- Studies & Siemens Internship

- Phenomenal Package

Présentation VP – 21/09/2015

Artzet Simon

Plan

- Studies & Siemens Internship
- Phenomenal Package :
  - Objectifs
  - OpenAlea / Visualea
  - PhenoArch data input
  - Pipelines - Biomass / 2D & 3D Organ
  - Binarization
  - Calibration
  - Multi-View Reconstruction
  - 3D & 2D Skeleton
  - 3D & 2D Segmentation
  - Package & Schedule

Studies

- BTS :
  - IRIS (Informatique et réseaux pour l'industrie et les services techniques)
- Engineer school :
  - EPITA (École pour l'informatique et les techniques avancées)
    - Spéciality **:** SCIA (Sciences Cognitives et Informatique Avancée)

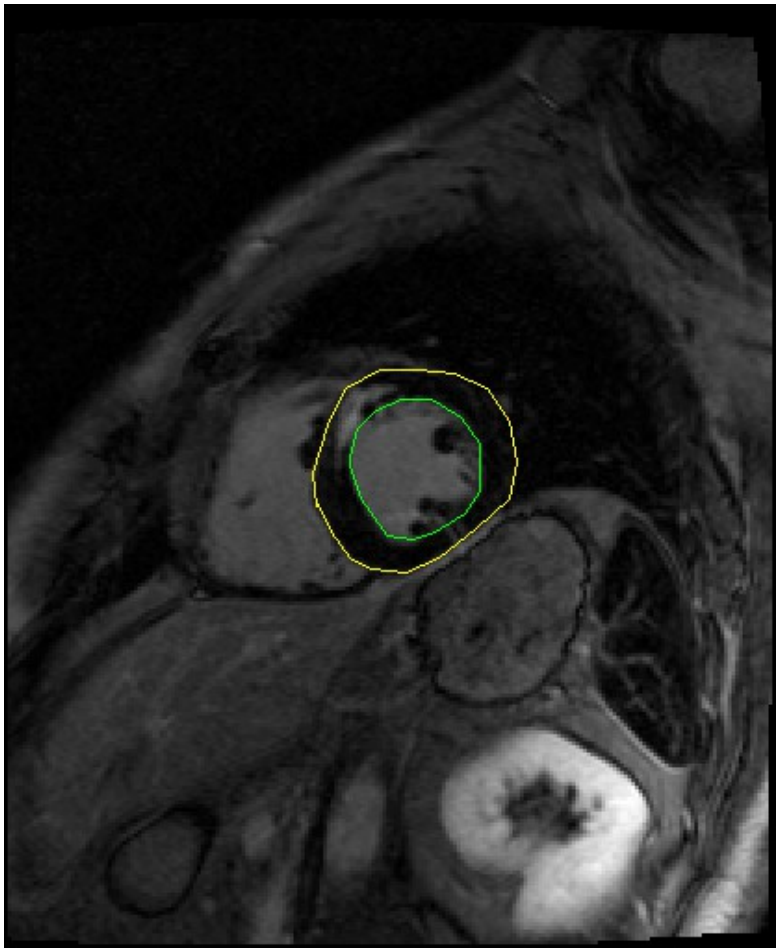
Siemens Internship - Bibliothèque MrFtk

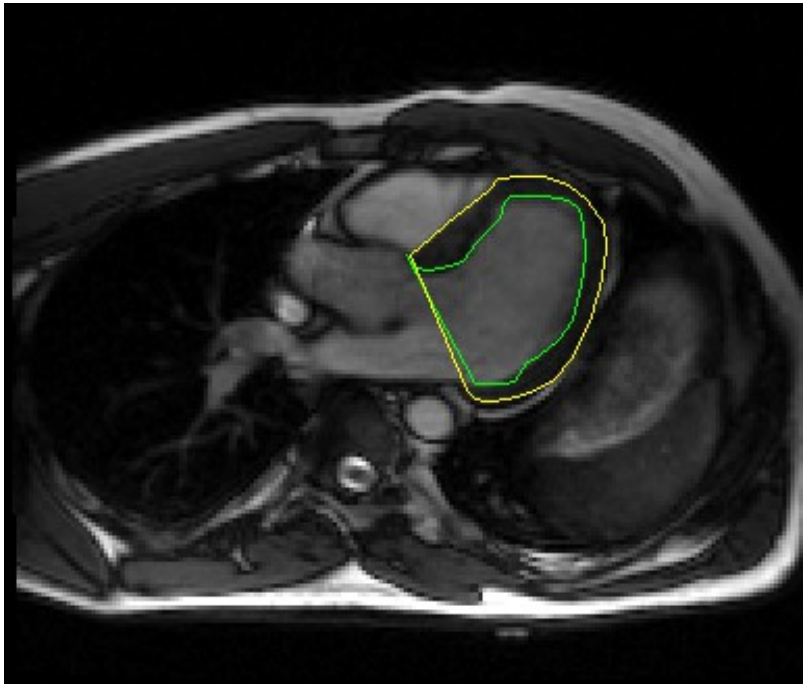
- Mrftk :
  - Magnetic Resonance Fusion Toolkit
  - Imagerie par résonance magnétique (IRM)
  - C++
- Traitement d'image :
  - Algorithme de post-traitement après acquisition :
    - Lent
    - Recalage
    - Segmentation

Siemens Internship – Main task

- Test unitaire et détection de fuites de mémoire :
  - CppUnit
  - Mettre à jour les tests unitaires
  - Validation auprès du service qualité
- Progression et arrêts d'algorithme de traitement d'images :
  - Multithreading
- Segmentation d'une cicatrice située dans le myocarde :
  - Segmentation
  - Recalage

