

# BIOMEDICAL IMAGING AND GENETIC (BIG) DATA & AI FOR PRECISION HEALTH


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1

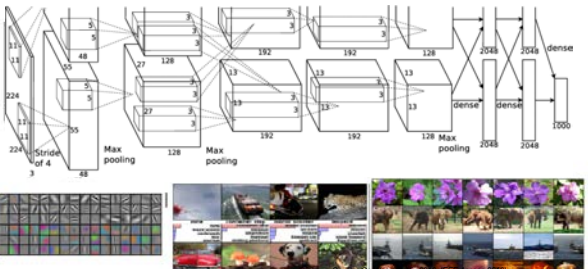

## Disclosure

Wiro Niessen is founder, scientific lead (0.2 fte) and shareholder of Quantib BV



2

### ImageNet 2012: Image Classification Breakthrough with convolutional neural nets





3

### ImageNet statistics\*

- More than 14 million images have been hand-annotated by the project to indicate what objects are pictured and in at least one million of the images, bounding boxes are also provided.
- ImageNet contains more than 20,000 categories with a typical category, such as "balloon" or "strawberry", consisting of several hundred images.
- Key to its success: large open data resource & challenge aspect.

\*Source: Wikipedia, Aug 21, 2019



4

"Anything you can do, AI can do better"





5

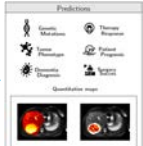
### Can this success be translated to clinical practice?

**Data**



→

**Predictions**



**Specific health domain challenges:**

- We need to collect more than images alone (genetics, omics, clinical information, exposome).
- We need to do to more than image perception.
- Human biology and pathology is highly variable.



6

## Promises & challenges in health domain

- DeepMind: "predicting acute kidney injury up to 2 days before it happens" (Nature, July 2019).
- 703.000 patients.
- 620.000 data points / 3.600 predictive.  
(Blood-tests, vital signs, past procedures, prescription, intensive care unit admission)
- No actual prediction has been made (retrospective study); accuracy is 55.8% and depends on time to event: prospective validation needed.
- Dataset obtained via US Department of Veterans Affairs: 94% male, and biased population.

Some features may be very much dependent on health care system/setting

7

## Data driven precision health requires health data infrastructure



Taking individual variability into account to promote health, prevent & optimize diagnosis, prognosis and treatment

Utilizing our rich data resources and AI



Anything you can do, AI can do better

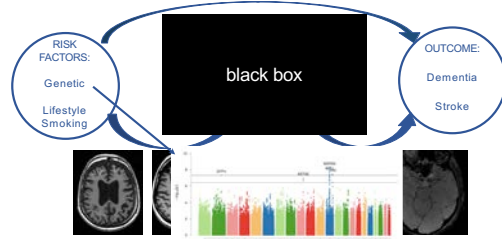
8

## Population imaging: Rotterdam Study



9

## Population imaging: design



10

## Rotterdam Scan Study (> 15.000 brain MRI) library of quantitative imaging biomarkers

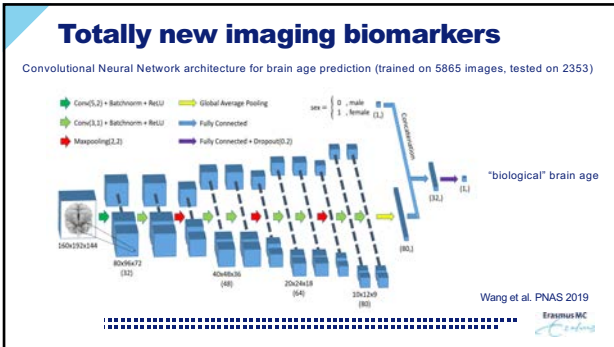
Brain tissue			
White matter lesions		Hippocampal shape and volume	Brain structures
Brain structures		Subcortical WML	White matter tracts
Microstructure		Structural connectivity	
Incidental findings			
Micro bleedings			

