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Integrating medical scientific knowledge with the semantically Quantified Self

Allan Third, George Gkotsis, Eleni Kaldoudi, George Drosatos, Nick Portokallidis, Stefanos Roumeliotis, Kalliopi Pafilis and John Domingue

CARRE

PERSONALIZED PATIENT EMPOWERMENT

Clinical Risk Factors

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Clinical Risk Factors

- Key source of medical advice
  - Obesity increases diabetes risk by 3.5, etc.
  - Cardiac patients
    - at risk of kidney problems
      - which can lead to other heart problems…
    - at risk of low physical activity
      - which can lead to....

Clinical Risk Factors

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  - Obesity increases diabetes risk by 3.5, etc.
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      - which can lead to other heart problems…
    - at risk of low physical activity
      - which can lead to....
- Comorbidity risk management

A risk factor association

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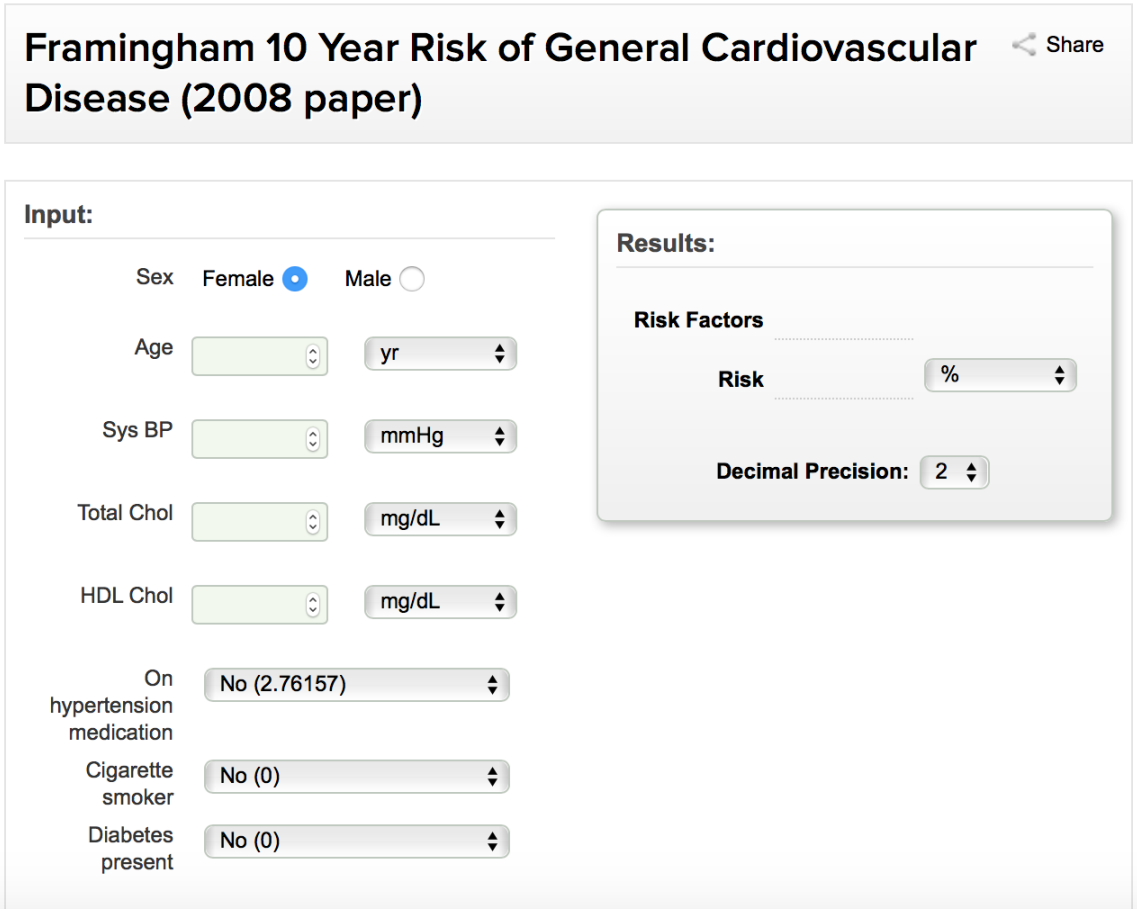
- Diabetes causes ischemic heart disease
  - Diabetic and male: 2.82 x more likely to develop IHD
    - Confidence interval 2.35 – 3.38
    - Source: Pubmed ID 24859435
  - Diabetic and female: 2.16 x more likely to develop IHD
    - Confidence interval 1.82 – 2.56
    - Source: Pubmed ID 24859435

