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WHAT ARTIFICIAL INTELLIGENCE COULD MEAN FOR THE HEALTH CARE SECTOR

TRACK 2: DIGITAL TRANSFORMATION ENABLES A PATIENT-CENTRIC, MULTIDISCIPLINARY DELIVERY OF CARE

15:40 - 16:15





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WHAT ARTIFICIAL INTELLIGENCE COULD MEAN FOR THE HEALTH CARE SECTOR

RUDY LAUWEREINS - VICE PRESIDENT

Health Care Cost (1970-2016)



HEALTHCARE **IS COMING**

DATA DRIVEN

protone

11010101010000101010011 101010101000010101010011 10101010100001010100011

19/1990010101010101010

0101000010101001111010101

a101



HEALTHCARE IS CHEREG

AUTOMATED AND IMPROVED DRUG DISCOVERY ACROSS MULTIPLE PHARMA COMPANIES

DRUG DEVELOPMENT CYCLE

IMPROVE FIRST STEP: DRUG COMPOUND DISCOVERY



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DRUG DISCOVERY: PREDICT COMPOUND THAT INTERACTS WITH CELL TARGET

MACHINE LEARNING PREDICTS TEST RESULT OF NON-TESTED COMPOUND-TARGET COMBINATIONS



Machine Learning: probabilistic prediction of non-tested compound-target combinations Uses test results of similar compounds (U*V) and known compound properties ($C^*\beta$)



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PREDICTION ACCURACY IMPROVED WHEN LEARNING ACROSS MULTIPLE PARTNER TEST DATA

SHARING COMPOUND-TARGET DATABASE BETWEEN COMPANIES NOT POSSIBLE...



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PRIVACY PRESERVING METHOD DEVELOPED FOR MULTI-PARTY PREDICTION NO SENSITIVE DATA SHARING $\mathbf{C} \times \boldsymbol{\beta} = \mathbf{U}$ BROKER U BROKEERBRIDGE ENGINE MACHINE U LEARNING **ENGINE** U U U' PRIVATE DATA COMPANY BROKERBRIDGE ENGINE BROKERBRIDGE BROKERBRIDGE ENGINE ENGINE **PRIVATE DATA COMPANY PRIVATE DATA PRIVATE DATA** $U' \times V = Y'$ COMPANY COMPANY ເກາຍc

PATIENT TRAJECTORIES FOR PRECISION MEDICINE

WHY PRECISION MEDICINE? NO CURE, NO PAY?

- Outcome-based pricing
 - Kymriah: If patient shows no response after the end of the first month, Novartis will not be reimbursed
 - Likely to be essential for expensive drugs
- Precision medicine
 - How to achieve high response rates?
 - Real-world endpoint = long-term outcome
 - Cannot wait that long for payment
 - Surrogate endpoint = short-term data prediction of real-word endpoint
 - How to assess reliability of surrogates?
 - Clinical trial data only partly reflects realworld outcomes
 - Modeling real-world patient follow-up



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SOLUTION: PRIVACY-PRESERVING MODELING OF PATIENT TRAJECTORIES PATIENT DATA STAYS AT HOSPITAL, DERIVED DATA SHARED TO IMPROVE PREDICTION

- Value for Pharma
 - Improved patient recruitment for clinical trials: know complete history of patient
 - Improved prediction of effect of drug on specific patient (Pay-for-cure)
- Value for Patient
 - Improved treatment: higher chance right drug for specific patient selected
- Value for hospital
 - Improved therapeutic decisions
- Value for government
 - Reduced health care cost: less ineffective treatments
 - Deeper insight in population health



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CELL SORTING AND CYTOMETRY

DETECTING CIRCULATING TUMOR CELLS (CTCS) TO PREVENT METASTASIS



CTCs are morphologically distinguishable E.H. Cho et al, Phys. Biol. **9** (2012) 016001

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VERY-HIGH-THROUGHPUT IMAGING FLOW CYTOMETER

Input

- Records images of cells in flow using lens-free imaging
- Fast sorting state based on bubble-jet technology
- Disposable fluidics
- Custom imaging chip with array of parallel imagers
- Scalable to 20,000,000 cells/s
- >1000-fold improvement over current systems

Fast microfluidic bubble-jet cell routing



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MINIATURIZED LENSFREE IMAGE FLOW CYTOMETRY REAL-TIME CAPTURING AND RECONSTRUCTING HOLOGRAPHIC VIDEOS OF CELLS



Hologram

Reconstruction



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AUTOMATIC CLASSIFICATION OF 3 TYPES OF WHITE BLOOD CELLS BASED ON COMBINED CLASSICAL FEATURE EXTRACTION AND DEEP NEURAL NETWORKS



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Classification results comparable with Sysmex on same blood sample; published in Lab on chip



