Big data in the agricultural and ecological sciences – a growing challenge

chris.rawlings@rothamsted.ac.uk

Head of Computational and Systems Biology

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ROTHAMSTED RESEARCH

Rothamsted Research

- Rothamsted is an independent scientific research institute
- Longest running agricultural research institute in the world (est. 1843)
- Delivering knowledge, innovation and new practices to increase crop productivity and quality
- Develop environmentally sustainable solutions for agriculture

Main funder

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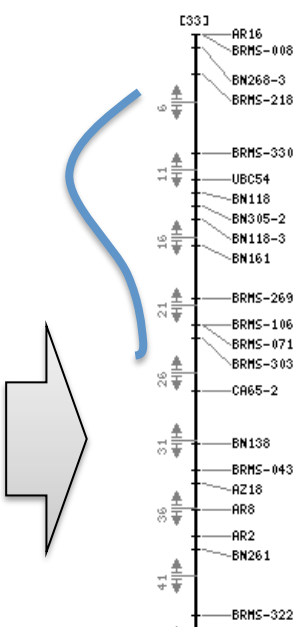
Relating genotype to phenotype

Genetics

- Studies of disease families
- Population studies (association genetics)
- Crop breeding populations
- Originally genetic markers
- Now genotyping by sequencing

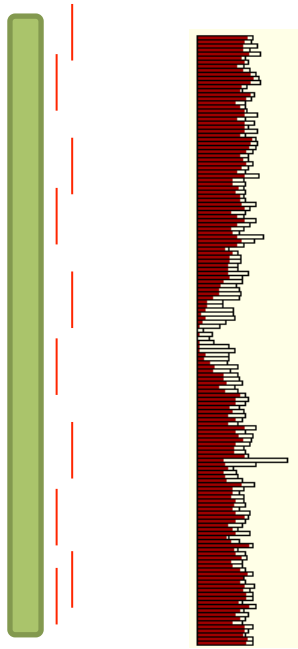
Phenotypic measurements

QTL **Linkage maps**

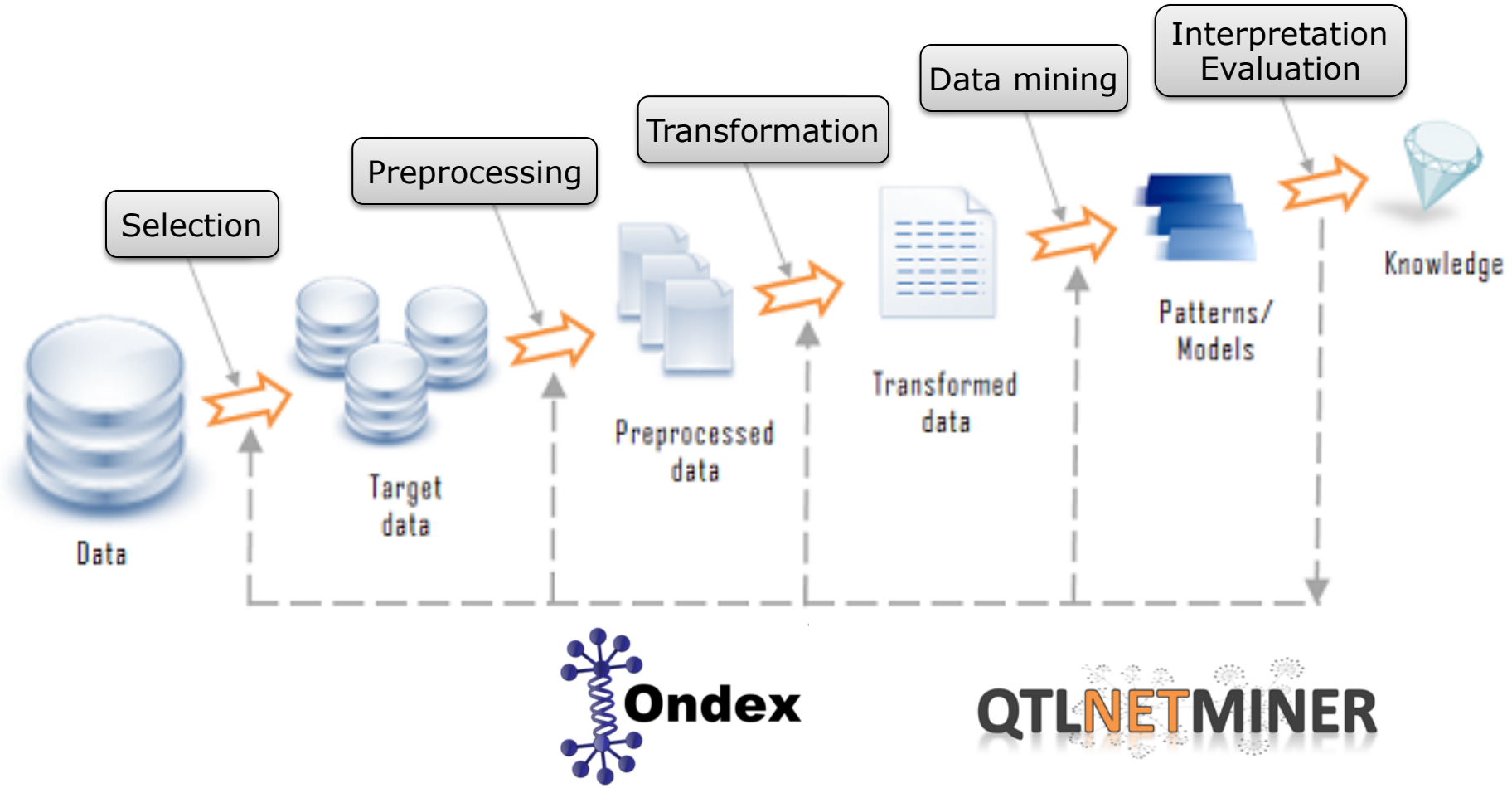


