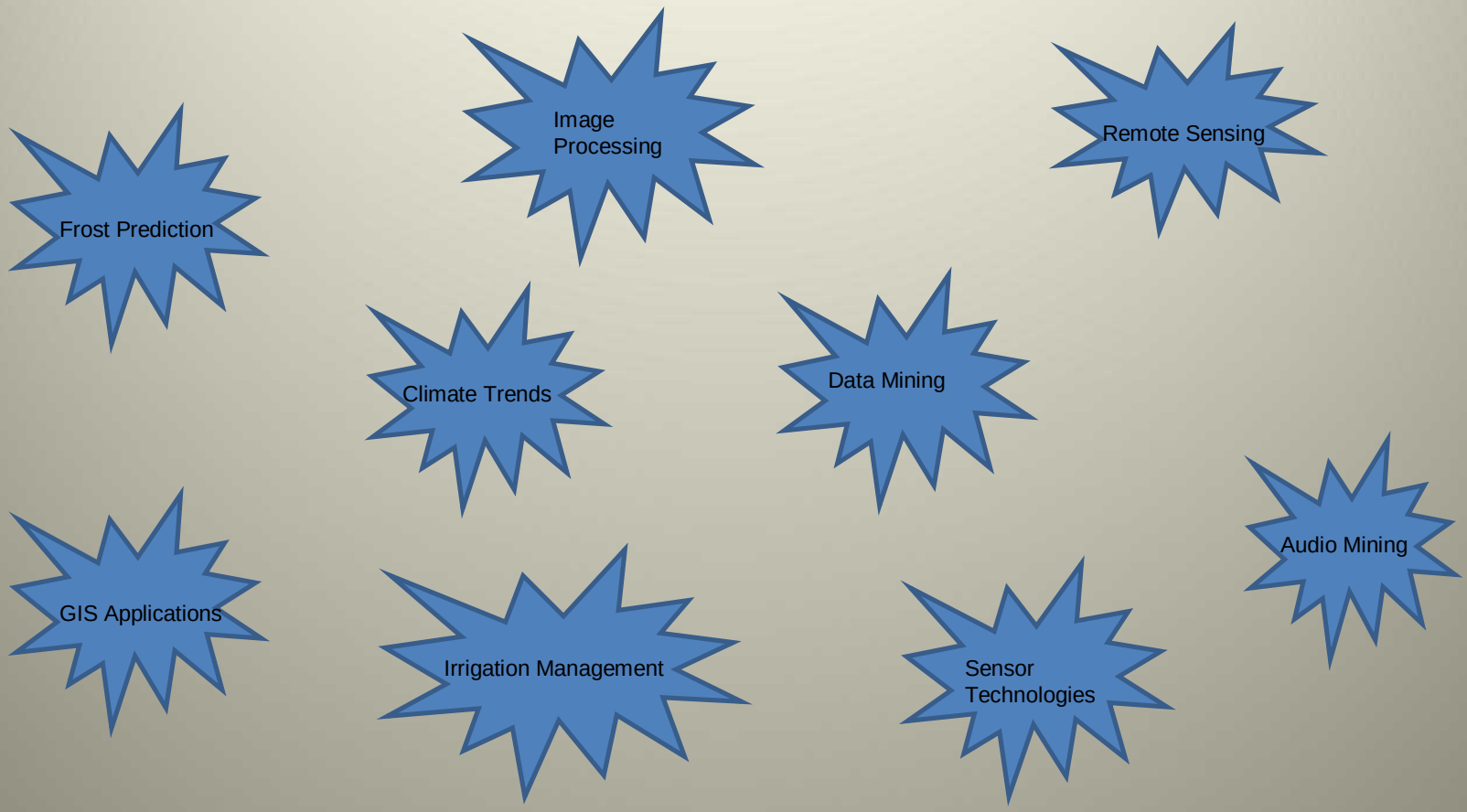
Precise data

Sensory perception

Imprecise data

Precision Agronomy

The Main Project

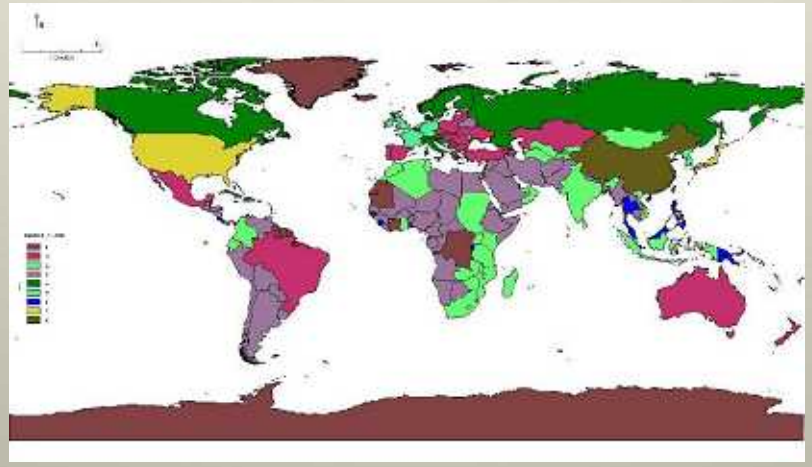


Spawns sub-projects

'Eno-Humanas'

Environmental factors influencing good grape growth for the production of great wine…an empirical study

USA



Japan

Chile

New Zealand

Uruguay

An International Research Collaboration

integrates precision data from sensors, with telemetry and software technologies plus human sensory perception (opinion) data

Eno-Humanas
It all began in 2007 with a question:

"What makes a good year for wine?"

Four main variables for good grape growth to make great wine

- Soil
- Climate
- Variety
- Terrain

Numerous correlated sub variables comprise matrix of environmental factors

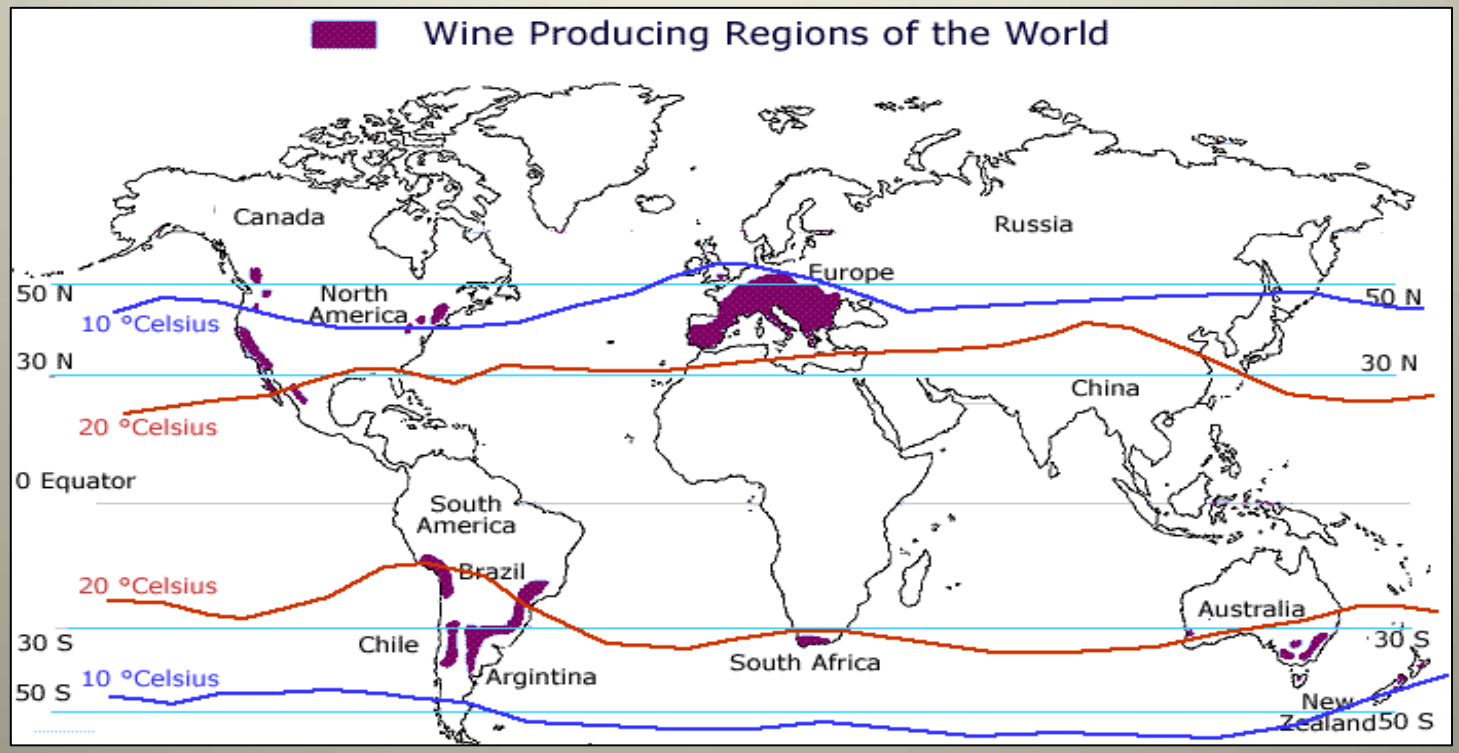
The Matrix
(database)

Unique Key (concatenated)= time+date+long:lat

Vector data

Temperature	^{o}C
Wind Speed	km/hr
Wind Direction	Ddd
Wind Chill	^{o}C
Humidity	%
Dewpoint	^{o}C
Solar Radiation (Pyrheliometer for Photsynthetic Light Measurement)	$umol/m^2/sec$
Pollution factors (CO_2)	%
Rainfall	mm
Barometric Pressure	hpa
Soil Moisture	%
Soil Temperature	^{o}C
Leaf Wetness	%
Sap Flow (volume and speed)	Ltrs/min
Plant growth Rate (Dendrometer)	%
Chemical composition analysis (Chromatographer)	%

Grape and wine characteristics relating to location, growing conditions, climate and environment

