Growing confidence in forestry's future Research Programme

SCION
FORESTS ▪ PRODUCTS ▪ INNOVATION

Phenotyping Individual Trees

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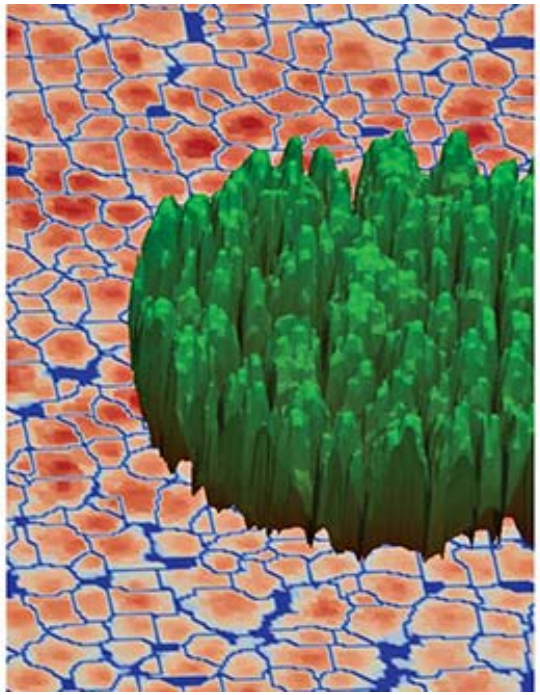


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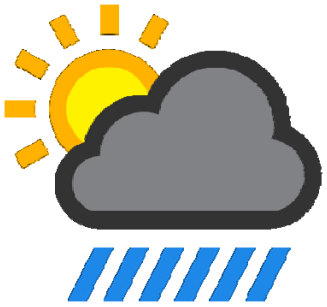
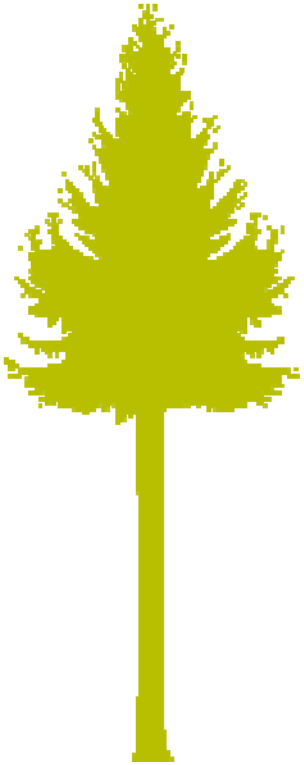
What is Phenotyping ?

- Assessment of attributes (traits)
- In response to genetic and environmental inputs
- Understanding GxExS





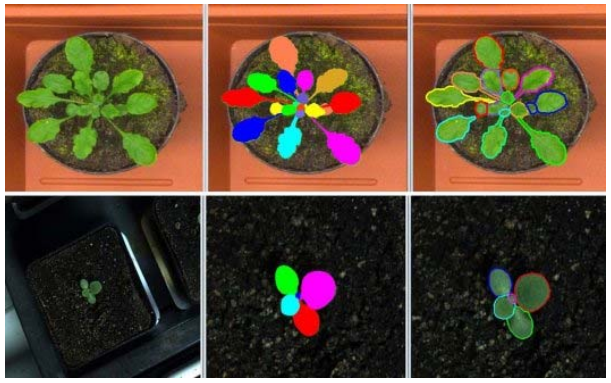
Phenotyping for Forestry – Why ?

- Improved breeds, matched to sites, and end uses

- Insights into drivers of growth:
  - improved silviculture: site-breed selection, treatments
  - next generation growth, wood quality, disease risk models
  - inventory applications: of the sensors, platforms, and analytical methods

Phenotyping Systems

- Molecular genetic techniques have advanced rapidly
- Need high throughput, robust, automated, phenotyping methods
- Sophisticated indoor facilities (Phenotron)
  - automated, controlled environment, remote sensing
- Machine Learning methods used to process large amounts of data from phenotron systems
  - bottleneck is now Image Segmentation (separating features of interest)