Siemens Internship - Registration





Siemens Internship - Registration

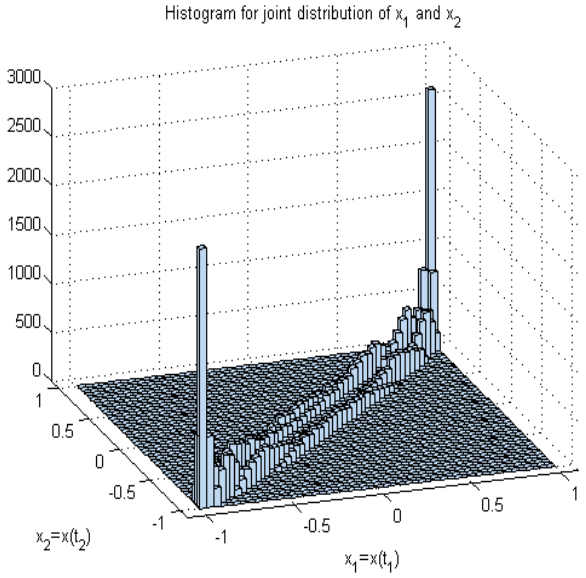
- Objectif :
  - Segmenter la cicatrice située dans le myocarde
    - Segmenter le myocarde
- Lecture d'article scientifique
- Outils Existant :
  - Free Form Deformation
    - Gaussian Local Cross-Correlation
    - $$P_{r,\sigma}(I_1, I_2) = P_{r,\sigma}(I_{\text{diff}}) = \frac{1}{N_{I_{\text{diff}}}} \sum_{x,y} \frac{1}{N_r} \sum_{(x-v)^2+(y-w)^2 \leq r^2} \frac{\sigma^2}{\sigma^2 + [I_{\text{diff}}(x,y) - I_{\text{diff}}(v,w)]^2}, \quad (4)$$
  - Transformation rigide 3D

Siemens Internship - Registration

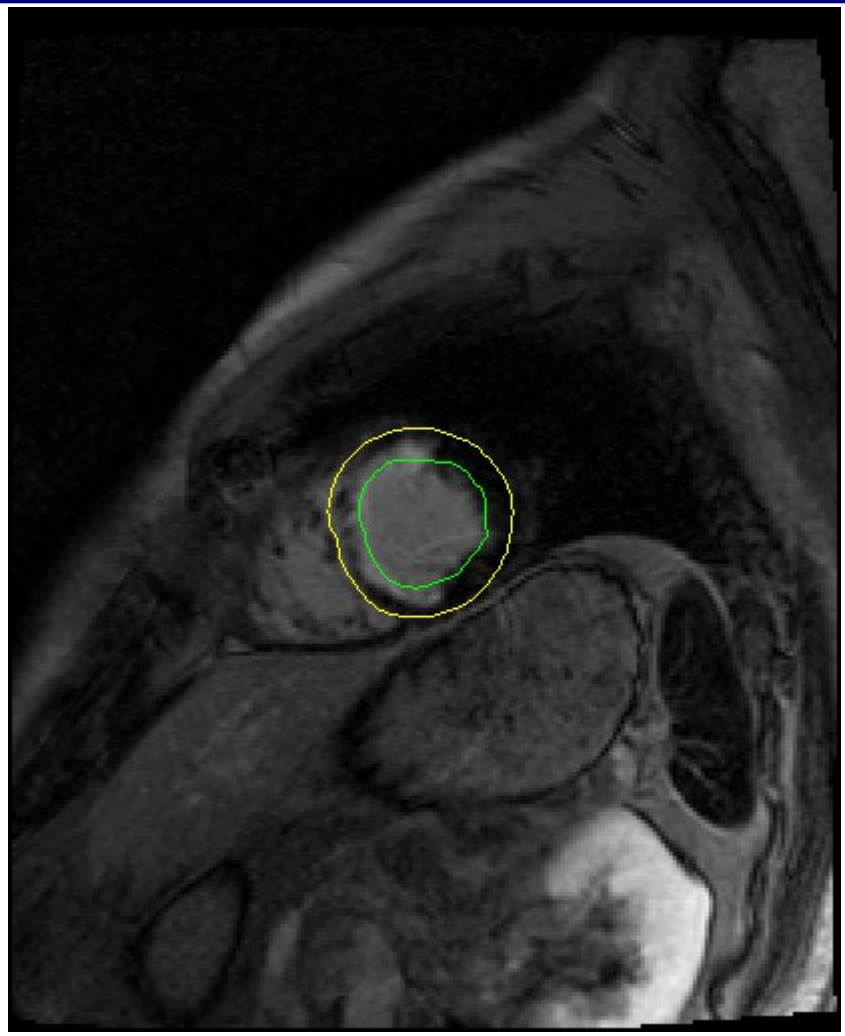
- Pré-traitement et recalage du contour :
  - Sélection de la slice la plus proche
    - Position dans l'environnement 3D
  - Redimensionnement des images
    - Espacement des pixels
  - Alignement des images
    - Translation et rotation dans l'environnement 3D
  - Sélection de la frame la plus proche
  - Application de la transformation rigide

Siemens Internship - Registration

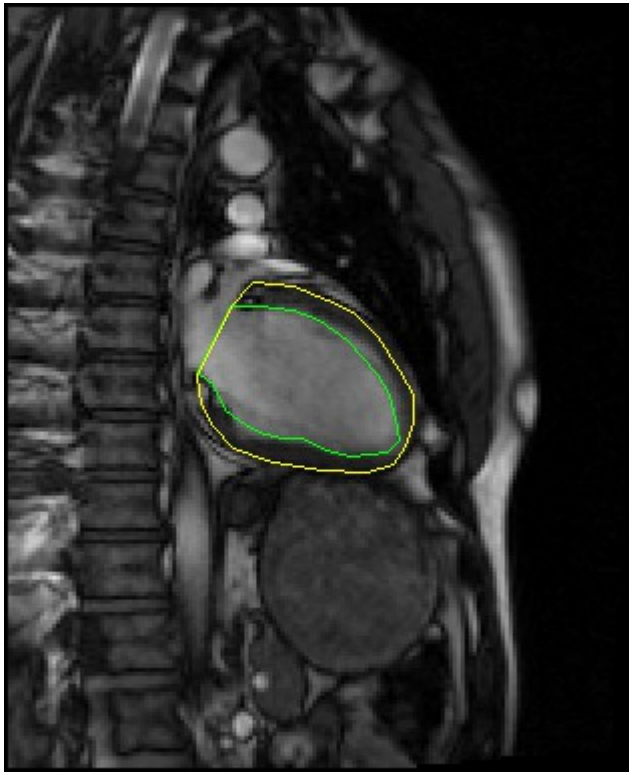
- Transformation rigide :
  - Pyramide d'optimisation
  - HillClimbing
  - Translation dans l'environnement 3D
  - Fonction de cout :
    - Normal Mutual Information
    - Histogramme conjoint

