

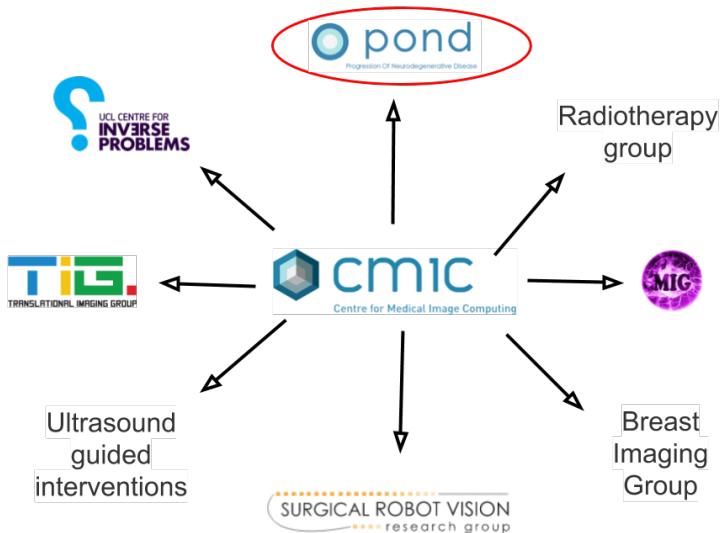
TADPOLE Competition: Prediction of Alzheimer's Evolution using Statistical Models and Machine Learning

Răzvan Valentin Marinescu Leon Aksman

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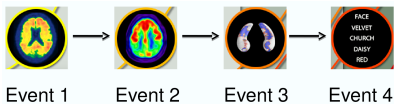
Progression of Neurodegenerative Diseases (POND)



POND Aim: Develop Computational Models for Disease Progression

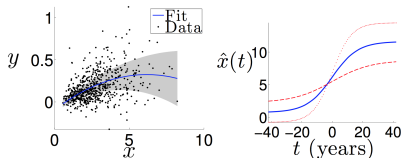
Event-Based Model

(Fontejin et al., Neuroimage, 2012)



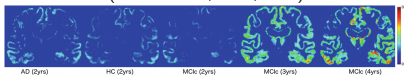
Differential Equation Model

(Oxtoby et al., submitted, 2017)



Gaussian-Process Regression

(Lorenzi et al., IPMI, 2015)



Subtype and Stage Inference

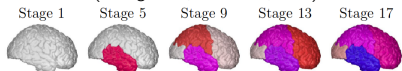
(Young et al., submitted, 2017)



POND Aim 2: Apply the Models to Distinct Neurodegenerative Diseases

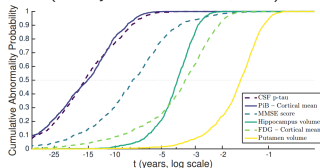
typical AD

(Young et al., submitted, 2017)



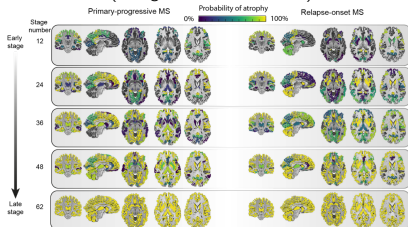
Familial AD

(Oxtoby et al., submitted, 2017)



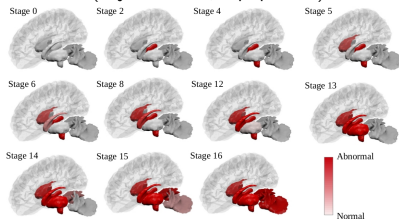
Multiple sclerosis

(Eshghi et al., Brain, 2017)



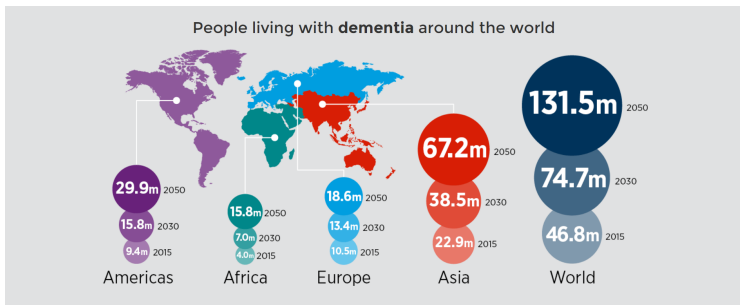
Huntington's disease

(Wijeratne et al., in preparation)