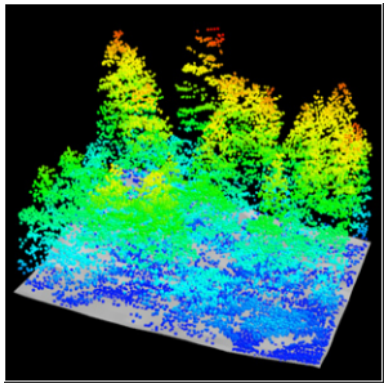


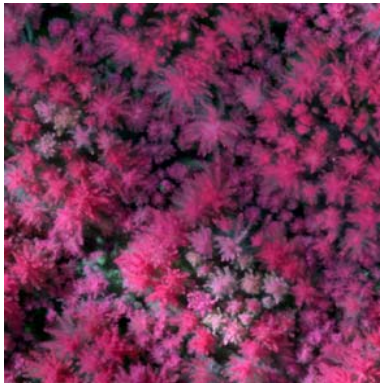
Phenotyping for Forestry

- Forestry presents special challenges
  - size and longevity
  - requires phenotyping in the wild
  - remote locations
  - mobile sensors
  - uncontrolled sensing conditions

Remote Sensing for Phenotyping

- Key traits can be summarised as:
  - size, form, wood quality, disease
- Various sensors
  - spectral: photo, multi- and hyper-spectral
  - spatial: LiDAR, Structure from Motion
- Different sensors are applicable to different attributes.
- Challenge is to find practical, effective, combinations for forestry





Individual Tree Phenotyping

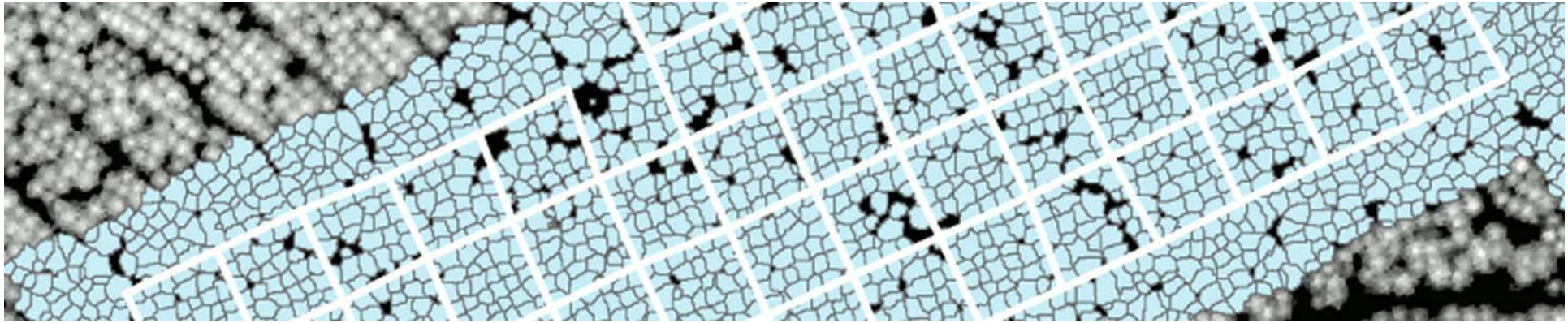
- Broad scale phenotyping across stands
- Tree level critical for single tree plot trials
- Applicable to obtain the ultimate level of detail
  - tree as the object of interest
- Identify trees growing better than neighbours
  - superior genetics – in that environment x silviculture

Tree Level Analysis of ALS - Size

- Developed methods to
  - detect individual trees
  - accurately delineate crowns
  - extract and derive various crown metrics (~50)