Genomic sequence

S.viminalis chromosome



Knowledge discovery process

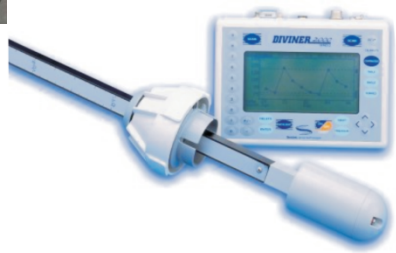


Crops - Phenotype

- Agronomic
  - Crop yield
  - Total biomass
- Plant Morphology
  - Architectural - macro-measurements
    - E.g. stem number, height, thickness, root structure
    - Light Interception – canopy
  - Non-destructive and destructive methods
- Biophysical and Biochemical
  - Photosynthesis
  - Tissue composition e.g.
    - Lipid content
    - Sugars – bioethanol
- **Environmental factors**
  - Weather
  - Soil moisture
  - Treatments (nutrients, pest management etc).

LiCOR Fluorometer

Delta T Sunscan



Sentek Diviner

New - Phenomics – HT Phenotyping

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- Automated measurements
- Exploit high resolution, multi-spectral cameras
- Image processing, computer vision techniques
- Non-invasive
- Measurements e.g.
  - Plant growth and development
  - Photosynthetic activity
  - Stress measurements