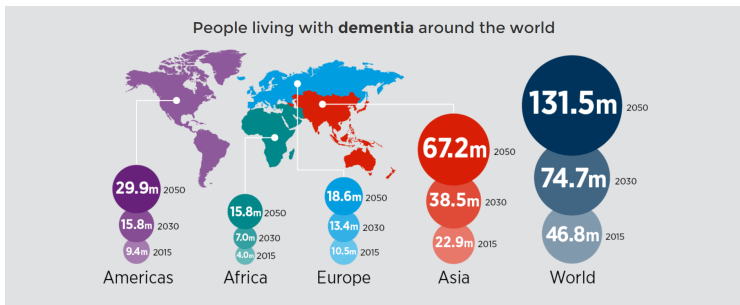
Alzheimer's Disease is a Devastating Disease

- ▶ 46 million people affected worldwide



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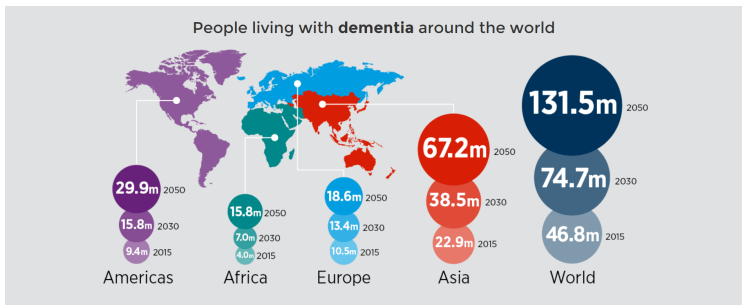
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- ▶ No treatments available that stop or slow down cognitive decline
- ▶ Q: Why did clinical trials fail? A: Treatments were not administered early enough

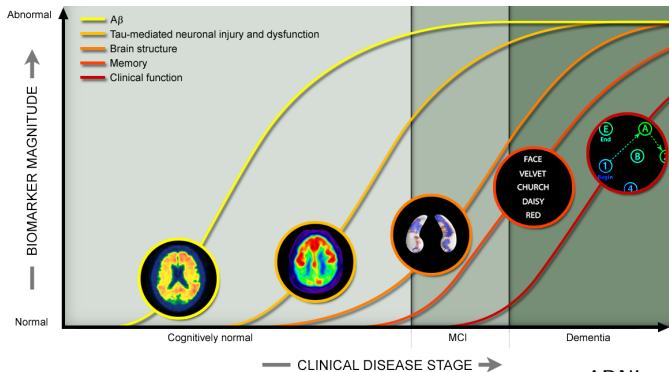
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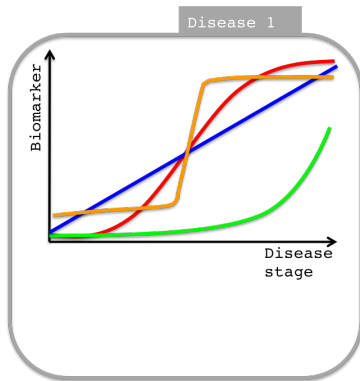
- ▶ No treatments available that stop or slow down cognitive decline
- ▶ Q: Why did clinical trials fail? A: Treatments were not administered early enough
- ▶ Q: How can we then identify subjects **early** in order to administer treatments?
- ▶ A: Biomarkers ...

Biomarker Evolution creates a Unique Disease Signature that can be used for Staging Individuals in Clinical Trials



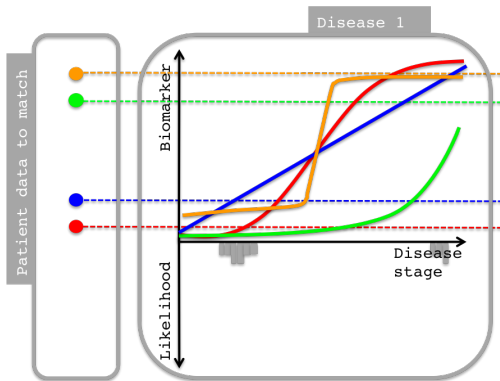
ADNI website

- ▶ Accurate disease staging → better patient stratification
- ▶ Problem: This is a "hypothetical" (i.e. qualitative) disease progression model
- ▶ Why construct a quantitative model?



