

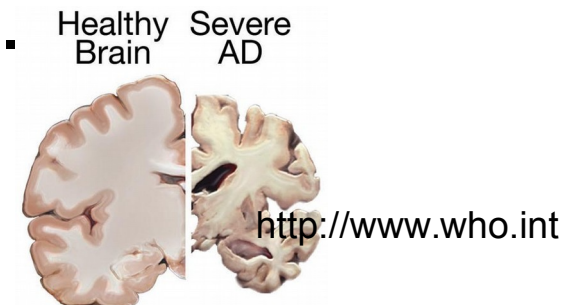
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biomedical engineer
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Brain images data mining: what's next?

CERN openlab "IT in Healthcare" Workshop
Geneva, Tuesday, 11 November 2014

Numbers and facts about Dementia

- ~35M people have dementia today. ~70M by 2030 and ~115M by 2070.
- When a diagnosis is made, it often comes at a relatively late stage of the disease.
- Alzheimer's disease is the most common cause of dementia (up to 70% of cases).
- Current drugs can in the best hypothesis just slow down the progression of the disease.
- Currently there is no cure.



Twin Labs

Brescia, Italy



IRCCS
CENTRO SAN GIOVANNI DI DIO FATEBENEFRAELLI – BRESCIA
Centro Nazionale per lo Studio e la Cura
della Malattia di Alzheimer e Malattie Mentali



Geneva, Switzerland



Laboratory of Neuroimaging of Aging

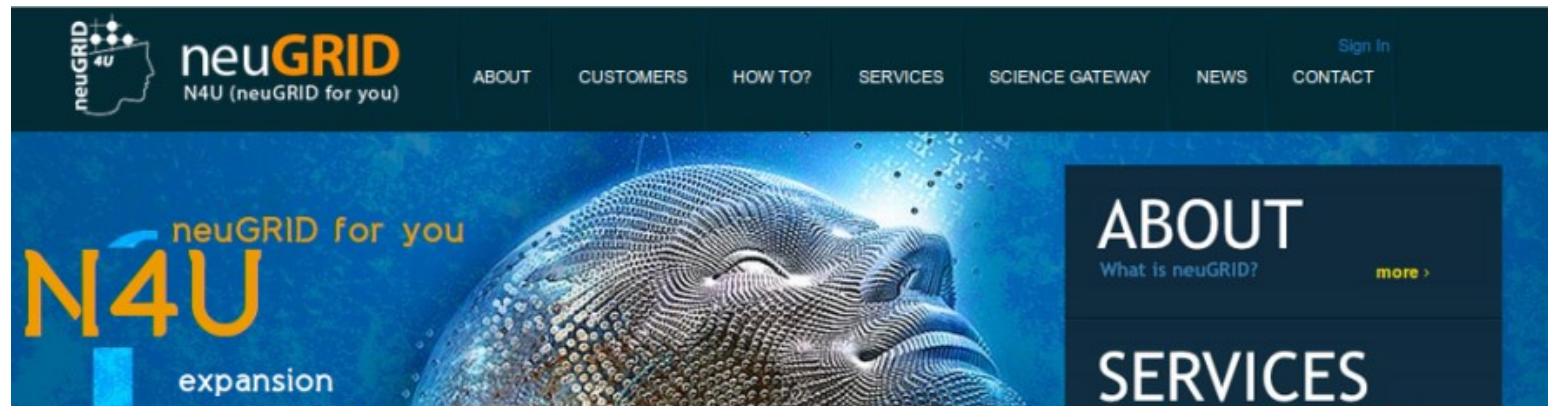
HUG  
Hôpitaux Universitaires de Genève

High Performance Computing

High Performance Computing



neuGRID: a grid-based image analysis environment



Large image datasets

Read More »

- OAS**
- LADIS**
- ADDNEUROMED**
- ADNI**

Algorithm pipe-lines for marker

$$e) \left(\frac{d^3 y}{dx^3}\right)^4 + 2 \frac{dy}{dx} = \sin x$$

Pipeline	Description
CIVET	Biological phenomenon
FreeSurfer	Cortical thickness
FSL	Cortical/subcortical anatomy
FSL	Structure (sMRI), microstructure (diff MR), function (fMRI)

Vast computational resources

Node	Storage (MB)	CPUs (n)
Sweden	3,557	40
Italy	3,170	40
France	4,095	2,600
Maat	1,268	8
Brazil	0	128
EGI	71,793	1,912
TOTAL	83,883	4,728