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Field Based Phenotyping

Phenomobile

http://www.plantphenomics.org.au/

http://www.plantphenomics.org/hrppc/capabilities/fieldmodule

Agricultural Interactions with the Environment

Delivering sustainable intensification

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AnaEE

A European infrastructure for analysis and experimentation on agro ecosystems

http://www.anaee.com/

Data Rich Interactions in Agri-Ecology

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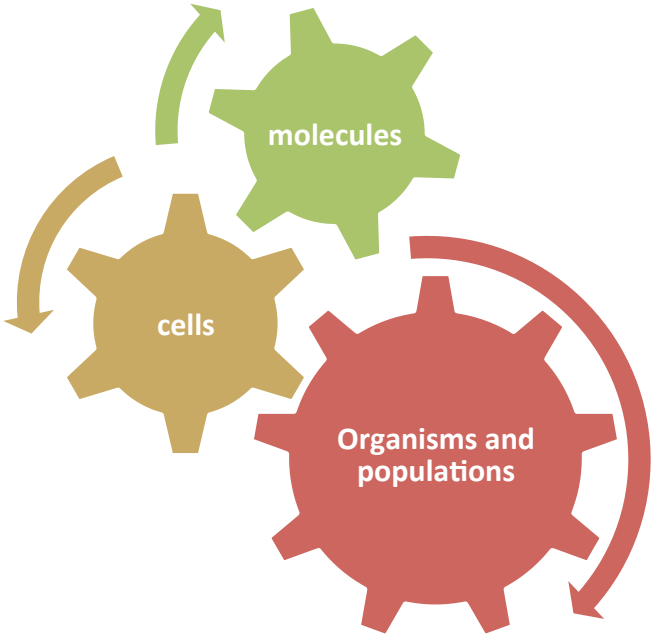
- Next generation sequencing
  - Genomes of host organisms
    - Large and complex
  - Genomes of pest and pathogen organisms
- Managing / integrating multi-omics datasets
  - Variety of data resources
  - Transcriptomics and metabolomics most important
  - Importance of model organisms
  - Range of data types

ELIXIR

- Measuring phenotypes and traits –
  - Until now - low throughput
  - Now moving to high throughput
  - Range of automation and imaging technologies
- Measuring the environmental factors
  - affecting agricultural production
  - Increasing sustainability of agriculture

AnaEE



ISBE

Modelling interactions and dynamics of biological systems at all scales

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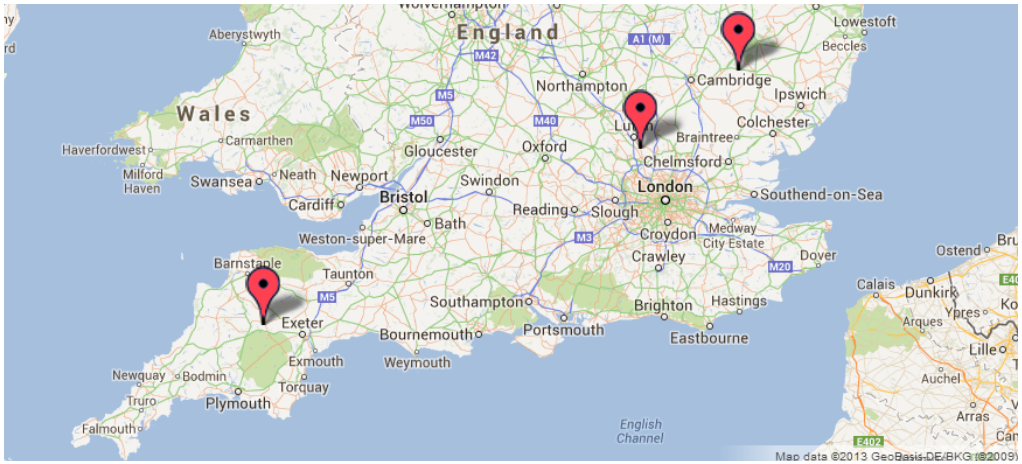
Rothamsted North Wyke Farm Platform