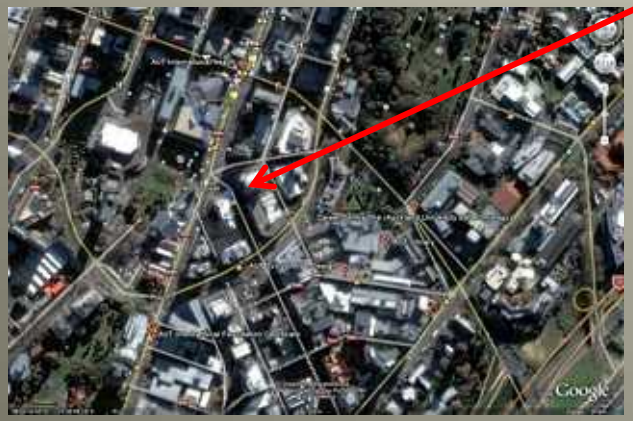


Research Partners

- **Universities**
  - Auckland University of Technology, New Zealand
  - Universidad Catolica del Maule, Chile
  - Universidad de Talca, Chile
  - ZonAmercia, Montevideo, Uruguay
  - University of California at Santa Barbara (UCSB)
  - Asia Pacific University, Beppu, Japan
- **Industry Partners**
  - EDA Systems, Irvine, California, USA
  - *Mahurangi River Winery,* Auckland, New Zealand
  - Kumeu River Winery, Henderson, New Zealand
  - *Casa Donoso Winery,* Maule, Chile
  - *Santa Elisa Research Vineyard*, Parral, Chile
  - La Agricola Jackson Winery, Montevideo, Uruguay
  - Fallbrook Winery, Irvine, Sth California

APU:33 20 N 131 28 E

Fallbrook: 33º 22’ N 117º 14 W’



AUT: 36º 51’ S 174º 52’ E

UCM: 33º 20’ N 131º 28’ E

Montevideo: 34º 53’ S 56º 04’ W

MAHURANGI RIVER

Producers of fine New Zealand wines

www.mahurangiriver.co.nz

Casa Donoso Winery, Valle de Maule, Chile

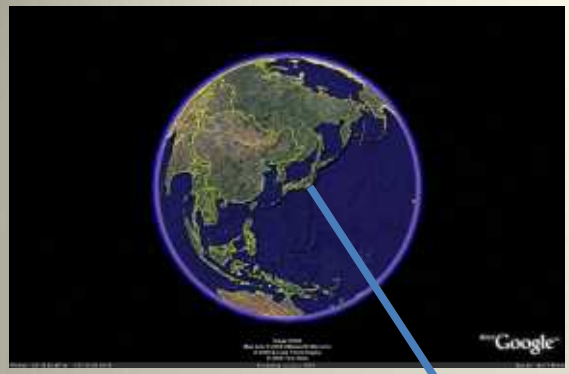
Santa Elisa Experimental Organic Vineyard, Parral, Valle de Maule

Universidad Catolica del Maule, Chile

La Agrícola Jackson

La Agricola Jackson, Montevideo, Uruguay

***Fallbrook Winery*,**
Sth California, USA


Google

Japan – Ajimu


Shenyang
Harbin
East Sea
Sea of Japan
Yellow Sea
West Sea
Eastern China Sea
Nagoya
Taipei
© 2008 Europa Technologies
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Image NASA
© 2008 NPGIS
©2007 Google

Technology Partners

- Colleagues in Electrical and Computer Engineering (AUT and UCM)
- Commercial entities from whom we have purchased equipment (La Crosse, Davis, Garmin, etc)
- A sensor technology design and development company in Sth California (Cognetive Systems)

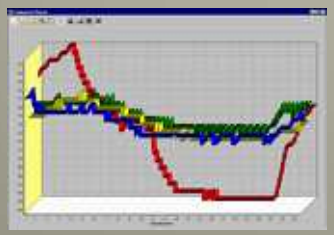
Electronic Design Associates (EDA) Inc

(*Cognetive*)

Irvine, California

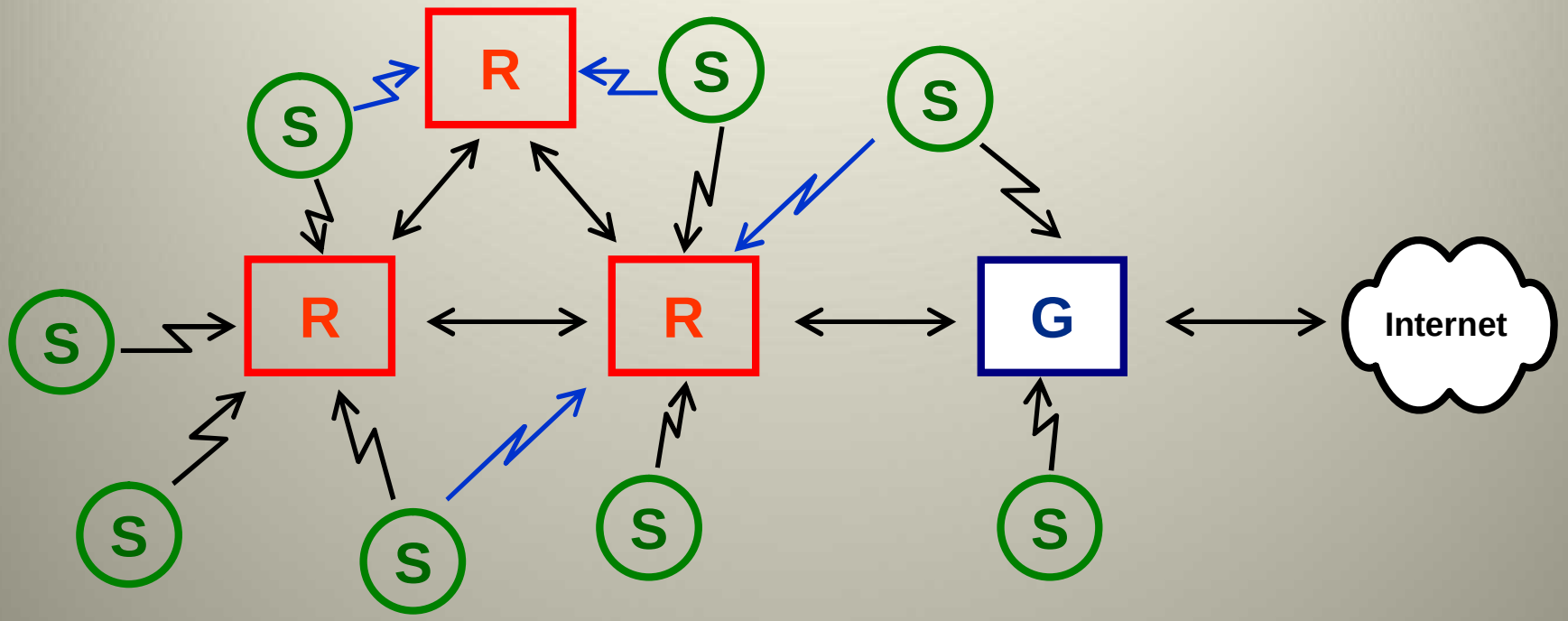
www.cognetive.com

New Zealand based subsidiary



Cognetive

Wireless Sensor Topology



S = Wireless Sensor (e.g. T, RH, Switch Closure)