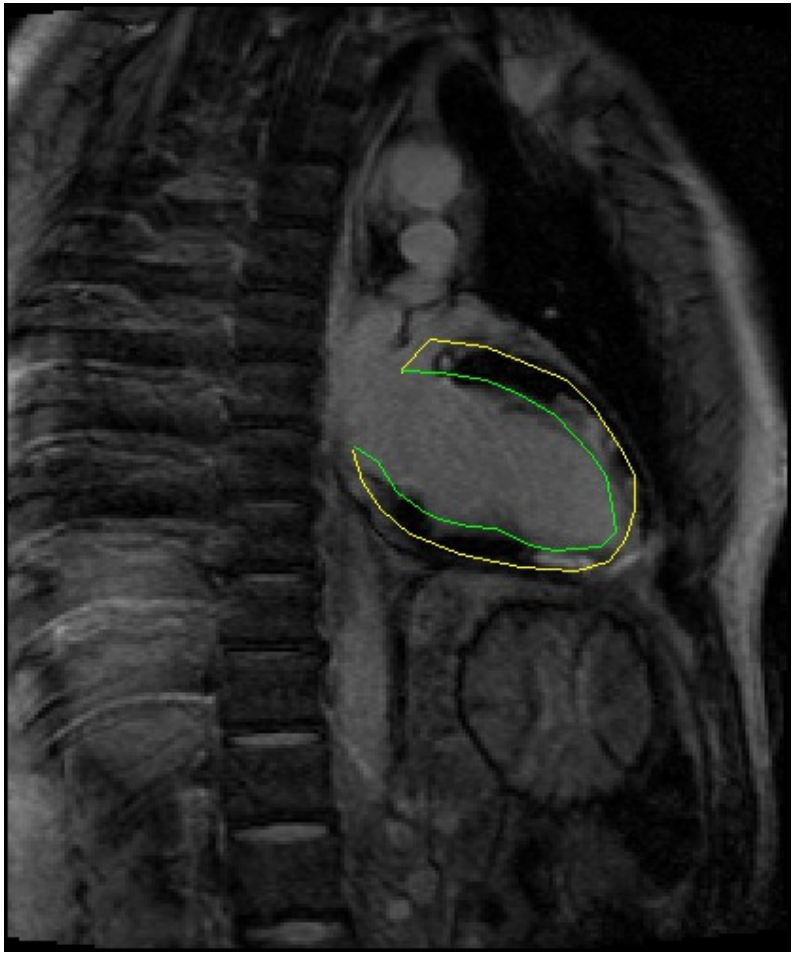


Siemens Internship - Result

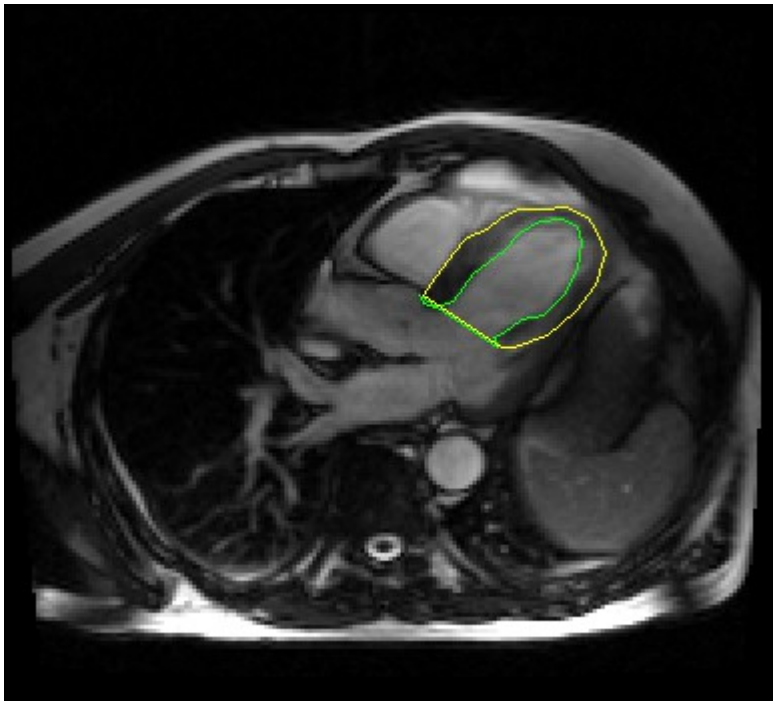


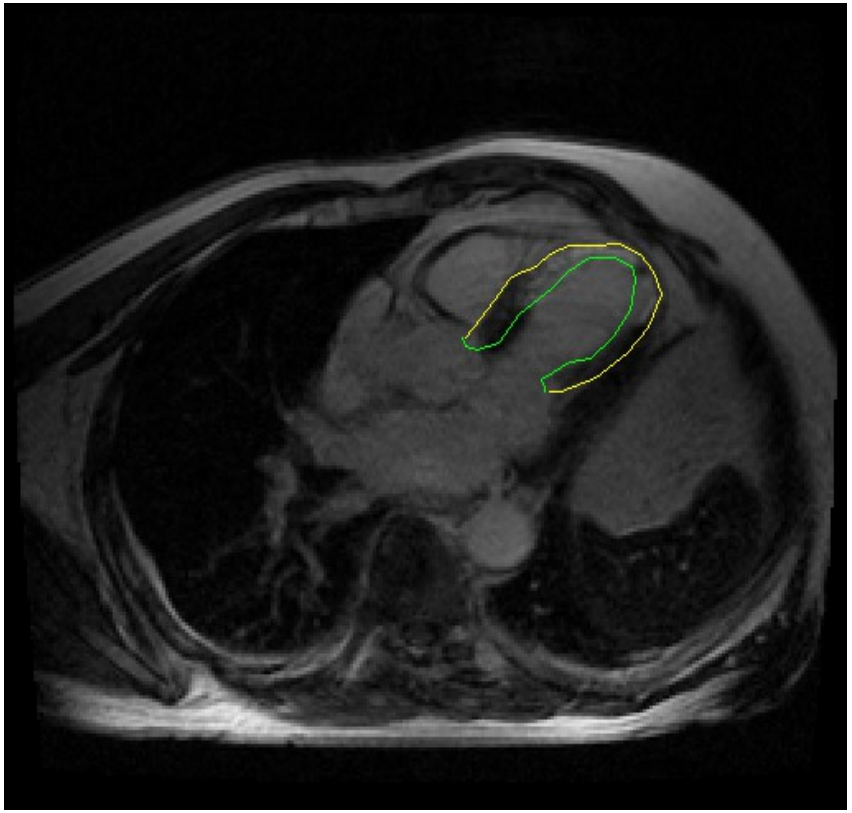
Siemens Internship - Result





Siemens Internship - Result

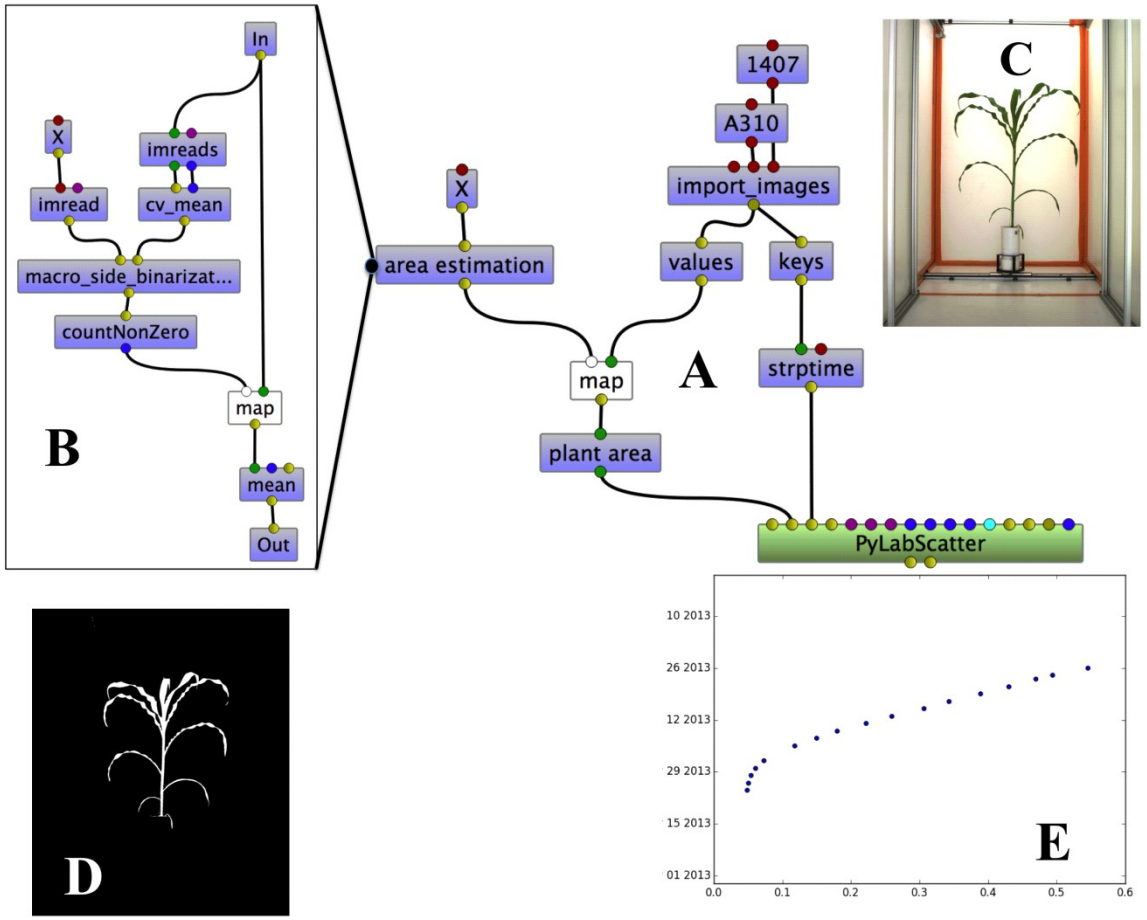




Phenomenal - Aim

- CDD LEPSE :
  - 01/06/2015

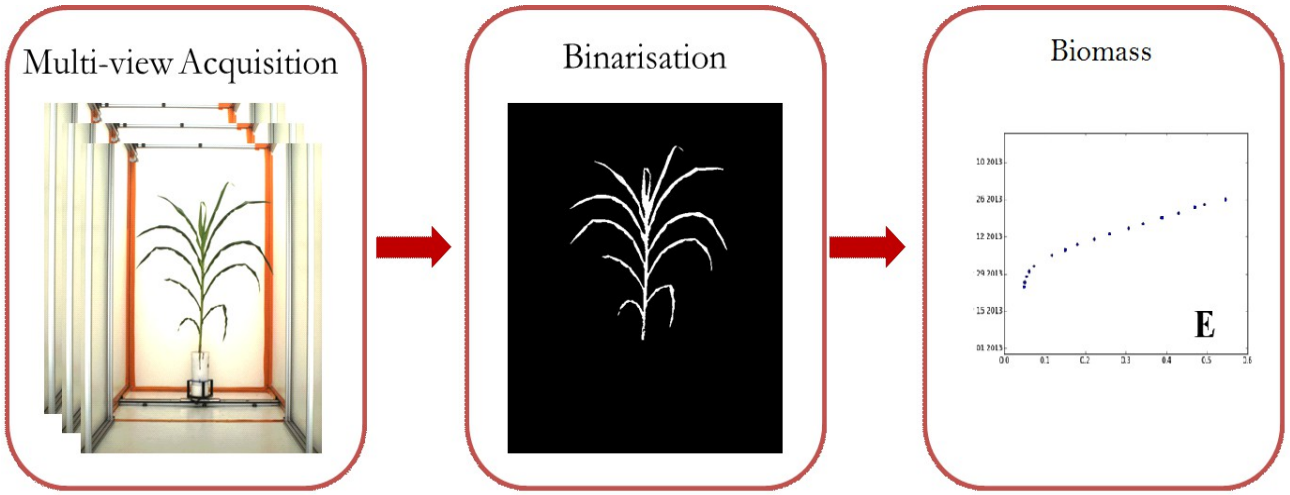
Phenomenal – OpenAlea / Visualea



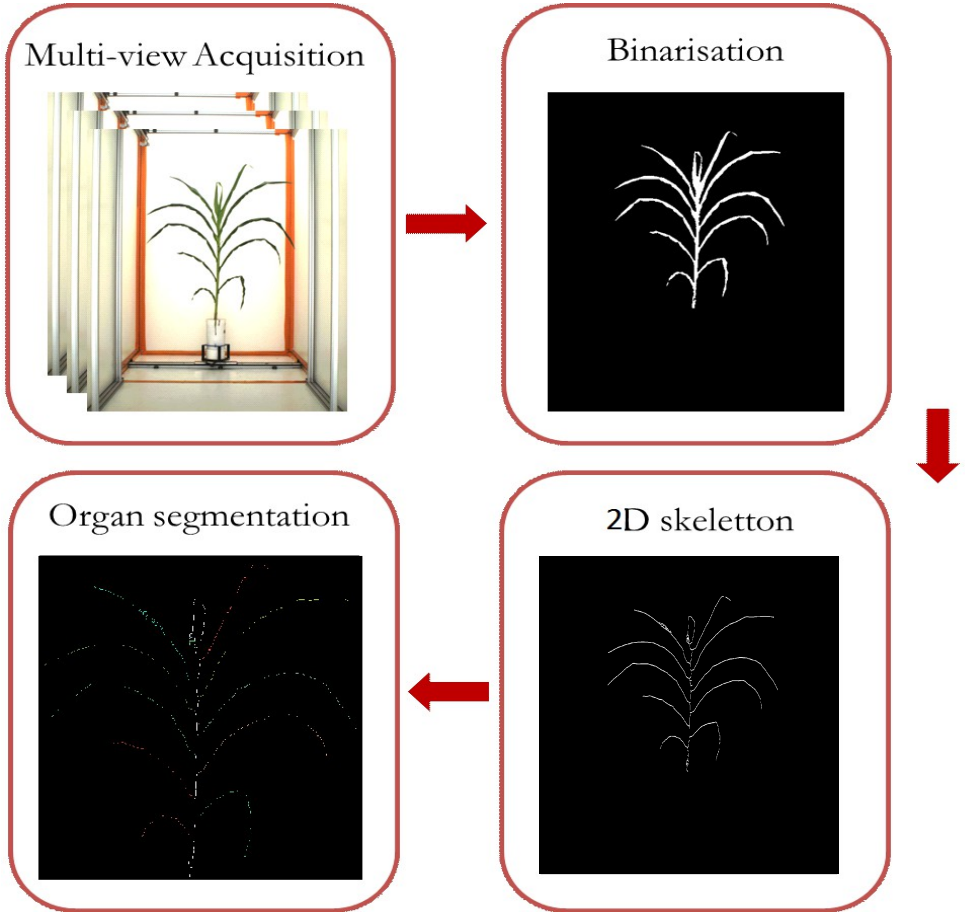
Phenomenal – PhenoArch data input