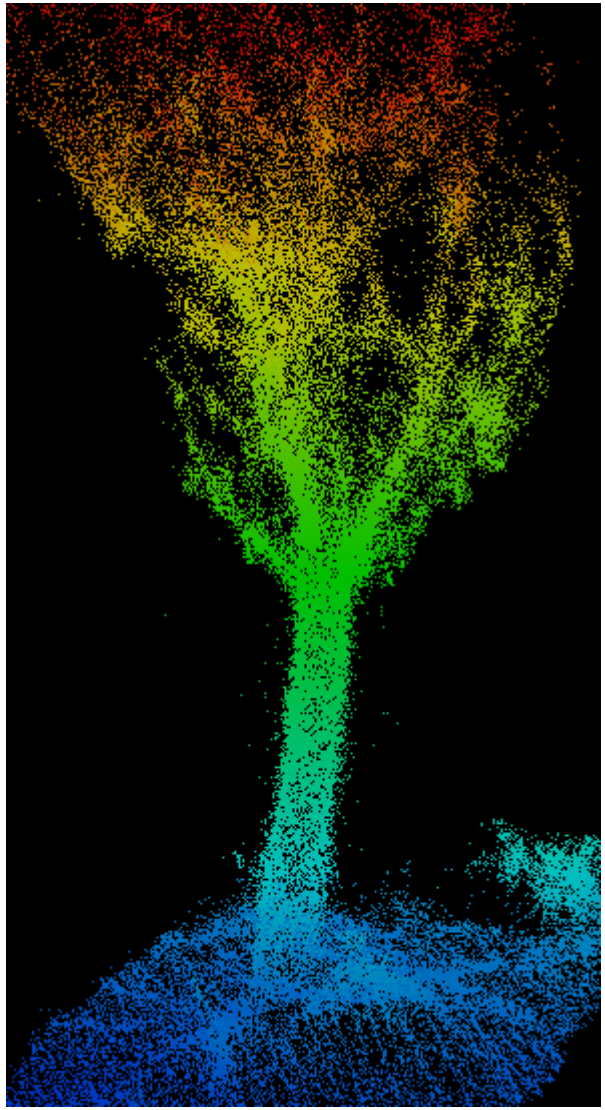
- Relationships with Size, form, wood quality, disease examined.

- Height, DBH and TSV estimated accurately.
- Correlation with disease also observed, due to effect on growth



Tree Level Analysis of TLS – Size + Form

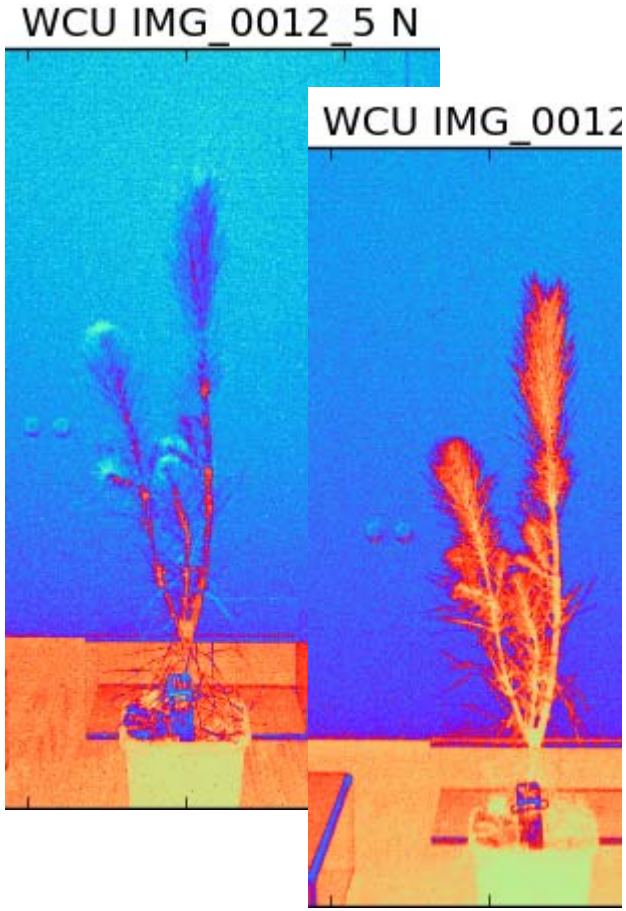
- TLS looks up from ground, sees lower stem
  - potential for DBH, stem form, pruned height, branching
- Promising early results with the ZEB1 hand held LiDAR scanner
- Development of image analysis methods
- Tree detection and DBH estimation improved
  - Detection 91%
  - DBH 10% overestimate



Multispectral Data - Disease

- Thorpe Road study
  - MS signal detected before obvious to eye

- Phenotyping Extension Funding - Potential laboratory application
  - Forest Genetics, Forest Health, Geomatics collaboration
  - seedlings of known genotypes inoculated with RNC
  - replace visual assessment – MK I phenotron
  - inform observations in forest
  - applications in the nursery