Existing risk calculators



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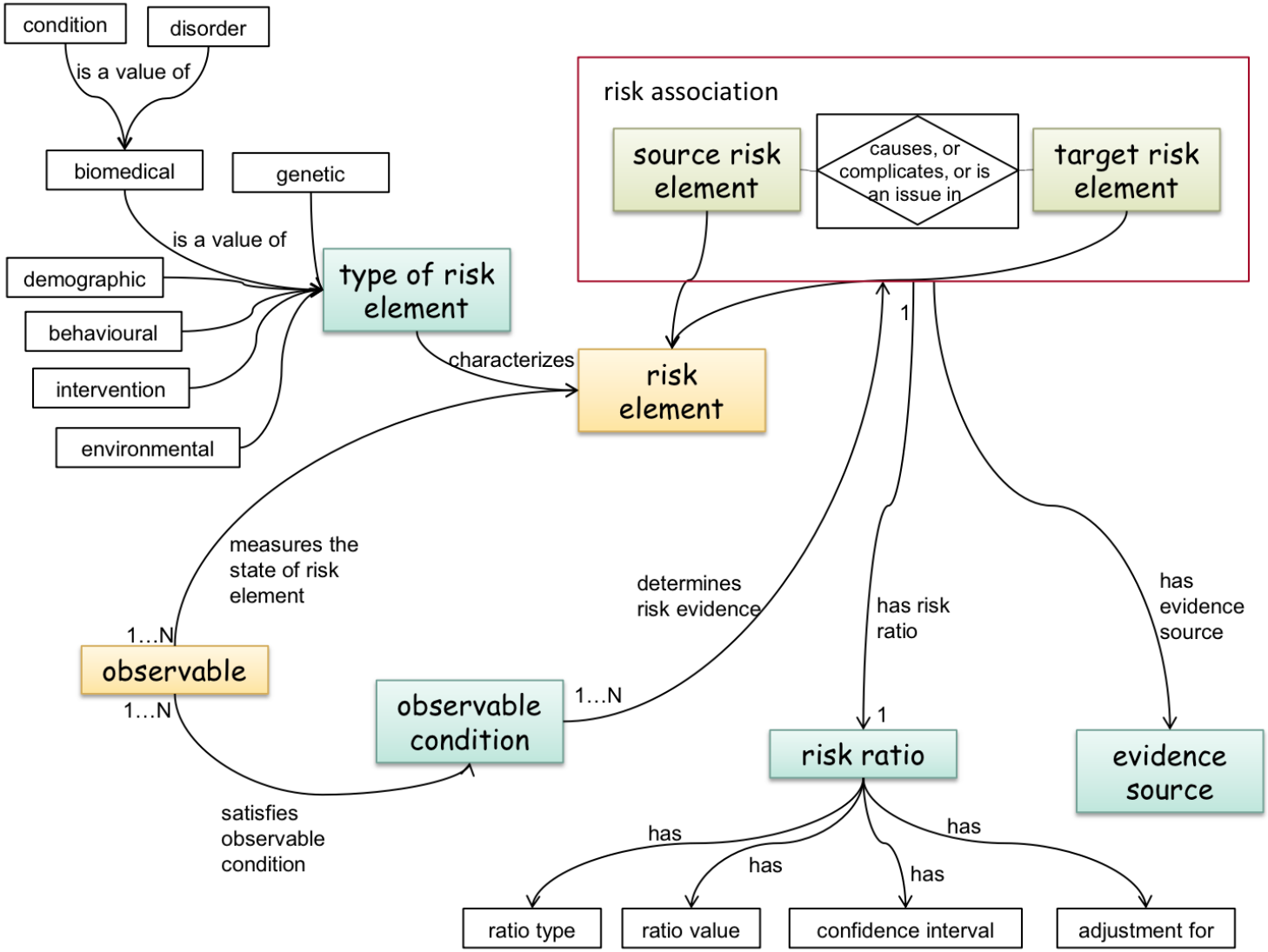

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Connecting to the patient

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Connecting to the patient

- "Quantified Self"
  - Cheap
  - Easy to use
  - Lots of data

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Recording QS measurements

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Recording QS measurements

- Lightweight measurement schema in RDF

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- Common vocabularies
  - Clinical Measurements Ontology
  - Unit Ontology
  - UMLS where relevant

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- Common vocabularies
  - Clinical Measurements Ontology
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  - UMLS where relevant
- Automatic data aggregation
  - Access-controlled quadstore

Integrating QS & risk factor data

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Integrating QS & risk factor data

- RF initial conditions
  - diabetic & (days since myocardial inf. < 30)
  - (physical activity NOT “high”) OR (25 < BMI < 35)