R = Mesh Repeater

G = Internet Gateway

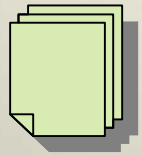
S Output = RF

R Output = RF and/or Serial

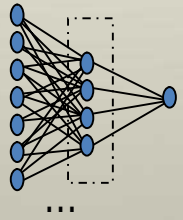
G Output = Serial or Ethernet

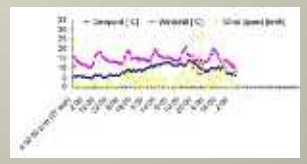
The *Eno-Humanas* system concept

Data gathered by sensors & uploaded to GRC server in real time



Trend analysis, prediction models, scenarios for crop management





NZ

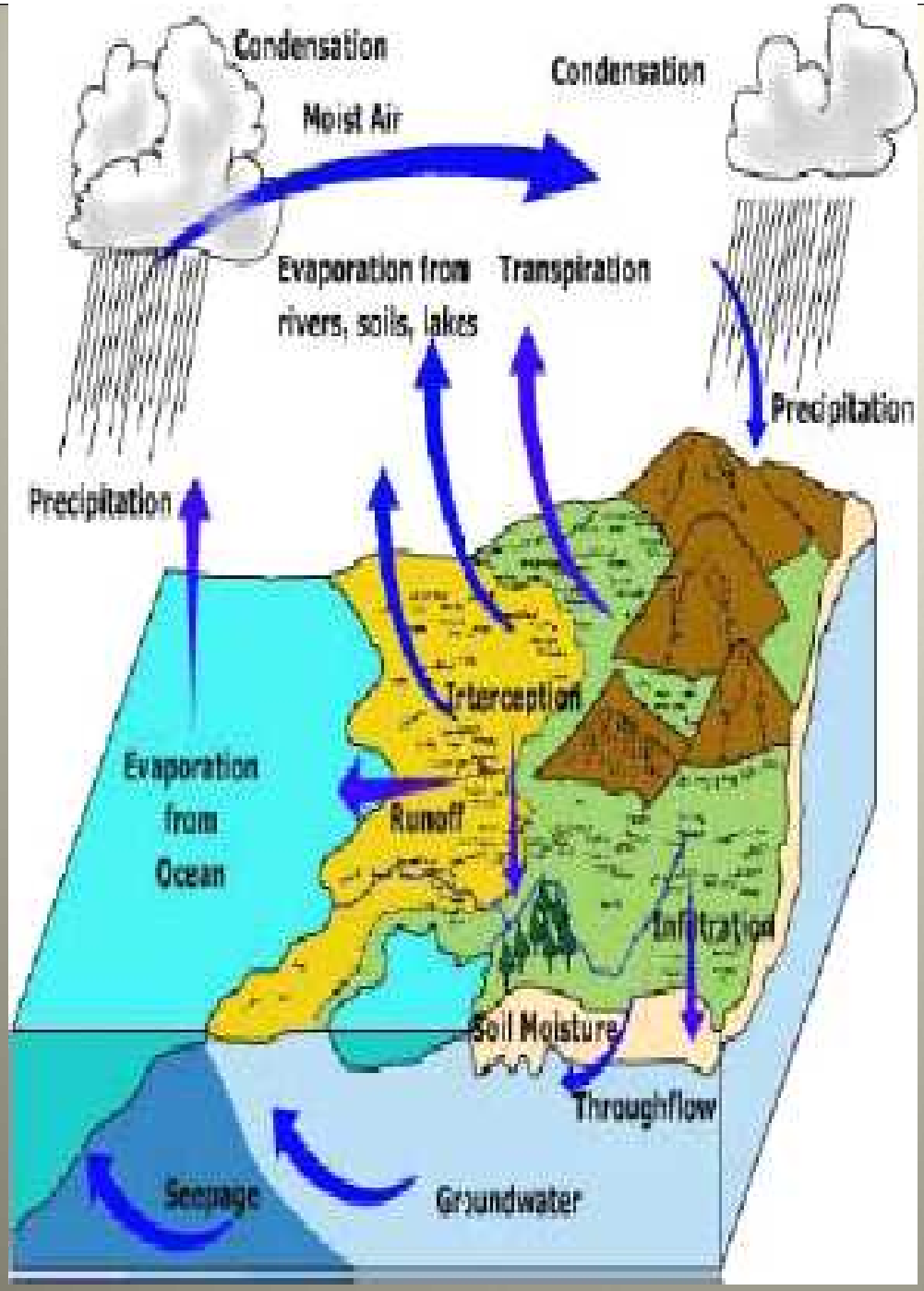
Chile

Japan

USA

Uruguay

Frost, irrigation, harvest, crop quality



CLIMATE

A major factor is the weather

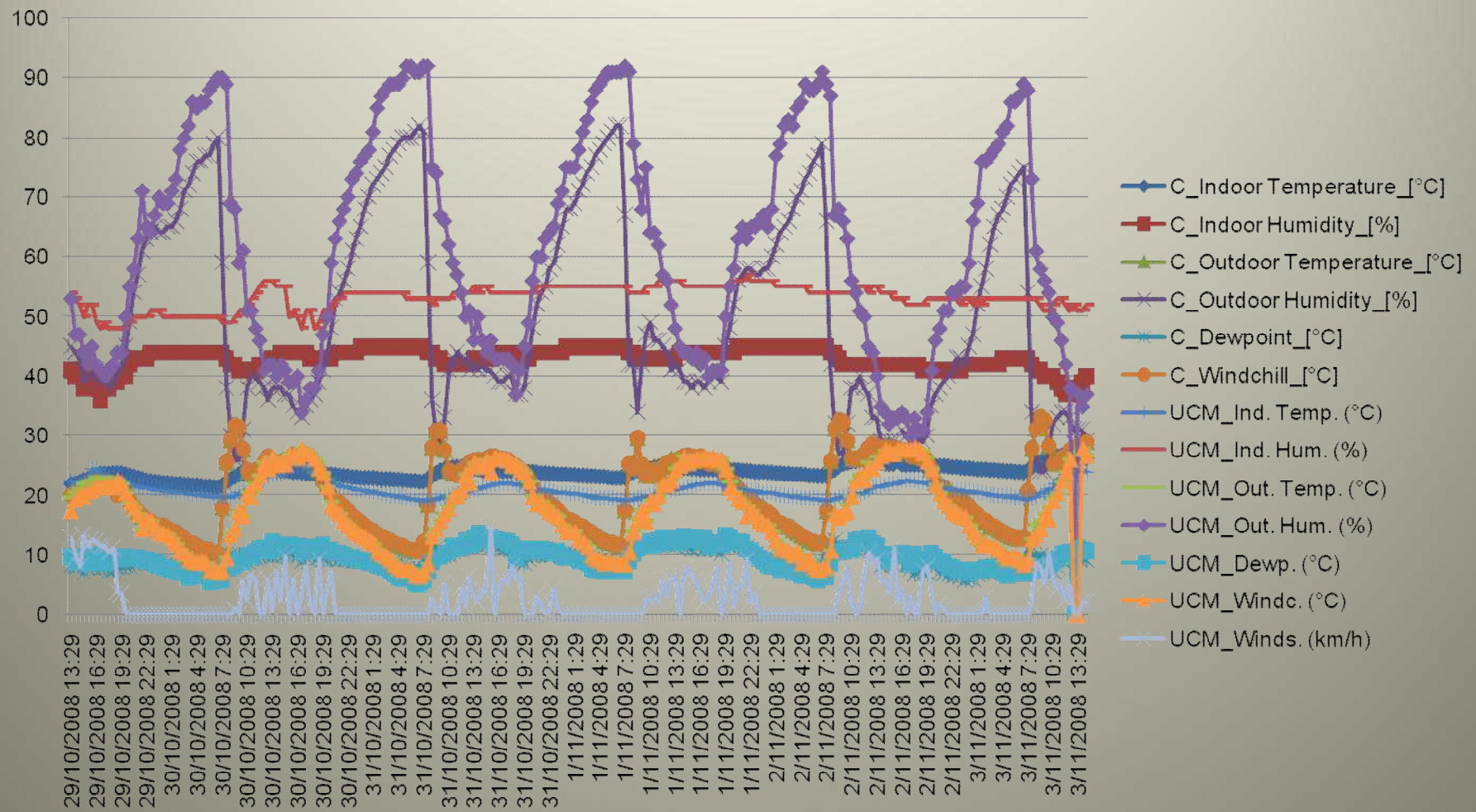
Weather patterns are changing.

We can't rely on historical data or intuition as in previous times, so prediction systems need to be built using historical and current real time data and micro climate sensitivity.

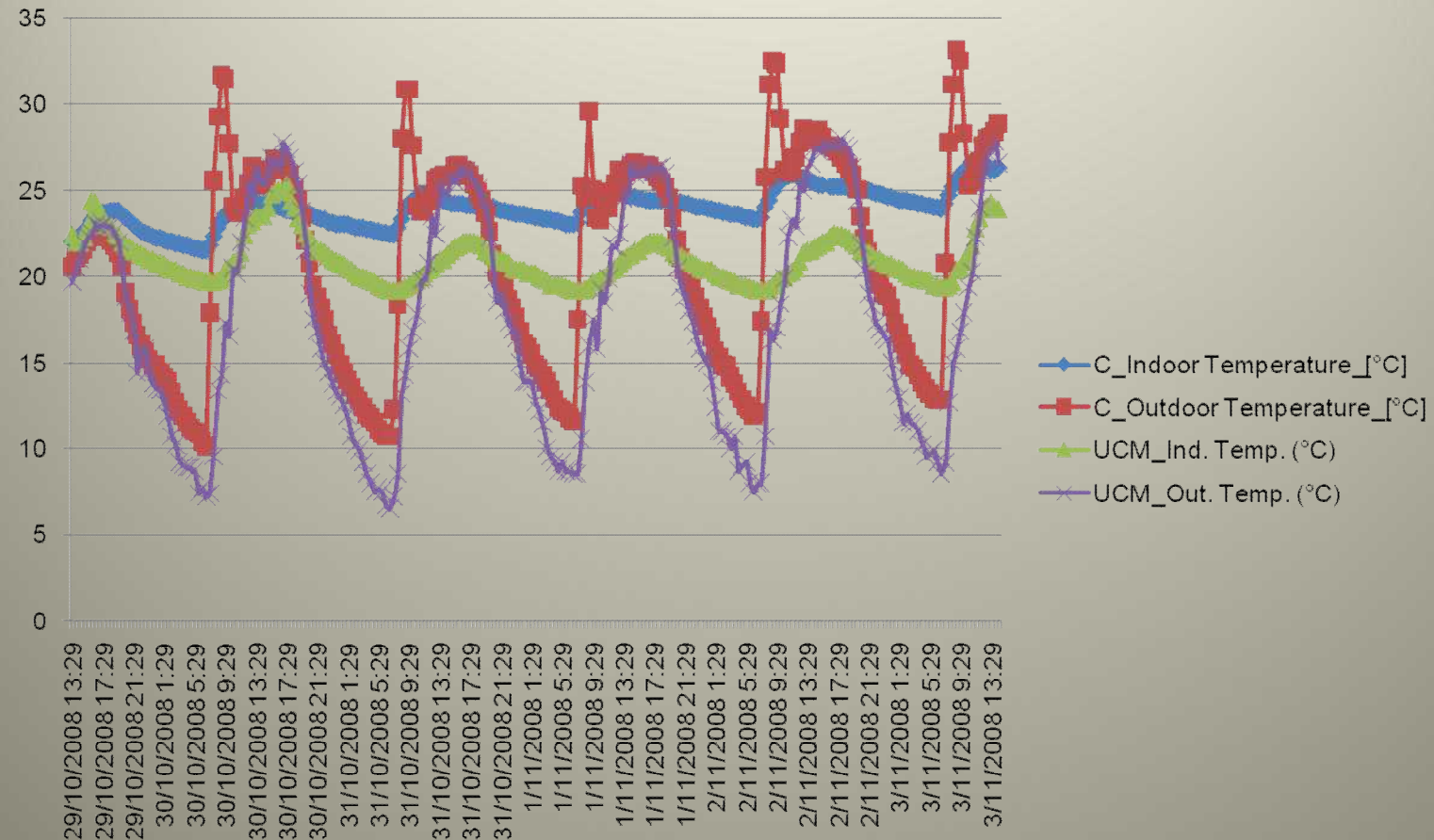
A multivariate nightmare!