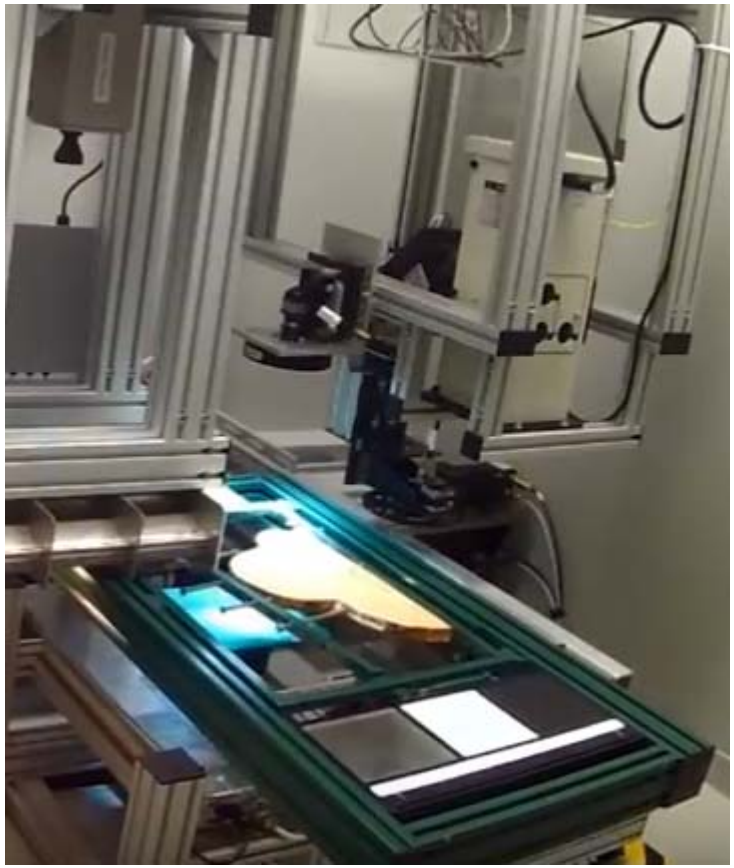


Wood Quality

- Wood properties difficult to measure
- Negative results so far with ALS
  - want correlated traits we can detect in remote sensing
  - link to stem form using TLS ?

- Watch for new technology, eg a portable CT unit ?

- The DiscBot is a world leading system
  - being applied to GxExS trials
  - links between remote sensed and destructive phenotyping



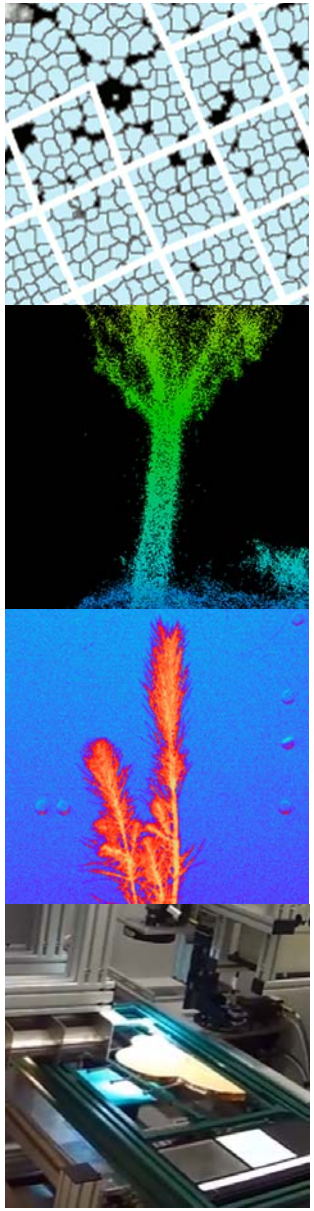
Tree Level Phenotyping - Conclusions

- Tree-level methods developed for
  - Size = ALS
  - Size, Form = TLS
  - Disease = MS
  - Wood quality - DiscBot

- Evaluating a range of sensors and platforms

- Meeting the challenge to:
  - develop automated phenotyping for forestry
  - associated image analysis methods

- Development of Remote Sensing and Phenotyping platforms



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