Help & Training

LEARN

Home Progetti Aiuto

neuGRID4you Help

Panoramica Attività Seg

Attività

Da 27-11-2012 a 26-12-2012

21-12-2012

- 23:18 Support #797
If you have openjdk, i
Try to start FF from a
Jérôme Revillard
- 21:29 Support #797
Hi Jerome,
both gateways. But it
Luigi Antelmi

ABOUT

What is neuGRID? [more >](#)

SERVICES

Processing, Datasets [more >](#)

QUOTATION

for quote [more >](#)

SCIENCE GATEWAY ACCESS

neuGRID

Graphical Interface
Single case analysis
Physician oriented

Command Line Interface
Parallel processing
Research Oriented

Segment Hippocampus using N4U setting

How to run the segmentation on MRI scans:
You have to upload:

- 1 Zip folder containing DICOMS or
- 1 nii.gz archive

Then provide the following information:

- Age of the Patient
- Sex of the Patient
- Model to use (default vs New trained model)
- Click Submit

Select Age of the Patient

50

Select Sex of the Patient

- M
 F

Select the models to use:

- Default models
 My models

Images (must be DICOM(s) in a folder Zipped as single archive or nii.gz file):

Browse... No file selected.

Status

Current state: Waiting for File to Upload
File name:

Submit!

```
WELCOME TO:
q@#@#@#@# .@#@#@#@# @#@#@#@#
@#@#@#@# [ @# #@# @#@#@#@# *#@#@
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pandora_user2@ng-hug-server4:~$

@echo "0 1 0 0" >> $ID\_bias1X.xfm
@echo "0 0 1 0" >> $ID\_bias1X.xfm
@echo "0 0 0 1" >> $ID\_bias1X.xfm
SFSL_PATH\fsorient -setformcode 1 $[ID]\nuC.nii.gz
SFSL_PATH\flirt -v -in $[ID]\nuC.nii.gz -ref $[ID]\nuC.nii.gz -applyxfm -init $ID\_bias
1X.xfm -out $[ID]\std.nii.gz
#####
@echo "$ID: Normalizing..."
SFSL_PATH\fslnaths $ID\_std.nii.gz -lnm 28.32 $[ID]\norm.nii.gz # 28.32 = icbn152 mean
rm $[ID]\std.nii.gz

@echo "$ID: Applying spherical MEDIAN filter (r=2mm) ..."
SFSL_PATH\fslnaths $[ID]\norm.nii.gz -kernel sphere 2 -fmedian $[ID]\norm\_median-Sph2.n
ii.gz

@echo "$ID: brain extraction (BET -B) ..."
SFSL_PATH\bet $[ID]\norm\_median-Sph2.nii.gz $[ID]\norm\_median-Sph2\_bet.nii.gz -B

@echo "$ID: Flirting... it may take a while..."
SFSL_PATH\flirt -ln $[ID]\norm\_median-Sph2\_bet.nii.gz -ref $TEMPLATE_BRAIN -omat $[ID]/
$[ID]\mat.xfm

303,1 58%
[3] 0:vim* "ng-hug-server4" 19:22 09-Nov-19
```


Report for Clinicians

ACM-AdaBoost Report



Subject info

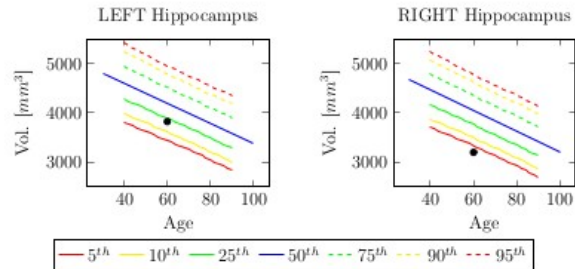
Patient ID: TestImageDICOMS Sex: M Age: 60

ACM-AdaBoost¹ Results

Model: wl3-75k-v2.0

Left Volume: 3822 mm³

Right Volume: 3194 mm³



Every colored line represents the *Prediction Percentile* for the hippocampus volume of a **non-pathological** subject.

¹J. H. Morra, Z. Tu, L.G. Apostolova, A.E. Green, C. Avedissian, S.K. Madsen, N. Parikshak, X. Hua, A.W. Toga, C.R. Jack, M.W. Weiner, P.M. Thompson. *Validation of a fully automated 3D hippocampal segmentation method using subjects with Alzheimer's disease mild cognitive impairment, and elderly controls.* Neuroimage, 43 (2008), 1:59-68.