- ~ 1600 plants :
  - Images :
    - 12 or 2 side view
    - 1 top view
  - Date

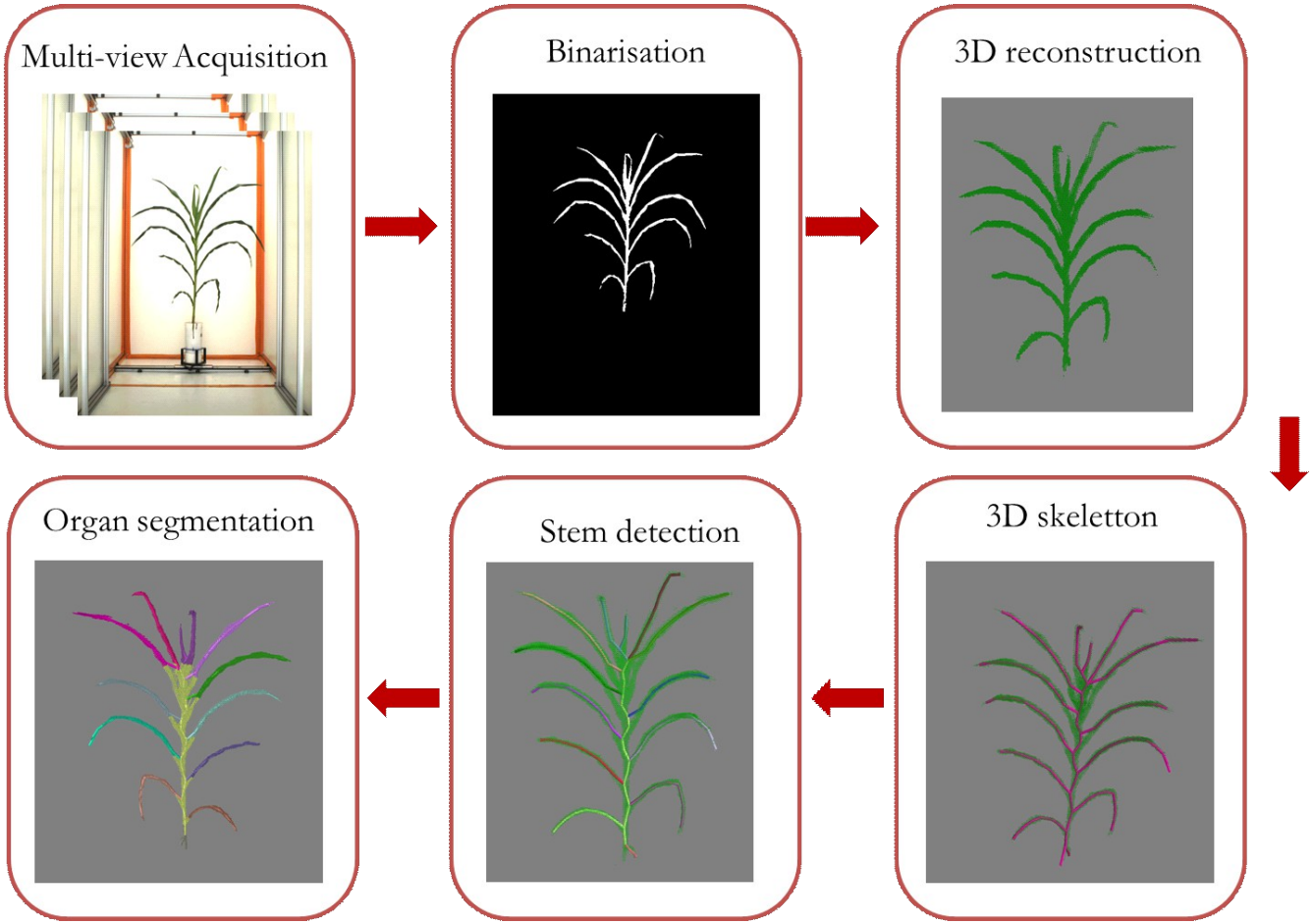
Phenomenal – Pipeline Biomass



Phenomenal – Pipeline Organ 2D

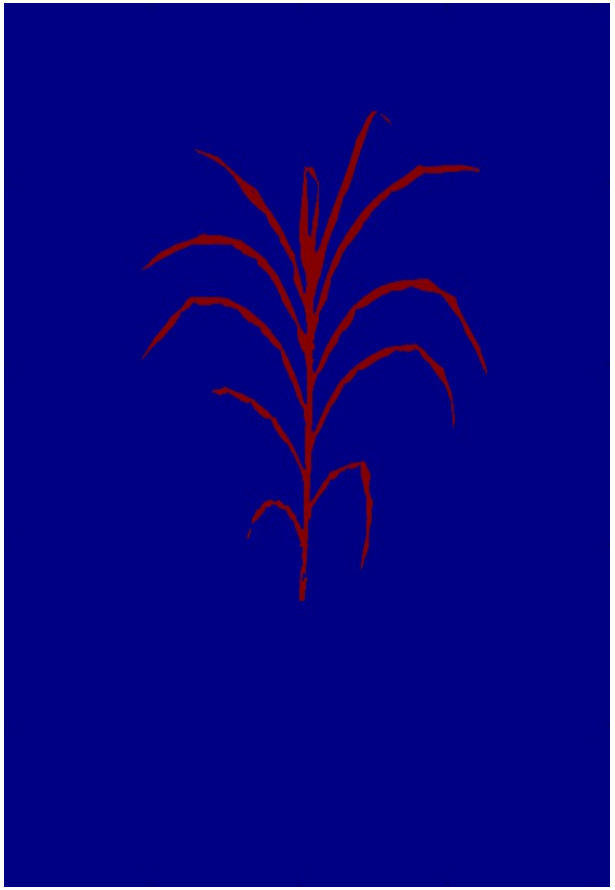


Phenomenal – Pipeline Organ 3D



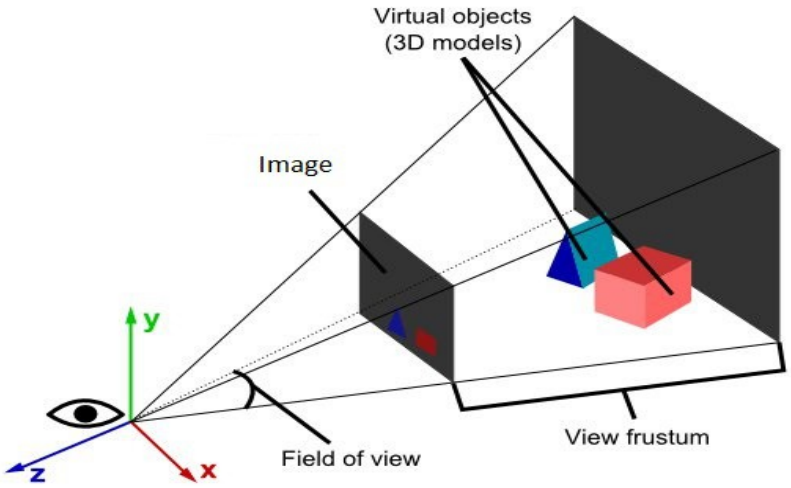
Phenomenal - Binarisation

- Algorithms :
  - Mask / ROI
  - Mean shift
  - Threshold HSV
    - Hue Saturation Value
  - Adaptive Threshold :