11

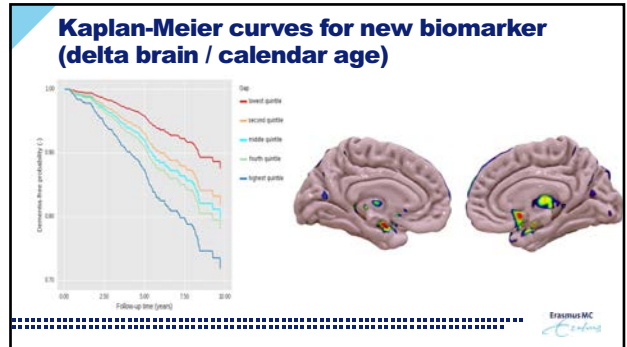
## Clinical decision support



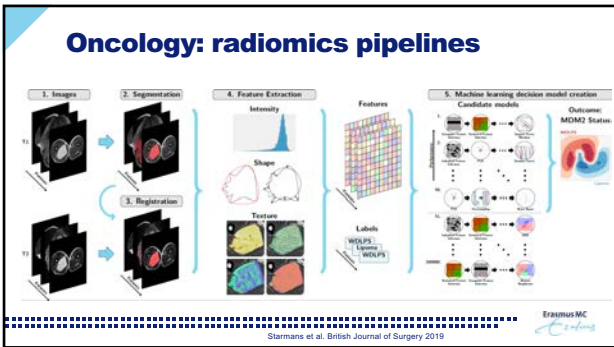
12



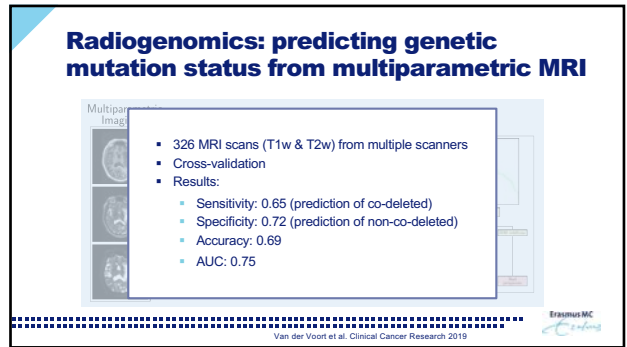
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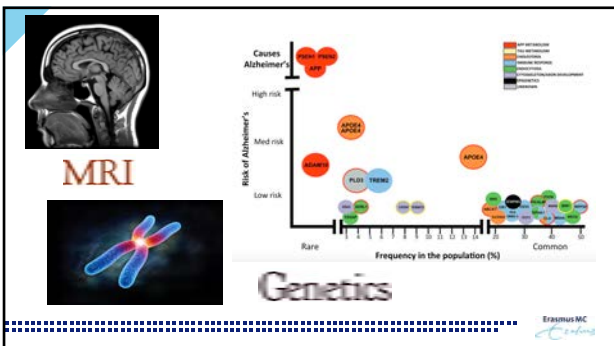
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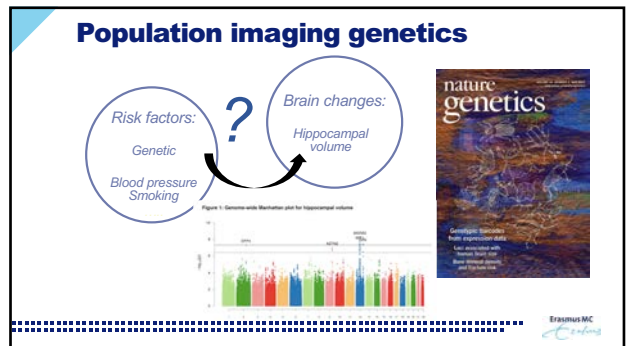
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16



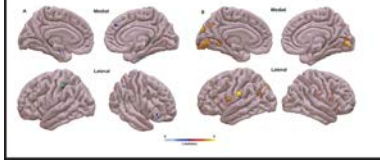
17



18

## Imaging genetics: gaining insight in relation genetic liability, environmental factors and imaging phenotype

VBM analysis consisted of 4071 nondemented persons with information available on both genome-wide genotyping and MRI data from the population-based Rotterdam Study. The mean age was 64.7 (±10.7) years and 2251 (55%) subjects were women.

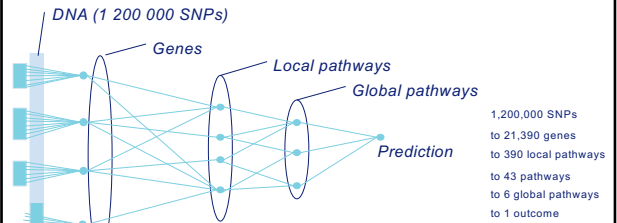


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Roche et al. Neurobiology of ageing

19

## Neural Network - KEGG Pathway



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20

## Future of imaging genetics

Holy grail: find phenotype = f (genotype, environmental factors)

Current approaches: mostly massive number of linear regressions

Promises in:

- Larger datasets
- Machine and deep learning for learning more complex relations

Challenges:

- DL/ML cannot straightforwardly be applied (heterogeneous data, biological variability)
- Modular approach, integrating prior knowledge with DL

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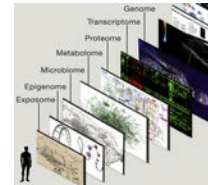
21

## Making more impact by enabling excellent data-driven life science



What is needed?

- Work on higher quality and better accessible (image) data for science and innovation
- Implement FAIR data, distributed access and Open Science
- Create ML/DL challenges for important tasks
- Prospective validation for responsible introduction AI



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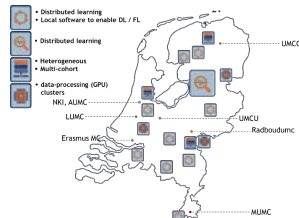
22

## FAIR data & distributed learning



Open data is about MORE THAN DISCLOSURE it must be FAIR

- Findable
- Accessible
- Interoperable
- Reusable



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23

## Future of health(care) because of AI



We have the potential to develop a "learning" healthcare system, where new patients are diagnosed / treated based on all available information

Bringing data, clinical knowledge and AI together is key: co-creation of diagnostic and prognostic tools: we need to invest in health data infrastructure

Clinicians will not be replaced, but their jobs will change!

The current hype in AI is mostly about image perception / quantification

Artificial intelligence can model complex relations: linking genetic liability and environment/lifestyle to outcome

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24

**Thank you**

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