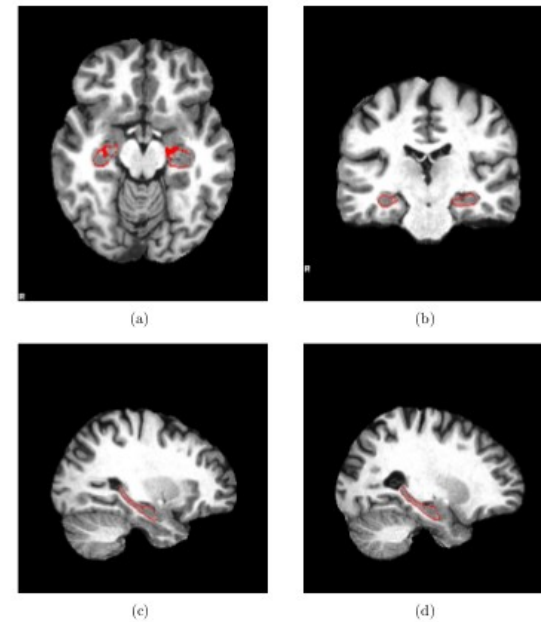


Figure 1: Segmentation of the brain scan registered to the ICBM-152 template. The letter "R" identifies the Right direction. (a) Axial view. (b) Coronal view. (c) Sagittal view centered on the Right Hippocampus. (d) Sagittal view centered on the Left Hippocampus.

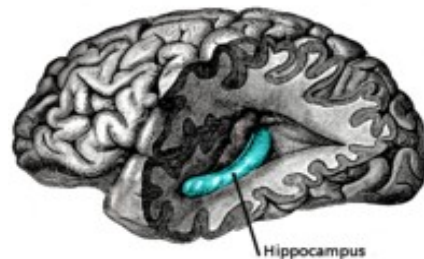
Scientific achievements



The hippocampal boundary shift integral is 70% more reproducible than FreeSurfer, manual and other hippocampal atrophy measurement algorithms

Keith S Cover^a, Ronald A van Schijndel^a, Adriaan Versteeg^a, Kelvin K Leung^b, Emma R Mulder^a, Remko A de Jong^a, Pieter J Visser^a, Baptiste Grenier^c, Jérôme Revillard^c, David Manset^c, Alberto Redolfi^d, Bob W van Dijk^a, Hugo Vrenken^a, Nick C Fox^a, Frederik Barkhof^a

^aVU University Medical Center, Amsterdam ^bUCL, London ^cgnubila, France ^dIRCCS San Giovanni di Dio Fatebenefratelli, Brescia, Italy (Contact: Keith@kscover.ca)



Conclusions

- MAPS-HBSI is roughly 70% more reproducible, based on BTB, than FreeSurfer, manual and the other algorithms
- ADNI1 post processing does not introduce significant noise based on the left-right symmetry of annualised PVC scatter plots
- The improved atrophy measurement is a step closer to hippocampus atrophy as a biomarker for individuals in AD

Biomarkers

2011: New Criteria for AD diagnosis



Alzheimer's & Dementia 7 (2011) 280–292

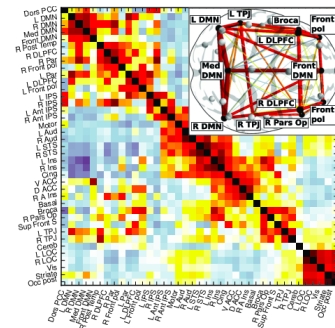
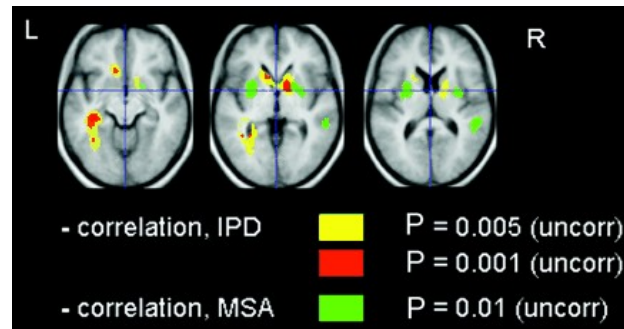
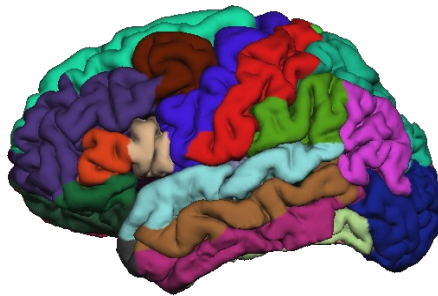
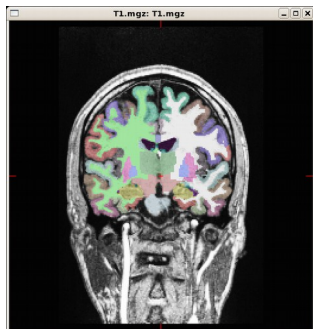
Alzheimer's
&
Dementia