Comparison of data from two locations only 5 kms apart

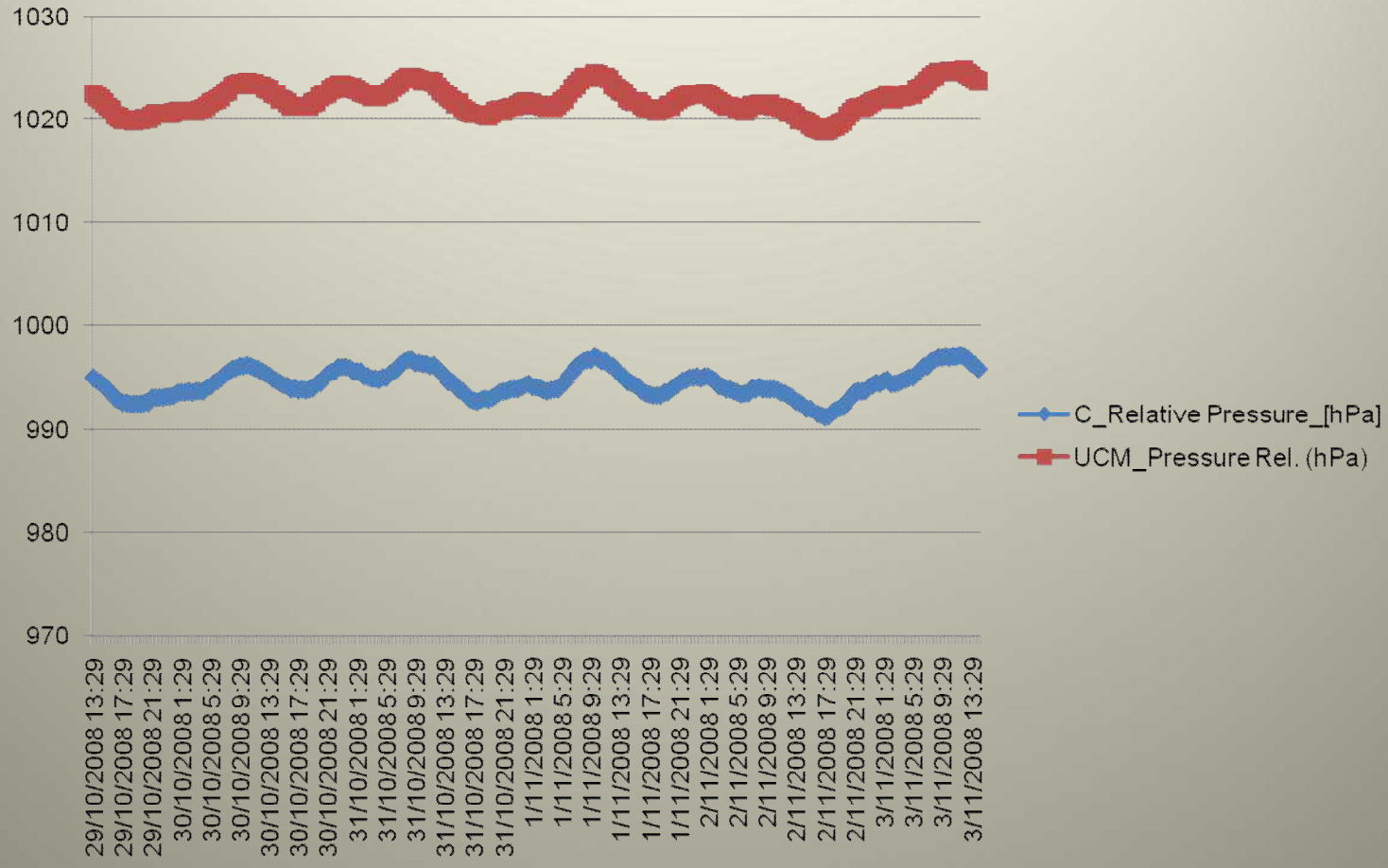
Casa Donoso Winery & UCM all data



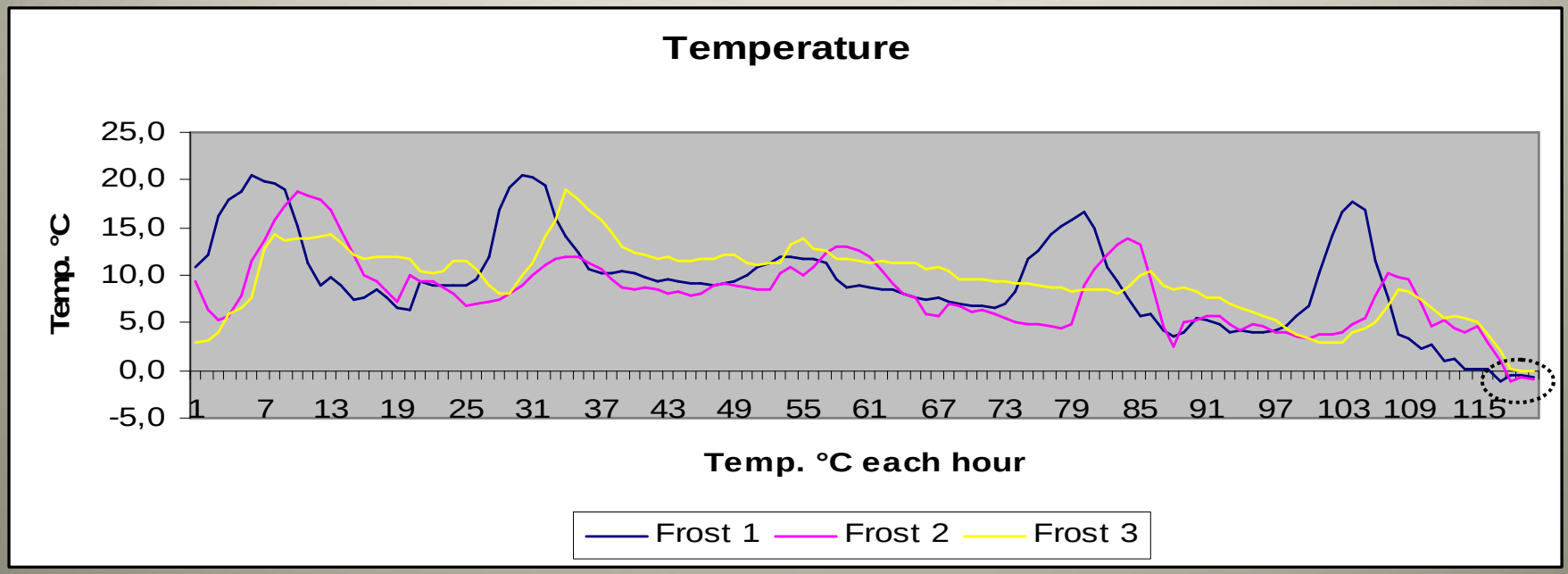
Casa Donoso Winery & UCM temperature(I&O)



Casa Donoso & UCM atmospheric pressure comparisons



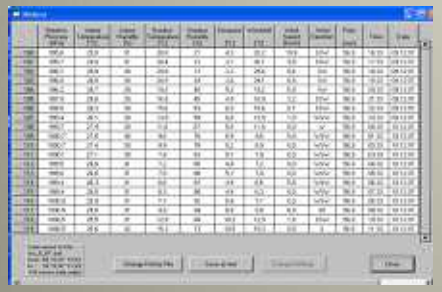
Temperature Tracking for frost prediction

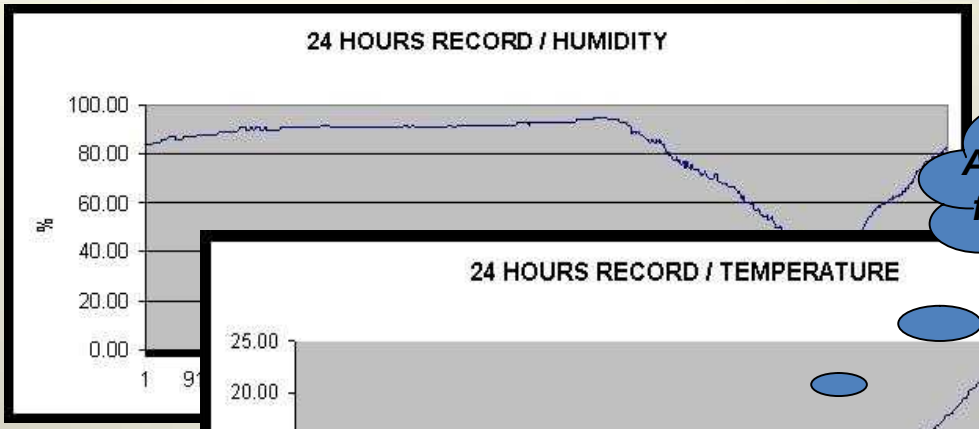


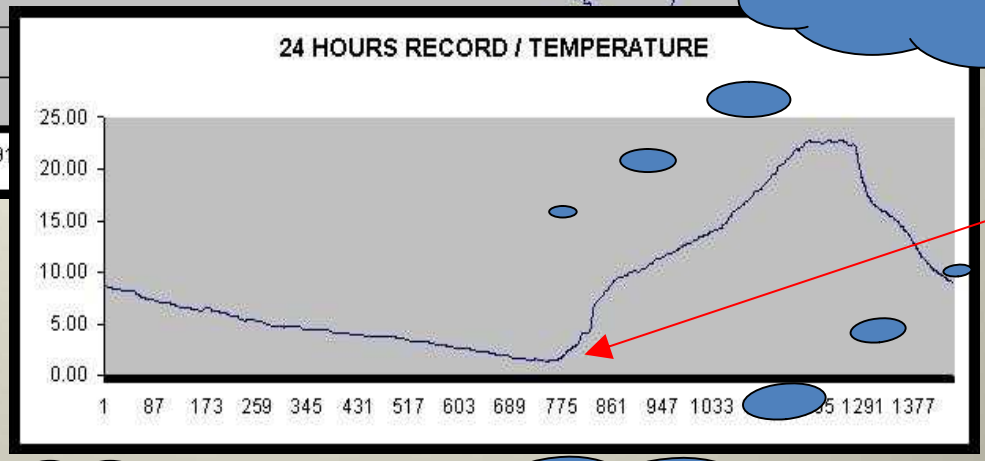
More variables needed for robust modelling and prediction

Questions and Prediction

a) Real Time







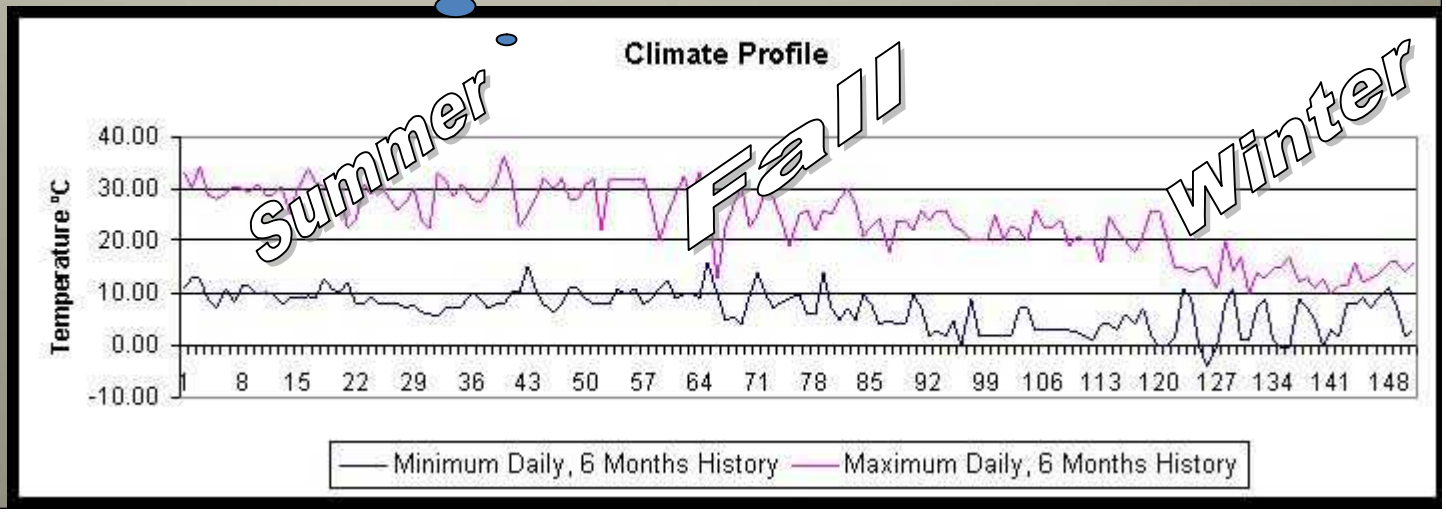
Are we having frost tomorrow? When?