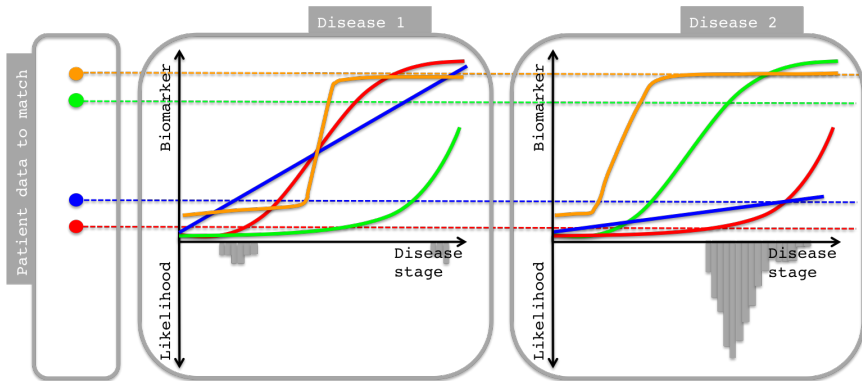
- Basic biological insight

Benefits of Quantitative Disease Progression Models



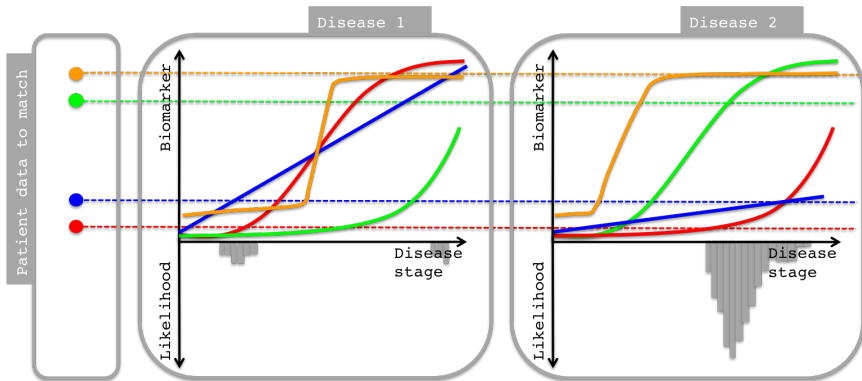
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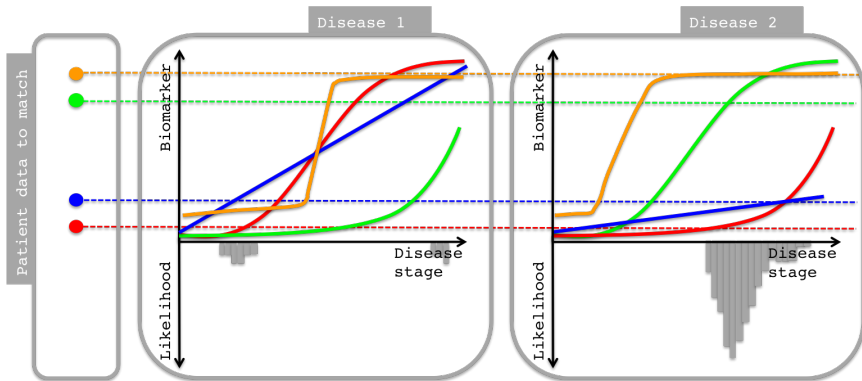
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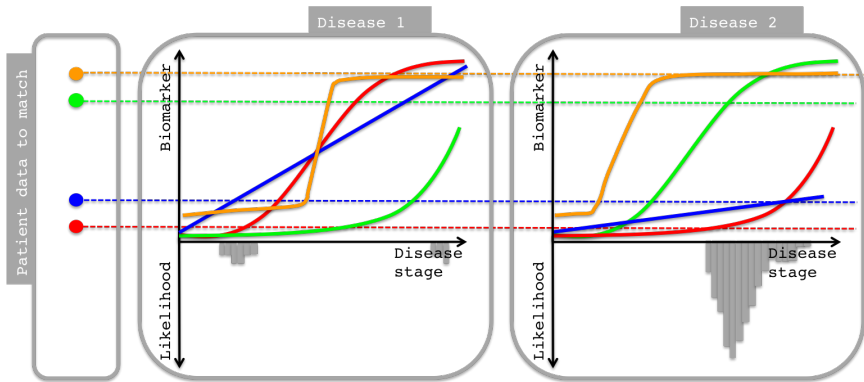
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- ▶ Predict future evolution of patients