Toward defining the preclinical stages of Alzheimer's disease:
Recommendations from the National Institute on Aging-Alzheimer's
Association workgroups on diagnostic guidelines
for Alzheimer's disease

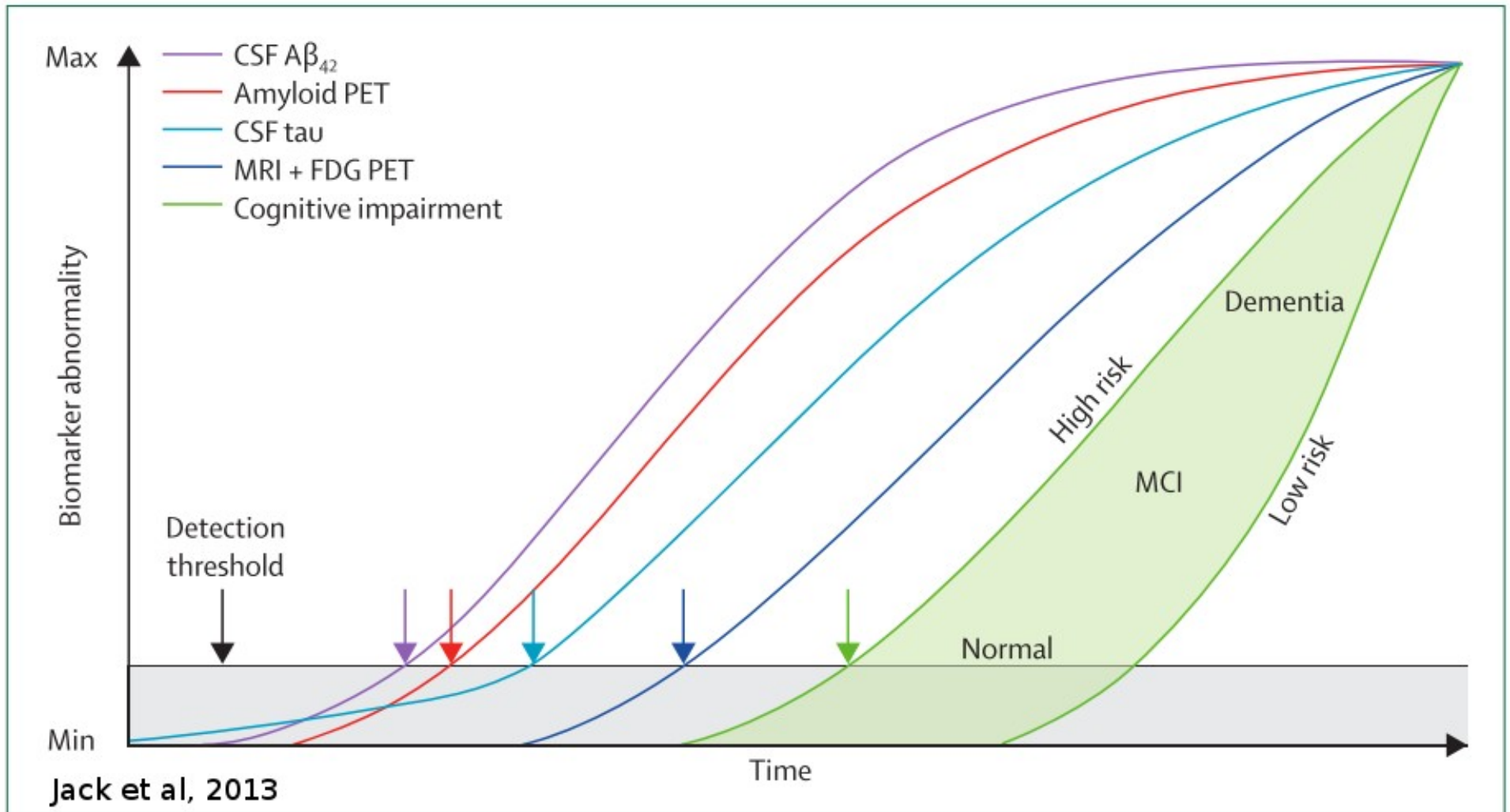
- Preclinical AD: a new concept that indicates that changes in the brain, can be detected before there are any clinical symptoms
- changes in the brain can begin 10 or more years before clinical symptoms like memory loss appear.
- Research must focus on finding early disease biomarkers.