1.3 ° C

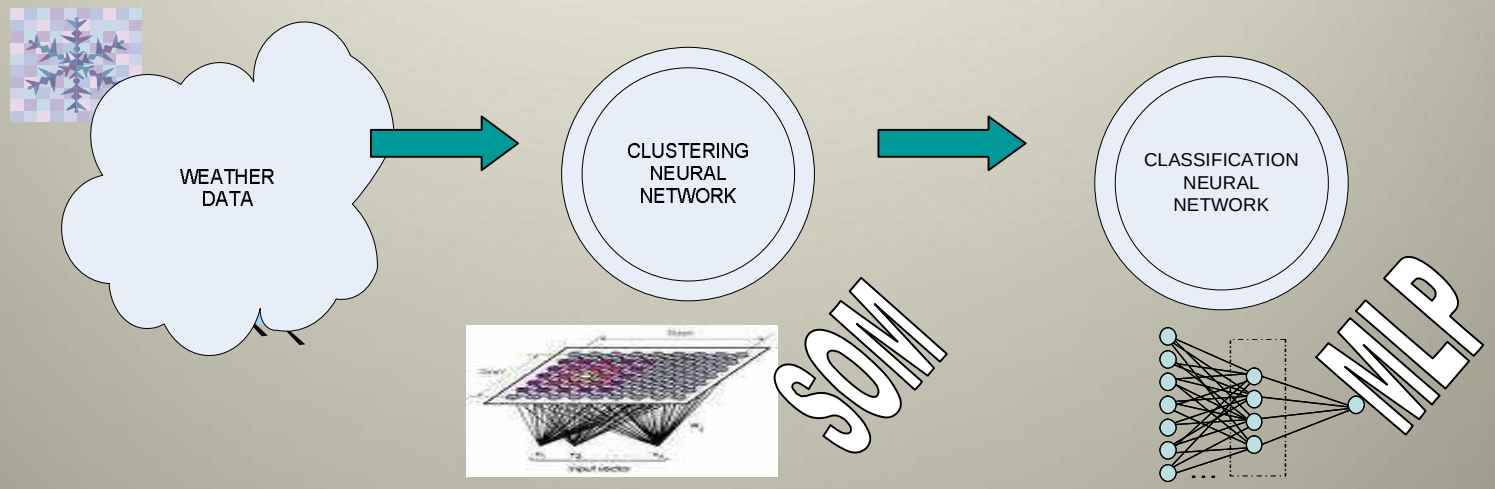
Global warming changes ?

When should we irrigate?

b) Long Term



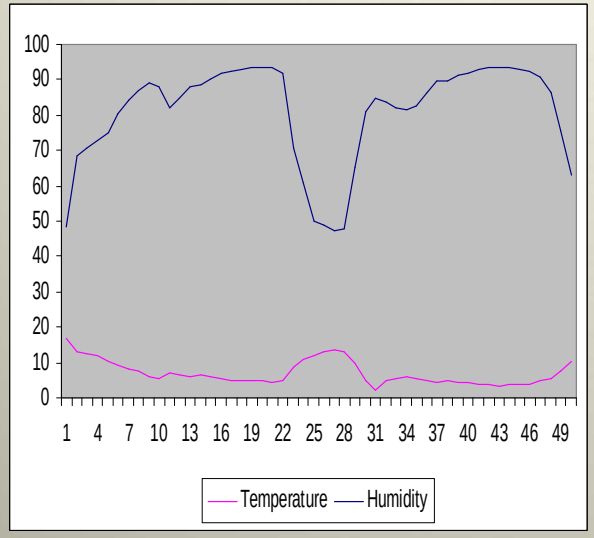
Using CNN for climate prediction

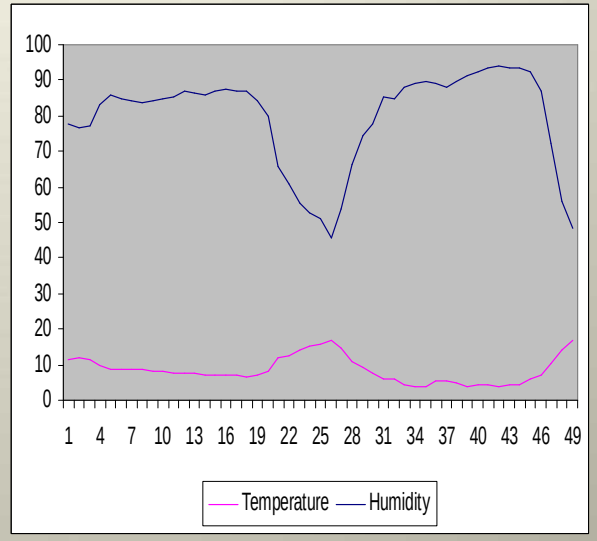


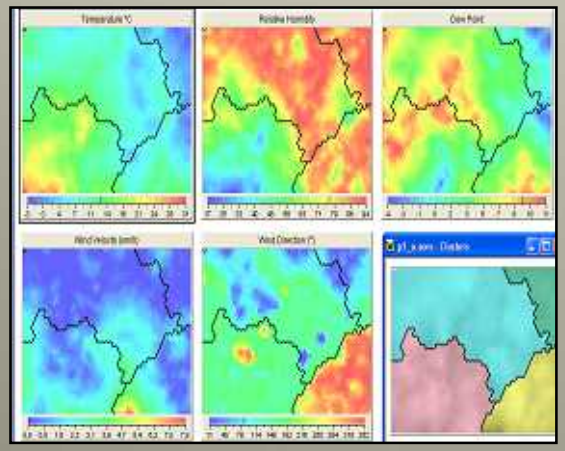
Prototype under construction

Identification of variables, collection, classification and processing of data

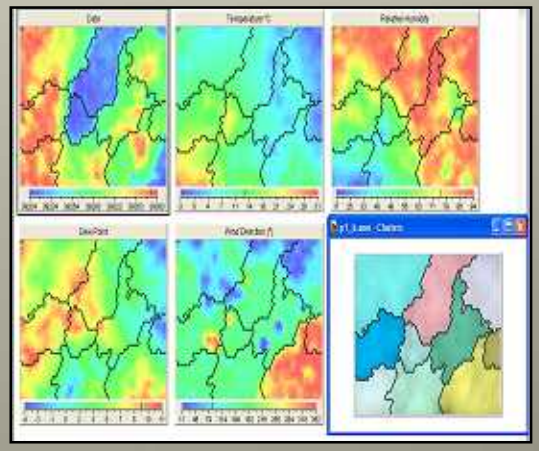
Temperature and Humidity plots for frost prediction
and
SOM depictions of data dependencies for
(a) temperature, relative humidity, dew point, wind velocity and direction
(b) date, temperature, relative humidity, dew point, wind direction





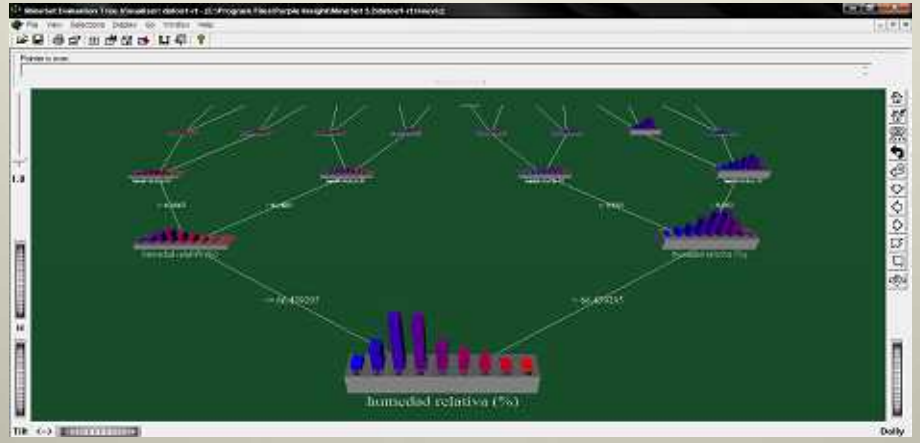


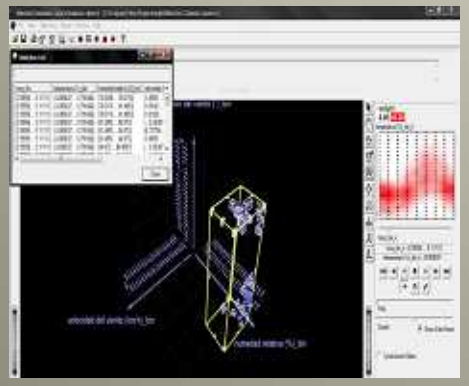
(a)



(b)

Mineset Visualisations





Clementine

Text and Data Mining

- To explore relationships between some ***qualitative*** data and some ***quantitative*** data in a precision agronomy research domain. That is, to explore explicit and implicit data relationships between *human opinion* and *scientific instrument data* (plant, soil and climate sensors).

- More specifically, to determine the strength of dependency between comments made about ***grape varieties*** and their ***growing conditions*** **,** which includes their ***geo-spatial location*****,** in the pursuit of determining quality characteristics for grape growing and wine production**.**

Location and Condition of the plants

Wine characteristics historically and now – referenced by location

Opinion of the wine

Correlations

Precise

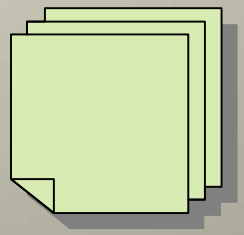
Imprecise

?