    - $$\mathrm{dst}(x,y) = \begin{cases} \mathtt{maxValue} & \text{if } \mathrm{src}(x,y) > T(x,y) \\ 0 & \text{otherwise} \end{cases}$$
    - Mean :
      - T(x,y) = Mean of the blockSize * blockSize neighborhood of (x, y)
    - Gaussian :
      - T(x,y) = Weighted sum (cross-correlation with a Gaussian window) of the blockSize * blockSize neighborhood of (x, y)



Phenomenal - Calibration

- Aim :
  - Project 3d point to 2d image



$$s \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_1 \\ r_{21} & r_{22} & r_{23} & t_2 \\ r_{31} & r_{32} & r_{33} & t_3 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

where:

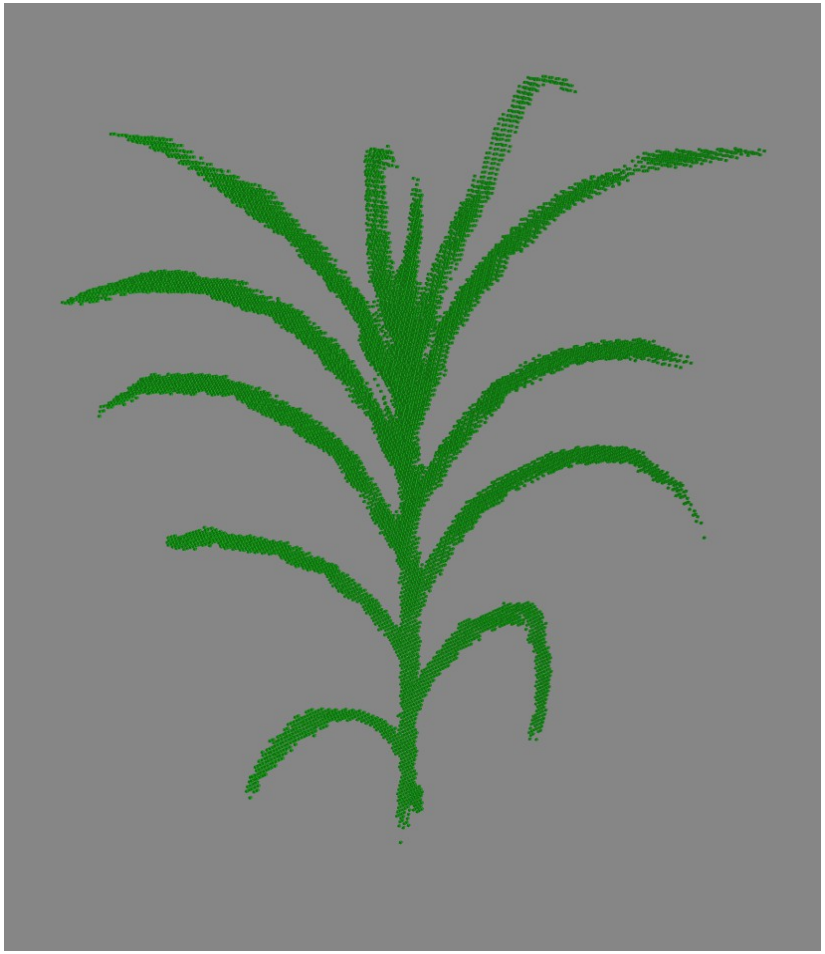
- (X, Y, Z) are the coordinates of a 3D point in the world coordinate space
- (u, v) are the coordinates of the projection point in pixels
- (cx, cy) is a principal point that is usually at the image center
- fx, fy are the focal lengths expressed in pixel units.