3-part WBC

classification



- Combine with fluorescence
- Feature extraction and classification
- Increasing sample complexity
- Machine learning on holograms (real time)
- Distributed machine learning

PREDICTING PRELIMINARY BIRTH RISK

PREDICTING PRELIMINARY BIRTH RISK





25-4-1993: my daughter @ day of birth 30 weeks, 1.6kg

13-9-2018: my grandson @ day of birth 40 weeks, 4.0kg



20k preterm

Preterm = <37 weeks of gestational age Leading cause of death among children <5yr

Improve prediction of preterm birth through analysis of structured and unstructured data



PREDICTING PRELIMINARY BIRTH RISK APPROACH



Anonymization

Structured model

Facts extraction

Unstructured model

Structured + unstructured



PREDICTING PRELIMINARY **BIRTH RISK**



Visualize predictive value of some structured features w.r.t. immanent premature birth



Structured model

Facts extraction

Unstructured model

Structured + unstructured



PREDICTING PRELIMINARY BIRTH RISK

CONVERTING UNSTRUCTURED NOTES INTO STRUCTURED INFORMATION

- Examples of unstructured MD notes on cervical length:
 - "measured cx length: funnel, still 9mm functional cx length.With valsalva 7mm."
 - "No by or vy cx length 33mm"
 - "Stabil cervix length (measurement yesterday 32mm)"



Structured model

Facts extraction

Unstructured model

Structured + unstructured



INFLUENTIAL WORDS IN THE NOTES

foetale bewaking type ctg continu normaal ctg af en toe een opspanning die ze voelt maar niet heel pijnlijk is hulp mobiliteit begeleiding bij verplaatsen naar afname ctg houding half rechtop zittend pols normaal rr normaal temp 35 80 sat bloedverlies zuurstoftoediening via aan omwille van art toegangspoort bloedvat uitgevoerd door zorgkundig vroedkundig perifeer microclave bod_or_phone bod_or_phone arm links in gebruik ja plaatsen geen tekenen van infectie type bloedafname veneus soort uitgebreid labo bij opname type staalafname urine soort urinesediment midstream controle 118 mmhg 71 mmhg 86 bpm 36 oedeem weeën geen om de pijnscore nausea braken moeheid type zorg bij mictie spontaan zelfstandig opvolging mictie mobiliteit gedeeltelijke hulp installatie afname ctg houding half rechtop zittend voeding glas inschenken opm geen bloed of vruchtwaterverlies _given_name_ kb goed fht ligging opm opdr nr controle 117 mmhg 70 mmhg 83 bpm 36 oedeem weeën geen om de pijnscore comfort liggende houding nausea braken moeheid type zorg bij mictie spontaan zelfstandig ontlasting spontaan ondersteuning movicol zn info uitscheiding evaluatie info uitscheiding begrepen varices negatief mobiliteit geen hulp houding rechter zijligging voeding glas inschenken _given_name_ kb goed fht ligging opm _doctor_ naam medicatie tocolytica atosiban tractocile amp tractocile nacl 100 ml intraveneus bod or phone opm loopt aan ml info medicatie evaluatie info medicatie begrepen naam medicatie tocolytica atosiban tractocile amp nacl 100 ml intraveneus 23 00 opm loopt aan 24 ml in ander ziekenhuis gestart info medicatie evaluatie info medicatie begrepen naam medicatie nacl 1000 ml intraveneus alles rustig

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PREDICTING PRELIMINARY **BIRTH RISK**

Visualize predictive value of some UNstructured words w.r.t. immanent premature birth

nlp cse nlp ml nlp nee plaatsen nlp penicilline nlp bloedafname nlp onderwerp nlp bij cse nlp bod or phone nlp oxytocine nlp_vocht uit nlp cse type nlp syntocinon nlp oxytocine syntocinon nlp ondersteuning arts nlp 30 nlp uit urine nlp begeleiding bij nlp anestheticum nlp handeling hulp nlp 330 ml nlp_dec nlp oxytocica oxytocine nlp andere nlp erythromycine nlp ondersteuning bedpan nlp partus nlp vaardigheden onderwerp nlp bv nlp begrepen naam nlp_mgso4 nlp soort kruisproef nlp erythrocine nlp hulp nlp 500 nlp_type bloedafname nlp trandate nlp op kamer nlp medicatie given name nlp tractocile 37 nlp_po



SHAP value (impact on model output)

Feature value

umec

Unstructured data improves overall prediction



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More important: support expert for better informed decisions, not replacing expert



EXPLAINABLE PREDICTIONS



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EXPLAINABLE PREDICTIONS



Explaining why the predictor comes to a certain conclusion

Patient gave birth within 85.9 hours



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embracing a better life