Quality of the fruit

Climate

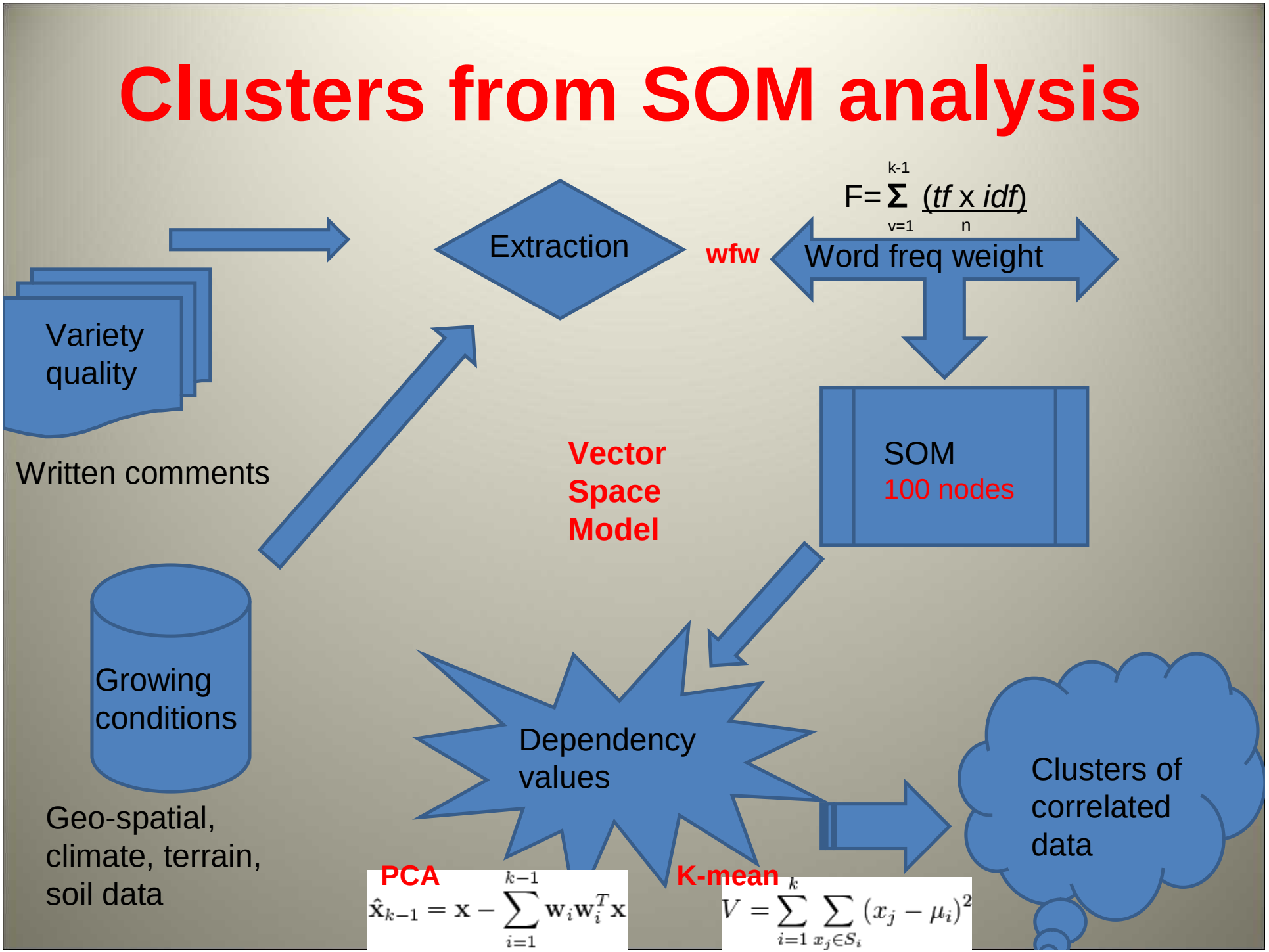
SOM methods



Written comments

Expert description of plants, wine, growing conditions

Clusters from SOM analysis



Vector space model

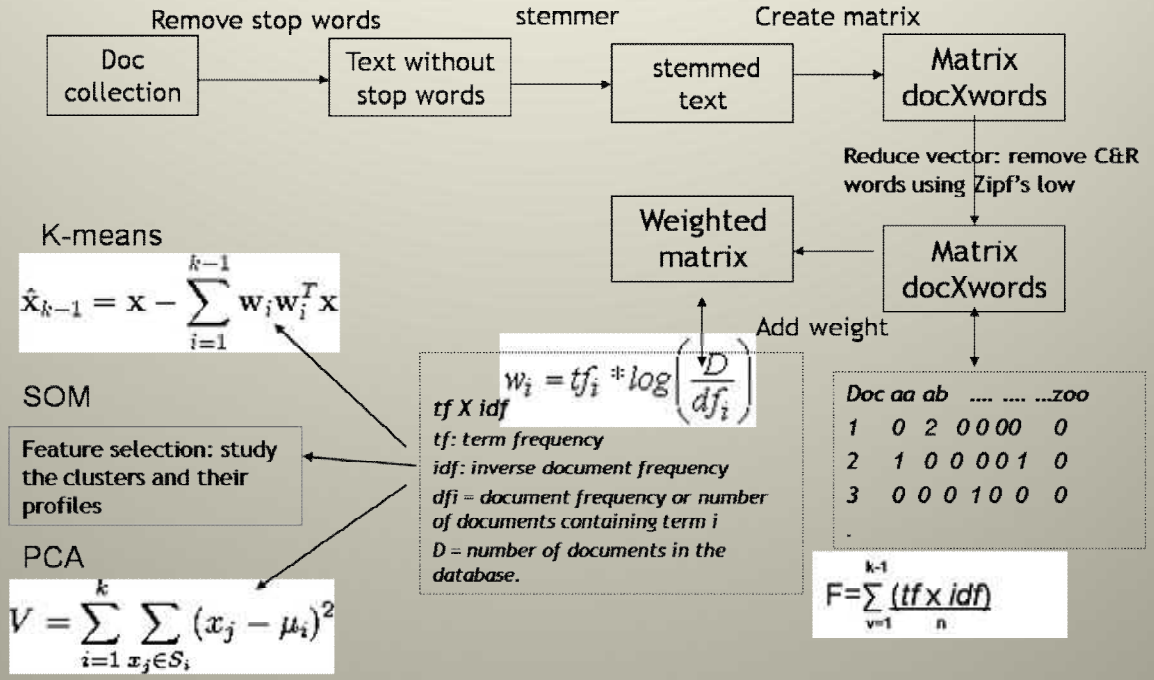


Diagram on the steps followed to create a word matrix of 95 New Zealand wines analysed in a pilot study.

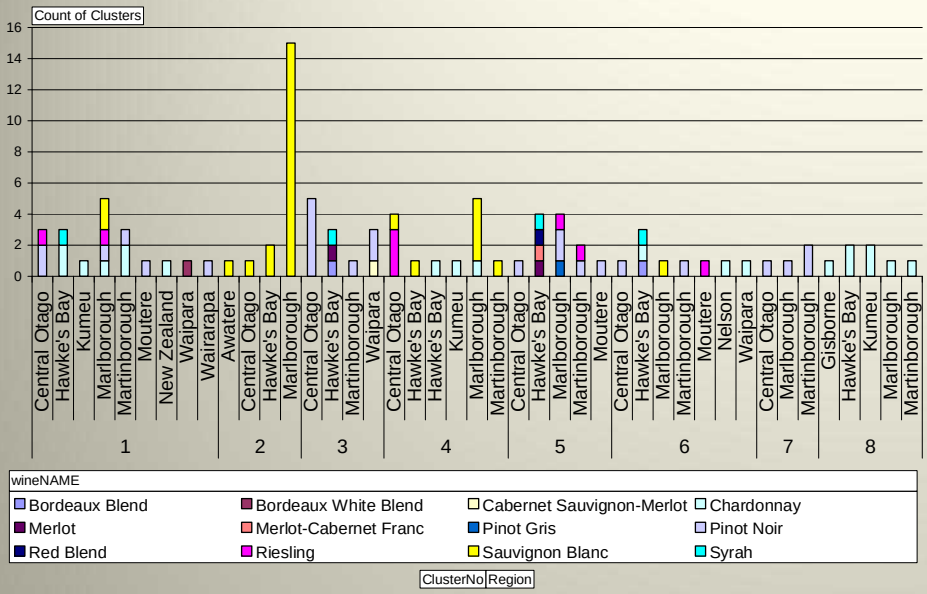
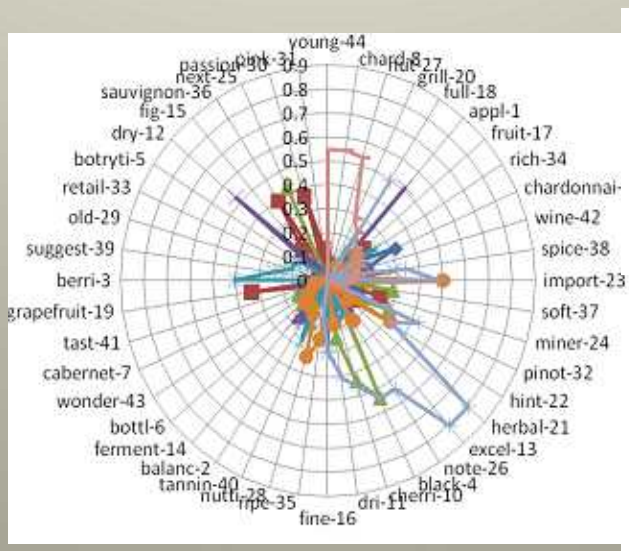
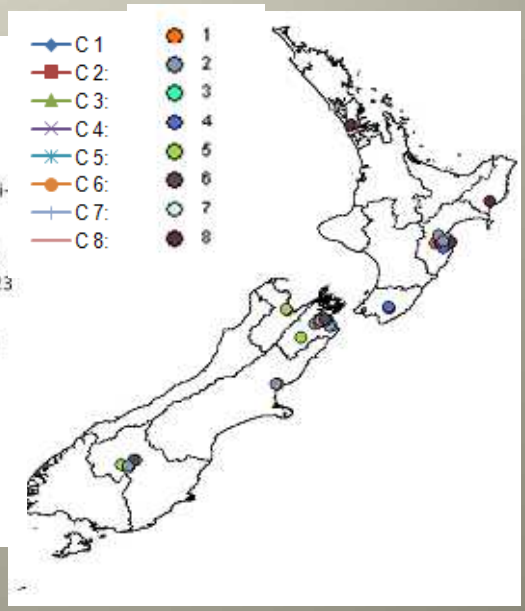
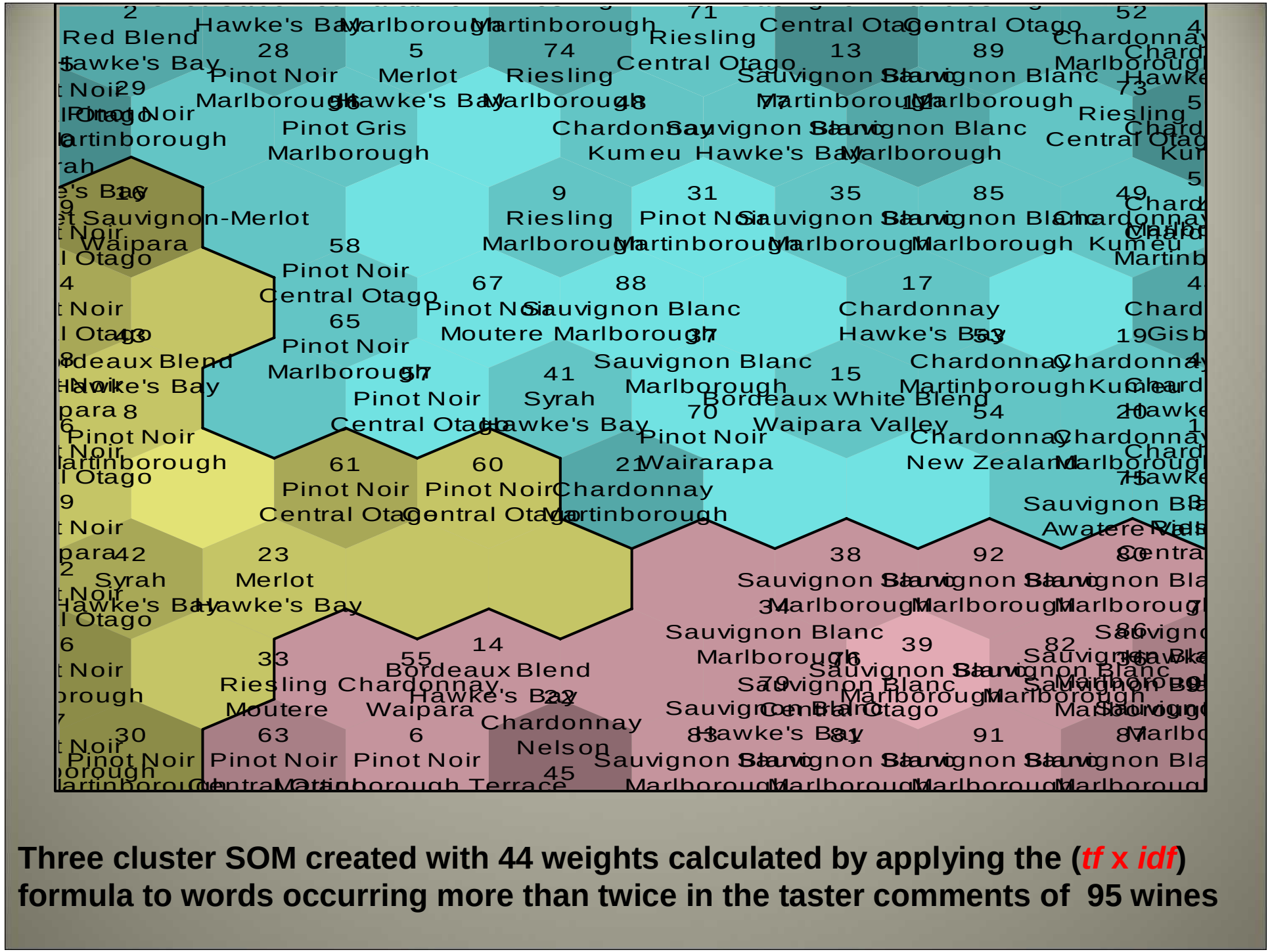