Phenomenal - Calibration

- Calibration manual :
  - Real measure
- Calibration OpenCV :
  - Chessboard :
    - ~ 120 images
    - 3 degree
  - Detect chessboard corners
  - Calibrate Camera
- Calibration with model physic :
  - Find physical parameters associated with a camera, using pictures of a rotating chessboard.

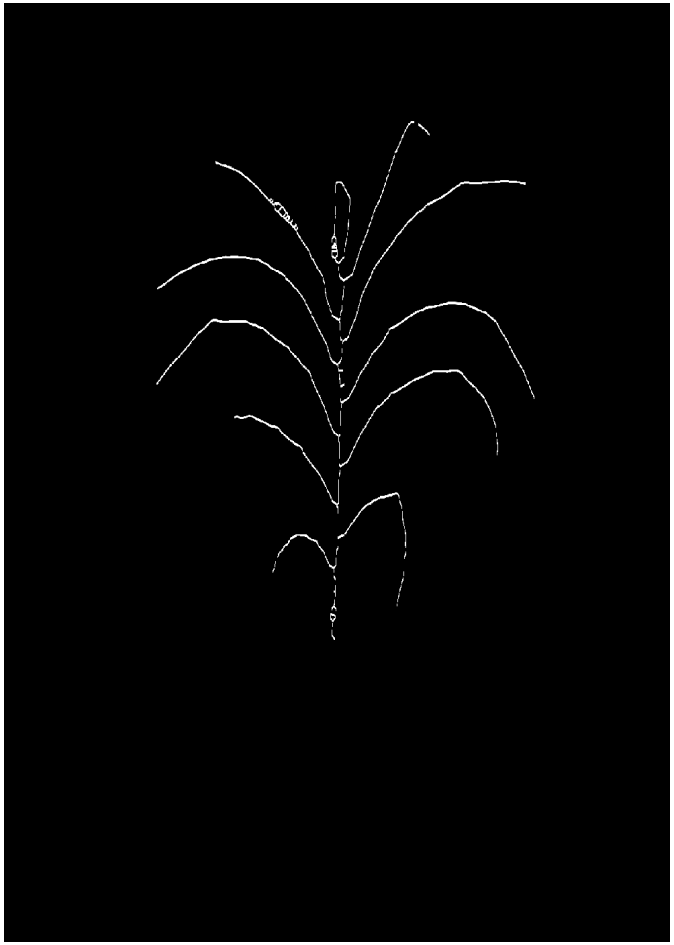
Phenomenal - Multi-View Reconstruction

- Algorithm :
  - Project each voxel on image
  - If projected point on image
    - Keep voxel for the next iteration
  - Split voxel in 8
- Out :
  - Voxel
  - Octree
  - Matrix



Phenomenal – 2D Skeleton

- 2D Skeleton :
  - Erode / Dilate
  - Thinning :
    - Successive passes
    - On each pass :
      - border pixels are identified
      - Removed on the condition that they do not break the connectivity of the corresponding object.

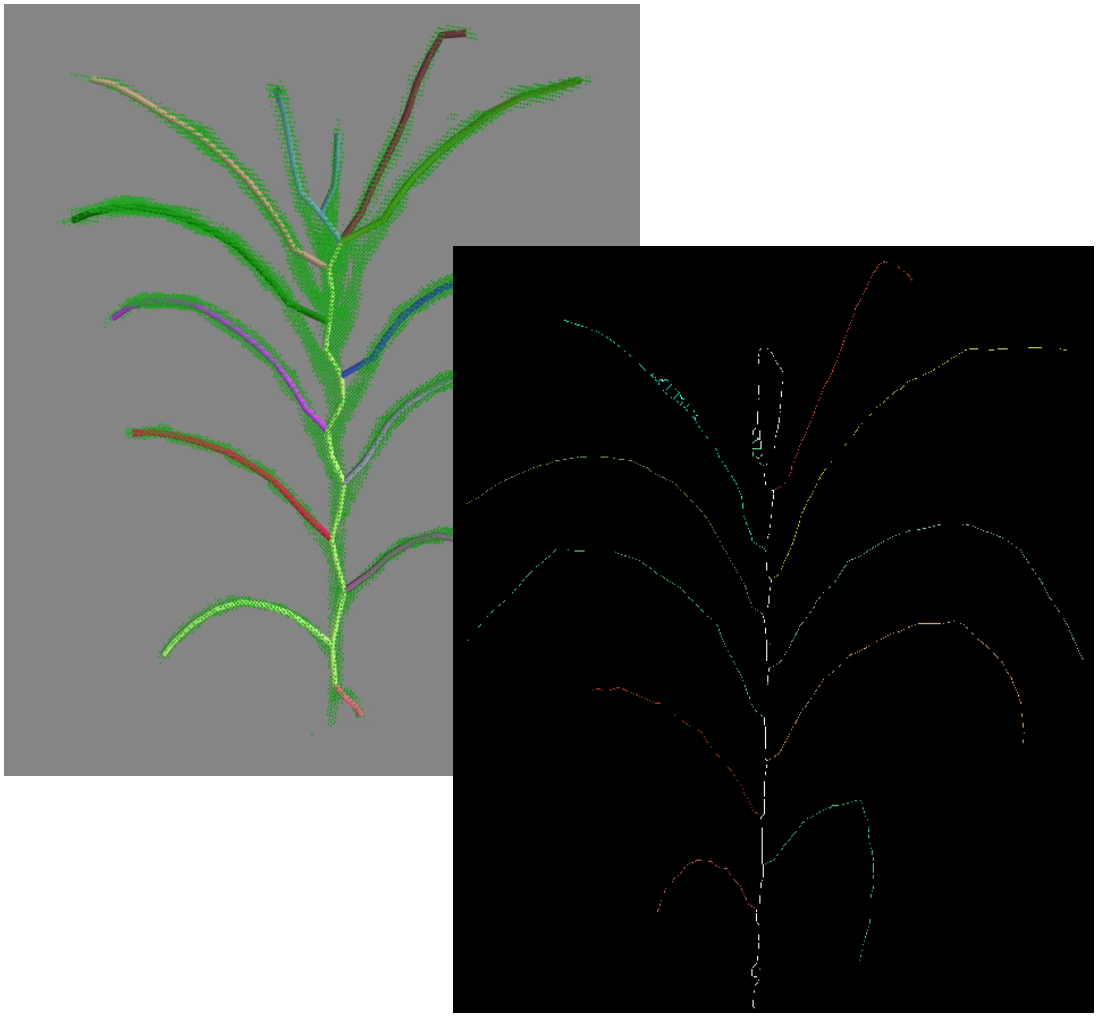


Phenomenal – 3D Skeleton

- 3D Skeleton :
  - Fred's Implementation of Xu et al. 07 method for main branching system :
    - PlantGL
    - MTG
    - Point (Segment)
  - 3D thinning algorithm :
    - From FIJI implementation
    - Soon