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- ▶ Early detection of disease in at-risk subjects

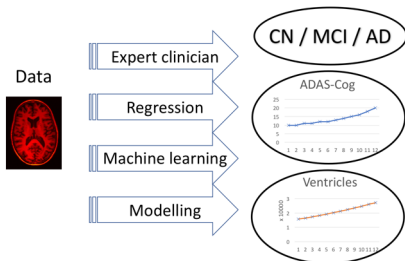
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Need to identify which models and features are best at above tasks ...

TADPOLE Challenge aims to identify algorithms that best predict future evolution of subjects at-risk of AD



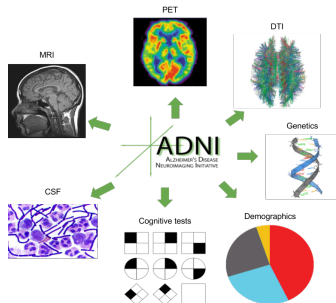
TADPOLE Challenge: Prediction of Longitudinal Evolution in Alzheimer's Disease

Razvan V. Marinescu, Neil P. Oxtoby, Alexandra L. Young, Esther E. Bron, Arthur W. Toga, Michael W. Weiner, Frederik Barkhof, Nick C. Fox, Stefan Klein, Daniel C. Alexander, the EuroPOND Consortium, arXiv, 2018

What to do

Input: Large dataset from ADNI:

- ▶ > 1,667 subjects with a total of 12,000 visits.
- ▶ > 2,000 biomarkers from imaging, demographic, cognitive and genetic data



Task: Estimate the progression over the next 5 years of three key biomarkers:

- ▶ Diagnosis
- ▶ ADAS-COG13
- ▶ Ventricle Volume

RID	Forecast Month	Forecast Date	CN relative probability	MCI relative probability	AD relative probability	ADAS	ADAS 50% CI lower	ADAS 50% CI upper	Ventricles	Ventricles 50% CI lower	Ventricles 50% CI upper
A	1	2018-01	0	1	0	30	25	35	0.024	0.021	0.029
B	1	2018-01	3	2	0	25	21	26	0.023	0.021	0.025
C	1	2018-01	0.24	0.38	0.38	40	25	50	0.025	0.023	0.028

Overall winner: lowest sum of ranks in the three categories above

- ▶ Diagnosis MAUC
- ▶ ADAS-COG13 MAE
- ▶ Ventricle Volume MAE

We will offer prizes!

Live leaderboard will show progress of each team this week:

RANK	TEAM NAME	MAUC	BCA	ADAS MAE	VENTS MAE	ADAS WES	VENTS WES	ADAS CPA	VENTS CPA	DATE
1	TeamAlgosForGood1	0.809	0.856	4.087	4.52e-03	4.087	3.81e-03	0.091	0.006	2017-09-18 09:34 (UTC+0)
2	FPC1	0.758	0.722	5.000	4.19e-03	4.976	4.19e-03	0.350	0.381	2017-09-18 09:34 (UTC+0)
3	FPC3	0.706	0.721	6.369	2.56e-03	6.736	2.56e-03	0.250	0.267	2017-09-12 22:51 (UTC+0)
4	FPC2	0.706	0.721	6.369	2.56e-03	6.711	2.56e-03	0.392	0.324	2017-09-18 09:34 (UTC+0)

Join the TADPOLE Challenge!

- ▶ URL: <https://tadpole.grand-challenge.org/>
- ▶ Prize fund: £30,000



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Tadpole Challenge

Welcome to The Alzheimer's Disease Prediction Of Longitudinal Evolution (TADPOLE) challenge.

Brought to you by the EuroPOND consortium in collaboration with the Alzheimer's Disease Neuroimaging Initiative (ADNI).