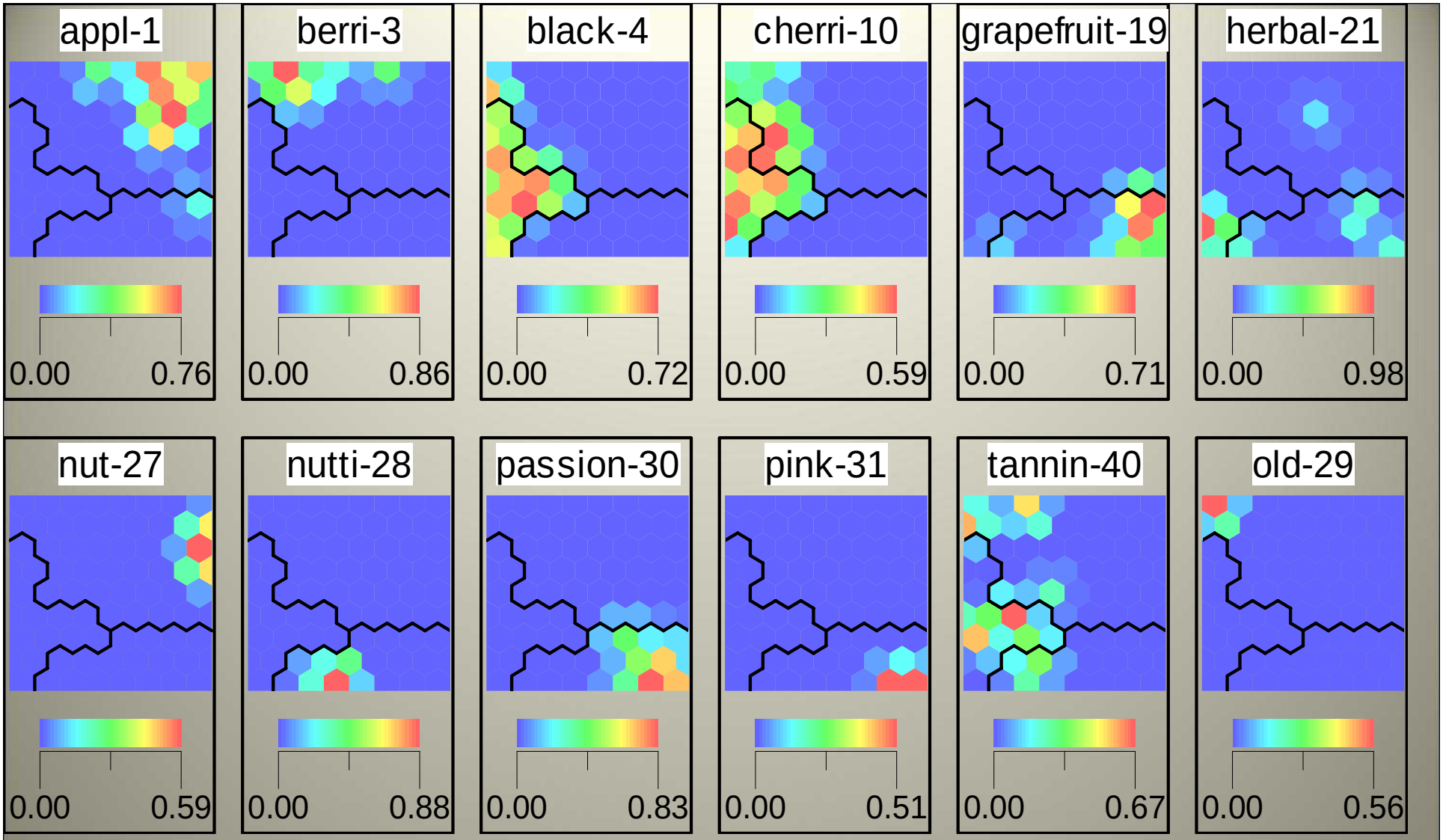
Fig. 2: **Histogram showing the number of wines in different clusters (*y* axis) and regions (*x* axis) of a SOM created with 95 NZ wine word matrix.** Fig 3**: SOM cluster profile radar (word average).** Fig. 4**: 95 NZ wine clustering projected on DIVA map.**



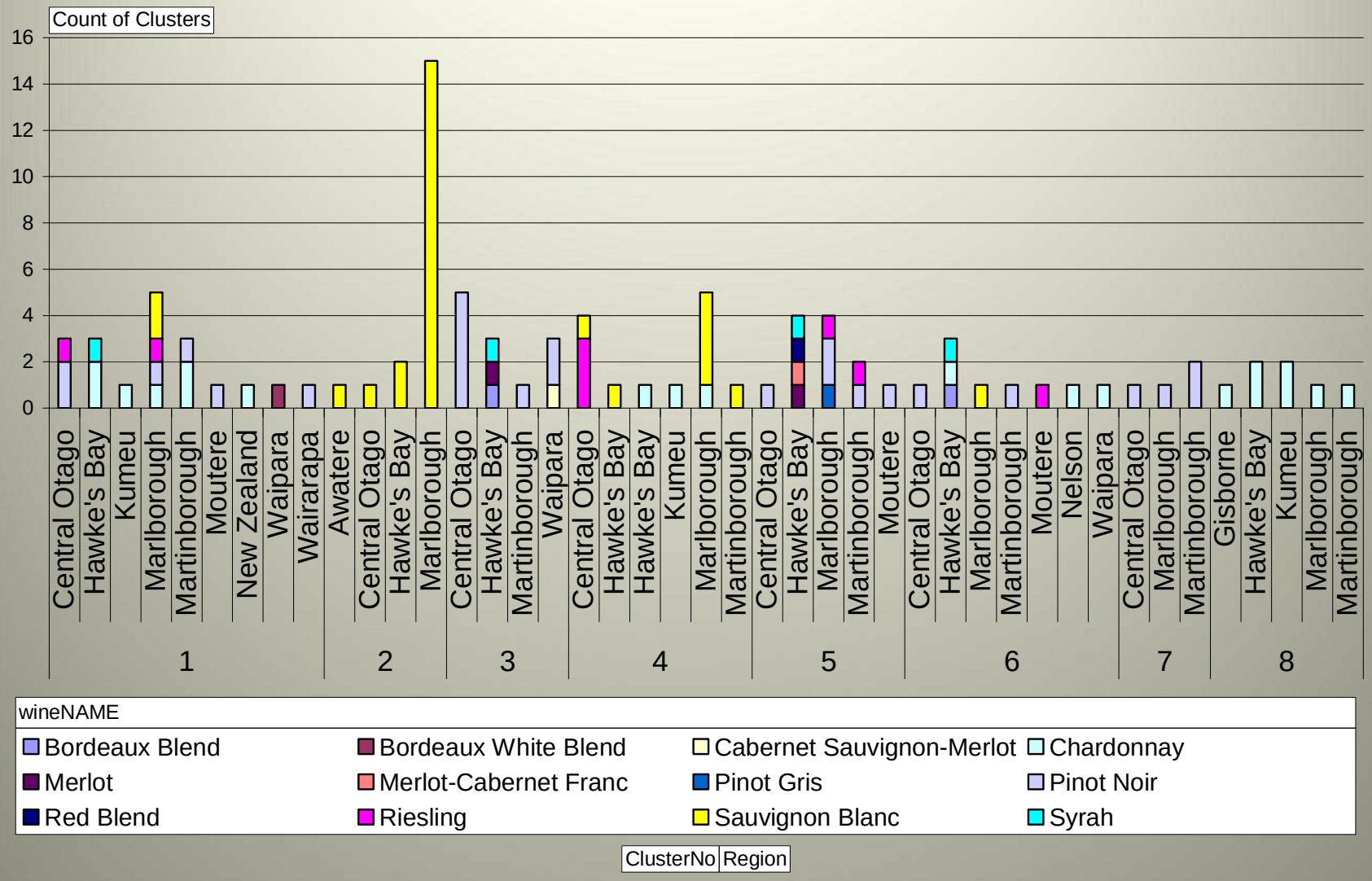




Three cluster SOM created with 44 weights calculated by applying the (*tf x idf*) formula to words occurring more than twice in the taster comments of 95 wines



A few SOM components showing the word weights in the clustering



Graph showing the wine grouping of the 8 cluster SOM of wine taster comments. The clustering reflects the wine variety by region. For example, Cluster 2 has Sauvignon Blanc from Awatere, Central Otago, Hawke's Bay and Marlborough regions

Sensors

A variety of climate, atmospheric, soil and plant sensors to collect growth influence factors