Phenomenal – 3D / 2D Segmentation

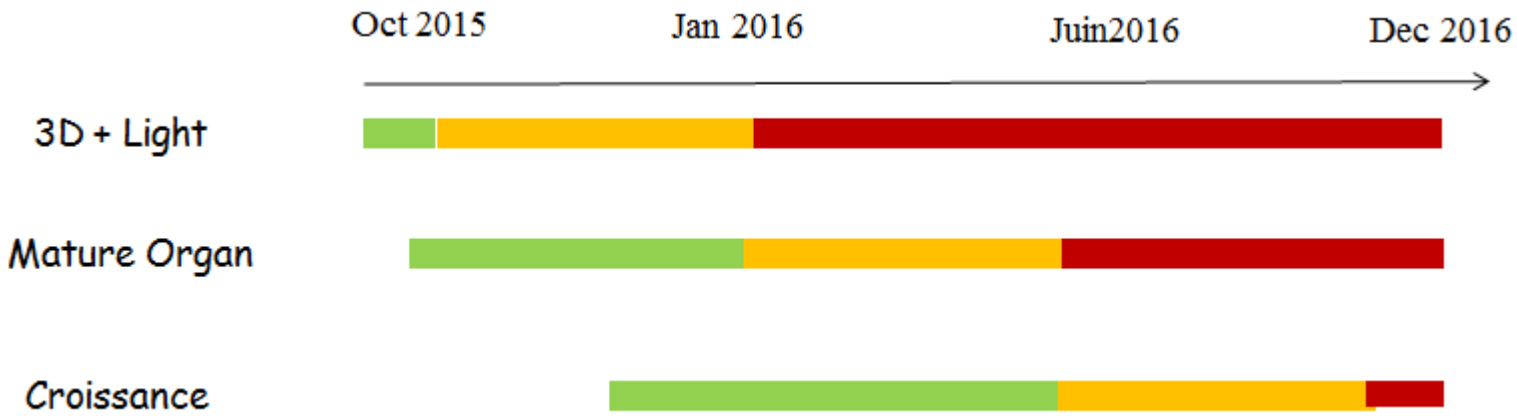
- Split in segment
- Detect Stem :
  - Angle orientation
  - Size
- Detect leaves :
  - Close to stem
  - Propagate



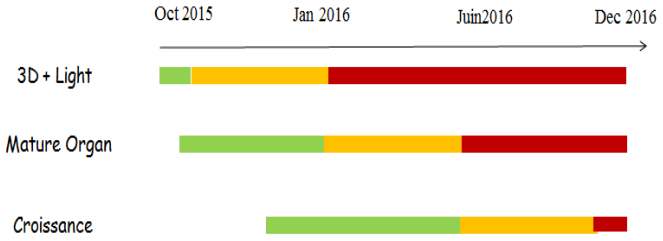
Phenomenal – Package

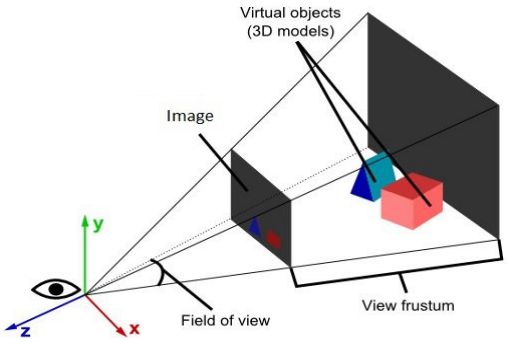
- Git :
  - Library :
    - test
    - example
    - doc
    - src
- Coding sprint :
  - Next Thursday :
    - Install and code review
- Prototype :
  - Functionality
- Beta test
  - Run tests : 1-3 manips, local server
  - First Analysis
  - Acceptance testing
- Finalization :
  - GUI (User, Phis, …)
  - Article methods

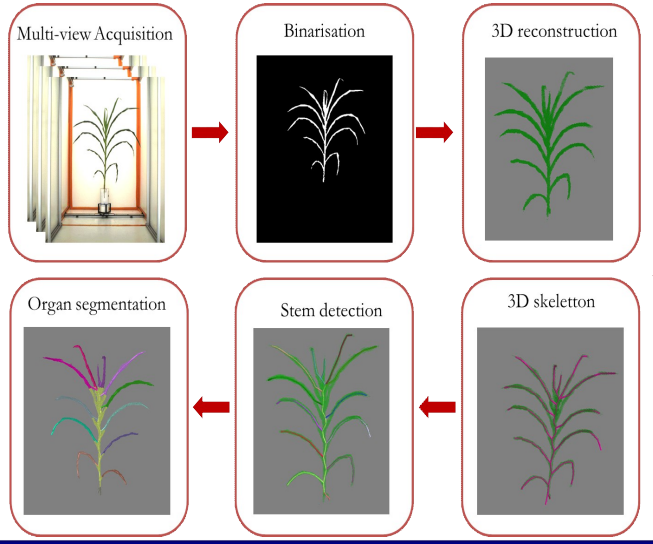
Phenomenal – Schedule

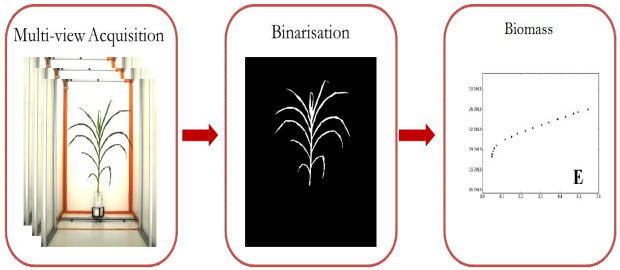


Questions


Oct 2015
Jan 2016
Juin2016
Dec 2016
3D + Light
Mature Organ
Croissance


Virtual objects
(3D models)
Image
y
z
x
Field of view
View frustum


Multi-view Acquisition
Binarisation
3D reconstruction
3D skeletton
Stem detection
Organ segmentation


Multi-view Acquisition
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E