What we are currently able to measure: the biomarkers

- Geometry (MRI)
- Functionality (fdg-PET, fMRI)
- Amyloid load (CSF, amy-PET)
- Pattern of atrophy/functionality



Hypothetical model of dynamic biomarkers



Tough Problems

Navier-Stokes

$$\rho \left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\nabla p + \nabla T + f$$

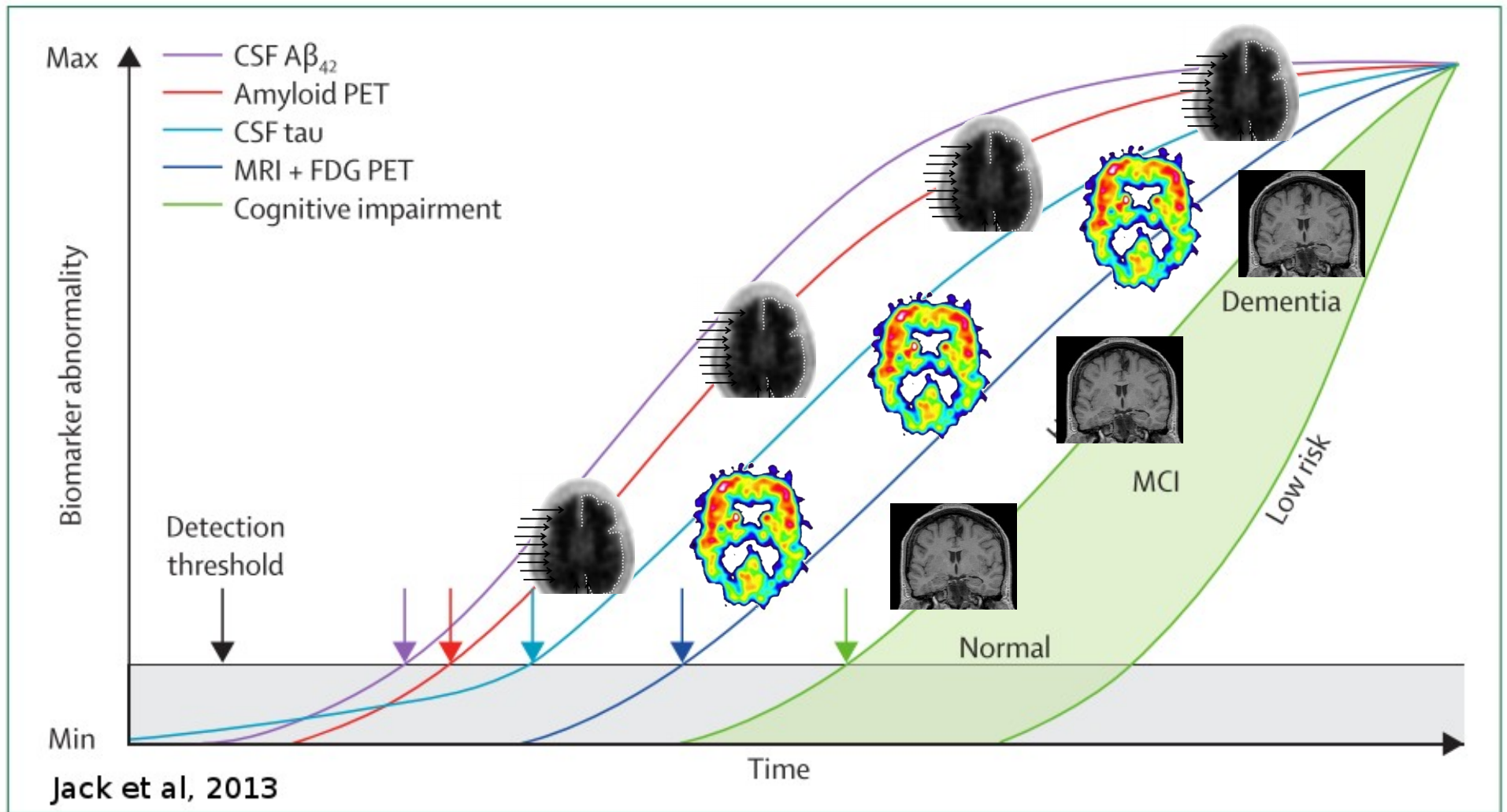


Black-Scholes

$$\frac{\partial V}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} = rV$$