An integrated multi-function sensor

Climate (wind, rain/precipitation, humidity, pressure, sunlight), cloud cover

Atmosphere (carbon density, herbicide saturation)

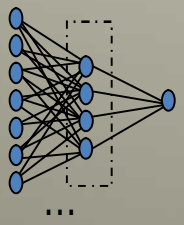
Radiation (UV, haze effect etc)

Terrain and Soil (type, moisture, temp)

Plant (roots, vine, leaves, grapes)

Precision data examples:
- Determining dew-point
- Measuring sap rise
- Correlating soil moisture/temp with radiation levels and atmospheric pressure

Prediction algorithms for frost and irrigation scenarios



Geo-computational topology for analysing logged data




Wireless

Wireless

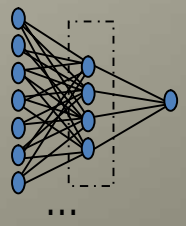
Wireless

Wireless

Data logger upload to central computer

Pseudo-real time ftp connection...packets at 30 sec intervals

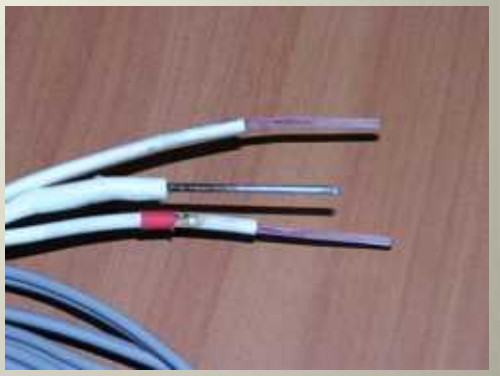
Statistics, correlations and trend analysis

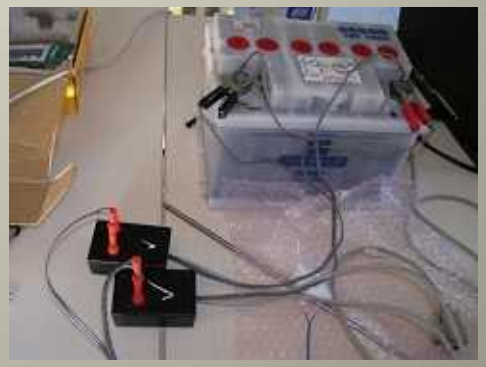


...

Predictions

Measuring sap rise in the vines





Soil moisture measurement for temperature and humidity

Image Processing and Resistence based methods

(leaf wetness – an indicator of healthy growth)

Image Processing with probe & infra-red methods

(taste - grape colour and sugar content)

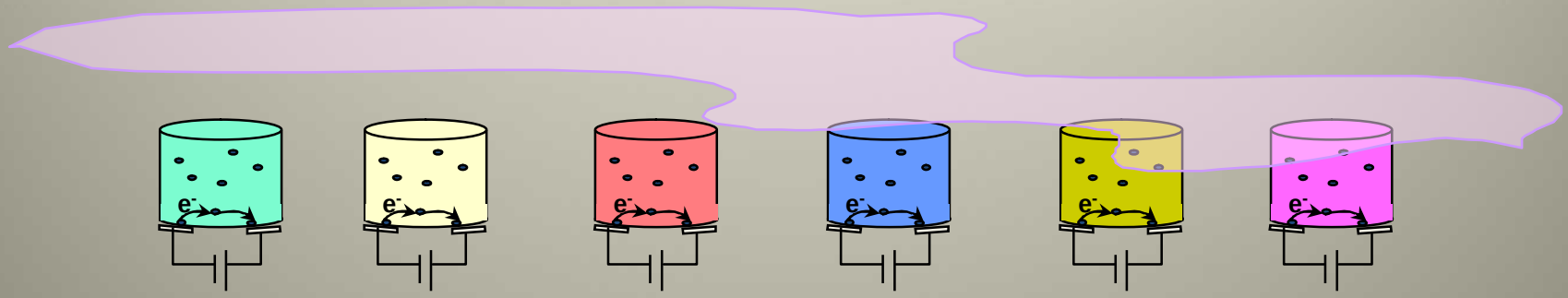
Image Processing and Solar Intensity (lux)
(cloud formations)

- **Time interval photos of sky**
- **Classification of cloud cover (full, partial, clear)**
- **Attribute data for Neural network correlated with other data/time**

The Electronic Nose

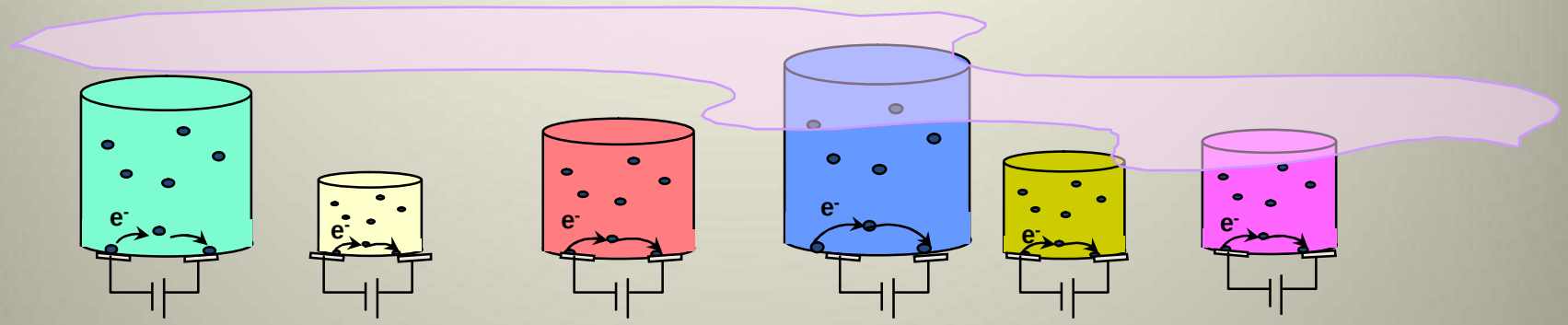
Measuring odour as a test of grape quality using Baseline Resistance

All of the polymer films on a set of electrodes (sensors) start out at a measured resistance, their *baseline resistance*. If there has been no change in the composition of the air, the films stay at the baseline resistance and the percent change is zero

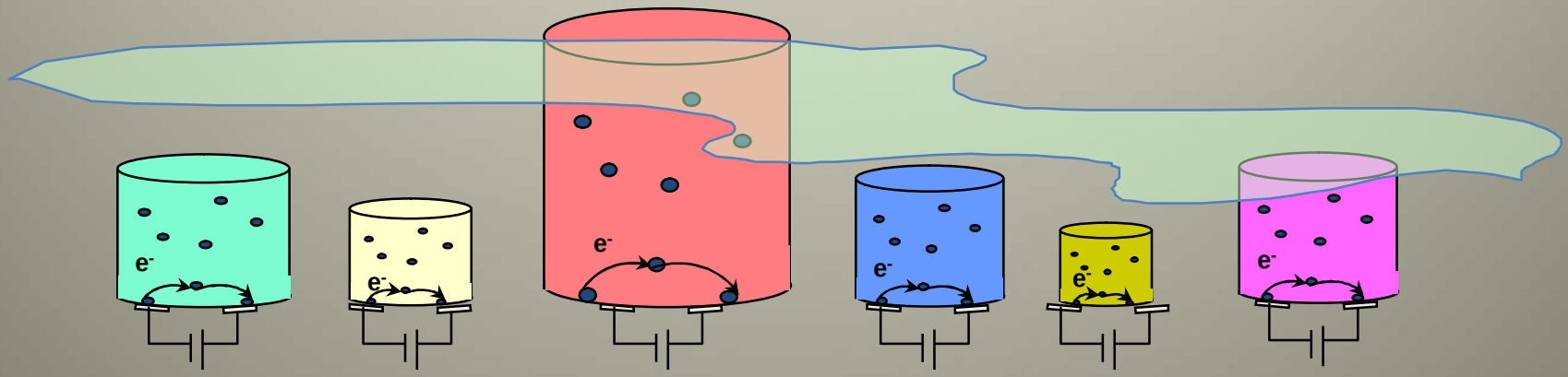


Odour – The Electronic Nose

Basic Concept - each polymer changes its size, and therefore its resistance, by a different amount, making a pattern of the change. Known odour spectrum for grapes compared with observed (sampled) odours.



If a different compound had caused the air to change, the pattern of the polymer films' change would have been different:



Speech Processing
and
Voice Printing

Audio mining & audio searching

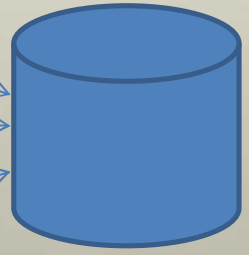
Audio mining is a technique that is used to search audio for occurrences of spoken words or phrases.

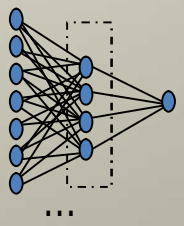
Sommelier Voice Printing

English

Spanish

French





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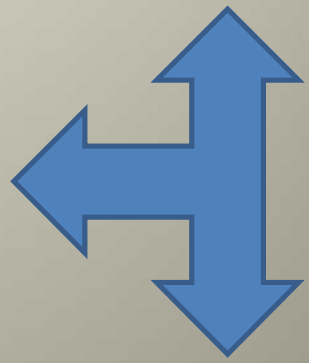
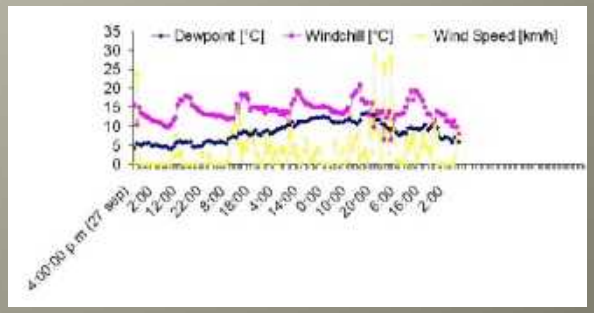
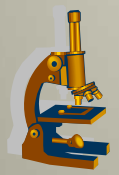




Eno-Humanas Conclusions

Historical data



Chemistry

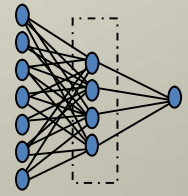
Expert input

Consumers

Multivariate complexity

Indefinite prediction potential

Neural Network technologies



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Plot discrete values and determine their dependencies

Prediction potential increases

Time Series experiments with lots of data required!

In our start up phase…..

Mostly identifying variables, gathering data and conducting multivariate analysis for cross correlating dependencies and other intrinsic data relationships.

Measure everything and mine the results!

Thank you!