Example AnaEE Site



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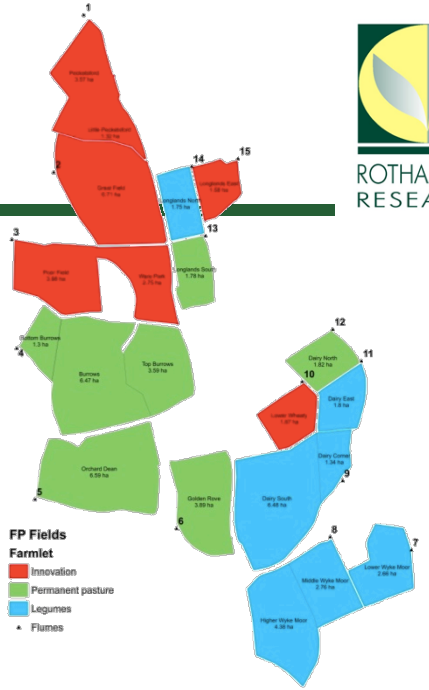
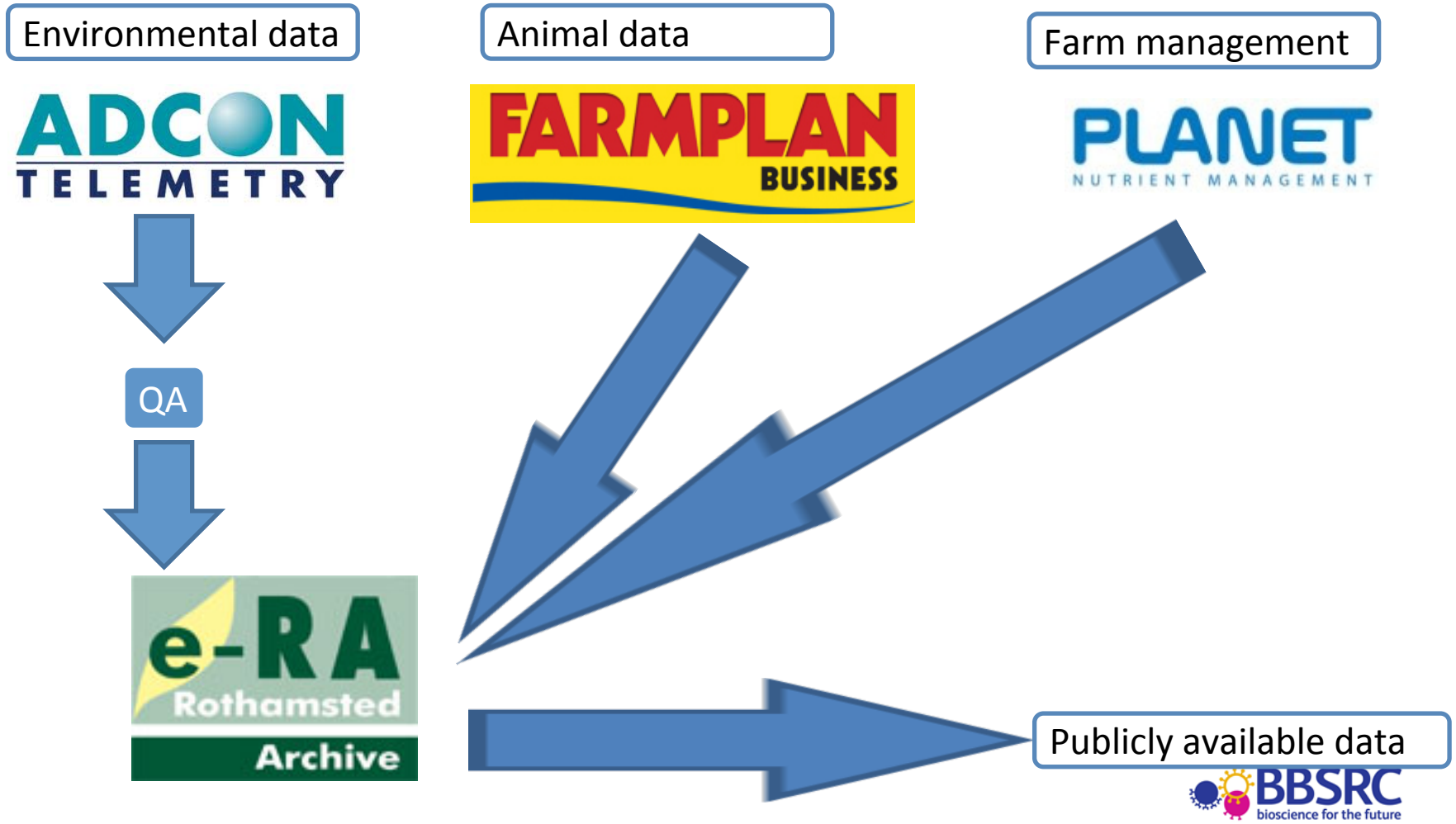
Main features



- Three “farmlets”
- Highly instrumented
  - Most instrumented farm in Europe(?)
  - Realtime data capture from 15 monitoring stations
- Known topology and hydrology
- Long term experiments – just starting
  - Baseline data 2 years
- Integration with remote sensing data
  - Satellite, hyperspectral imaging

Databases


Environmental data
Animal data
Farm management
ADCON TELEMETRY
FARMPLAN BUSINESS
PLANET NUTRIENT MANAGEMENT
QA
e-RA Rothamsted Archive
Publicly available data
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