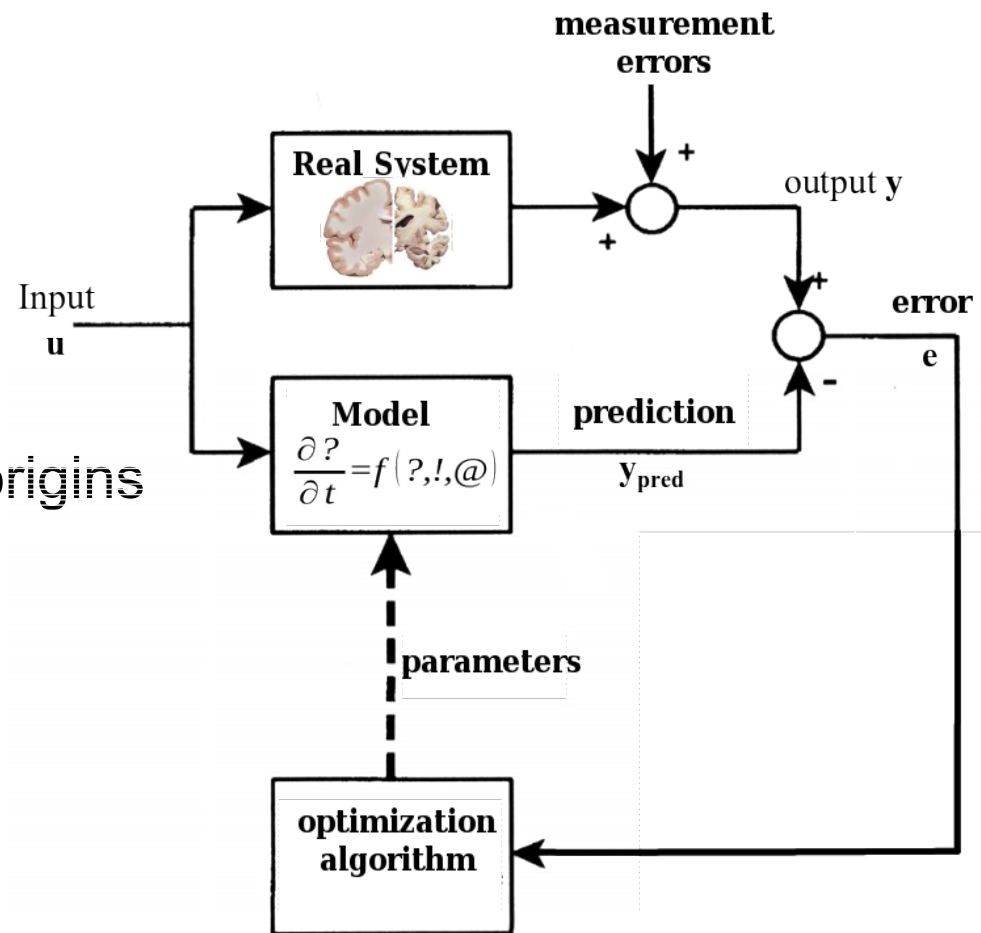


The Challenge: $\frac{\partial ?}{\partial t} = f(?, !, @)$



Advantages of a quantitative model

- Quantify disease dynamics
 - Disease tracking (pharma)
 - Early diagnosis (clinicians)
- Identify drugs that works
 - Short-term end-points
- Personalized medicine
- Test hypothesis on disease origins
 - Tau vs Beta debate



$$\frac{\partial ?}{\partial t} = f(?, !, @)$$