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Integrating QS & risk factor data

- RF initial conditions
  - diabetic & (days since myocardial inf. < 30)
  - (physical activity NOT “high”) OR (25 < BMI < 35)
- Need
  - Complex custom functions
  - Disjunction
  - Negation
  - Somehow still easy for doctors…

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Custom expression language

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- Simple language expressing conditions on QS data

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Custom expression language

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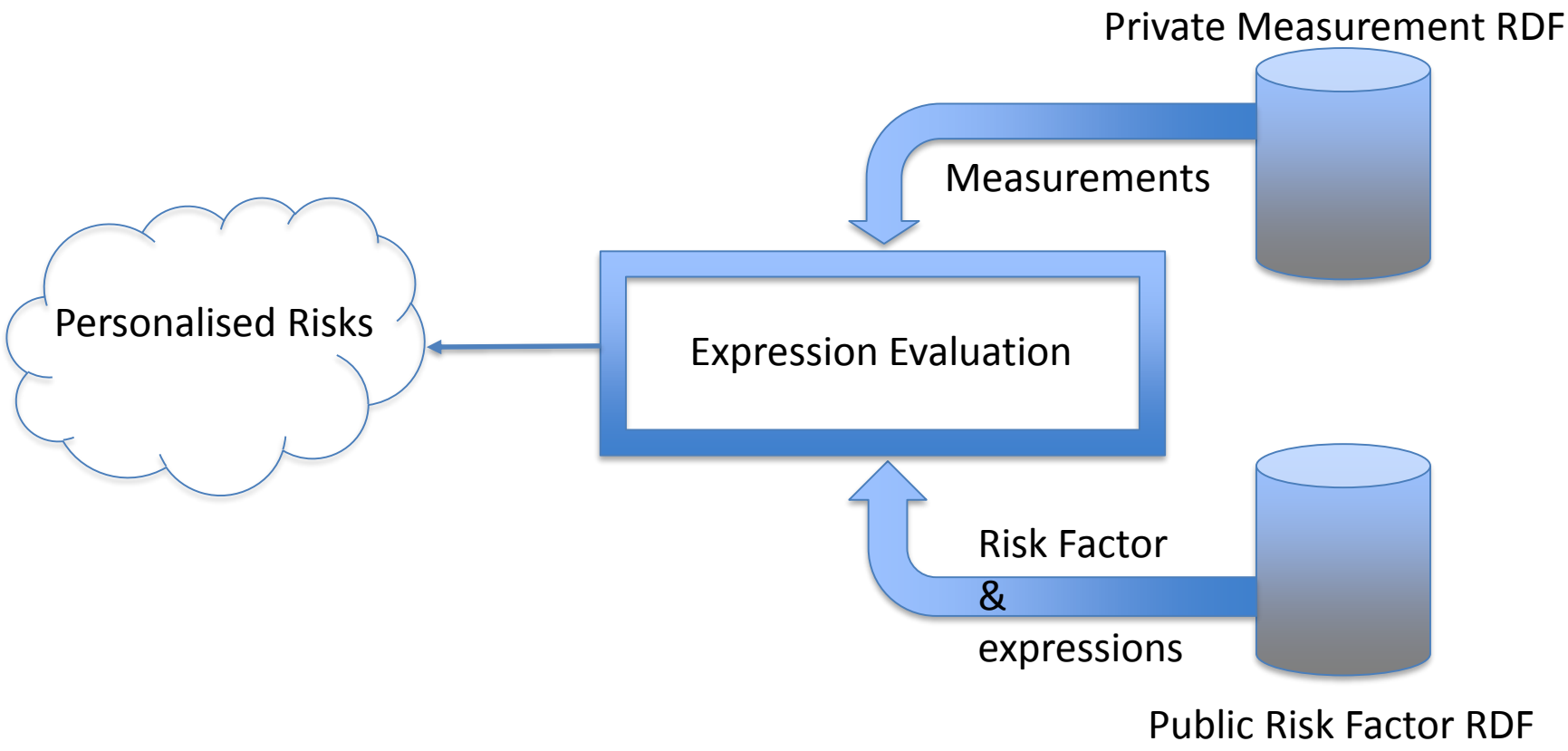
- Readable by medical experts
  - Graphical tool for *writing* by medical experts
- Stored with risk association


Private Measurement RDF
Measurements
Personalised Risks
Expression Evaluation
Risk Factor
&
expressions
Public Risk Factor RDF

Risk factor data capture

- 96 risk factors
  - 253 risk associations based on
    - 53 clinical states
    - 90 different observables
- Cf. reference.medscape.com
  - 36 risk factors, ~36 scientific publications
    - Grade unknown

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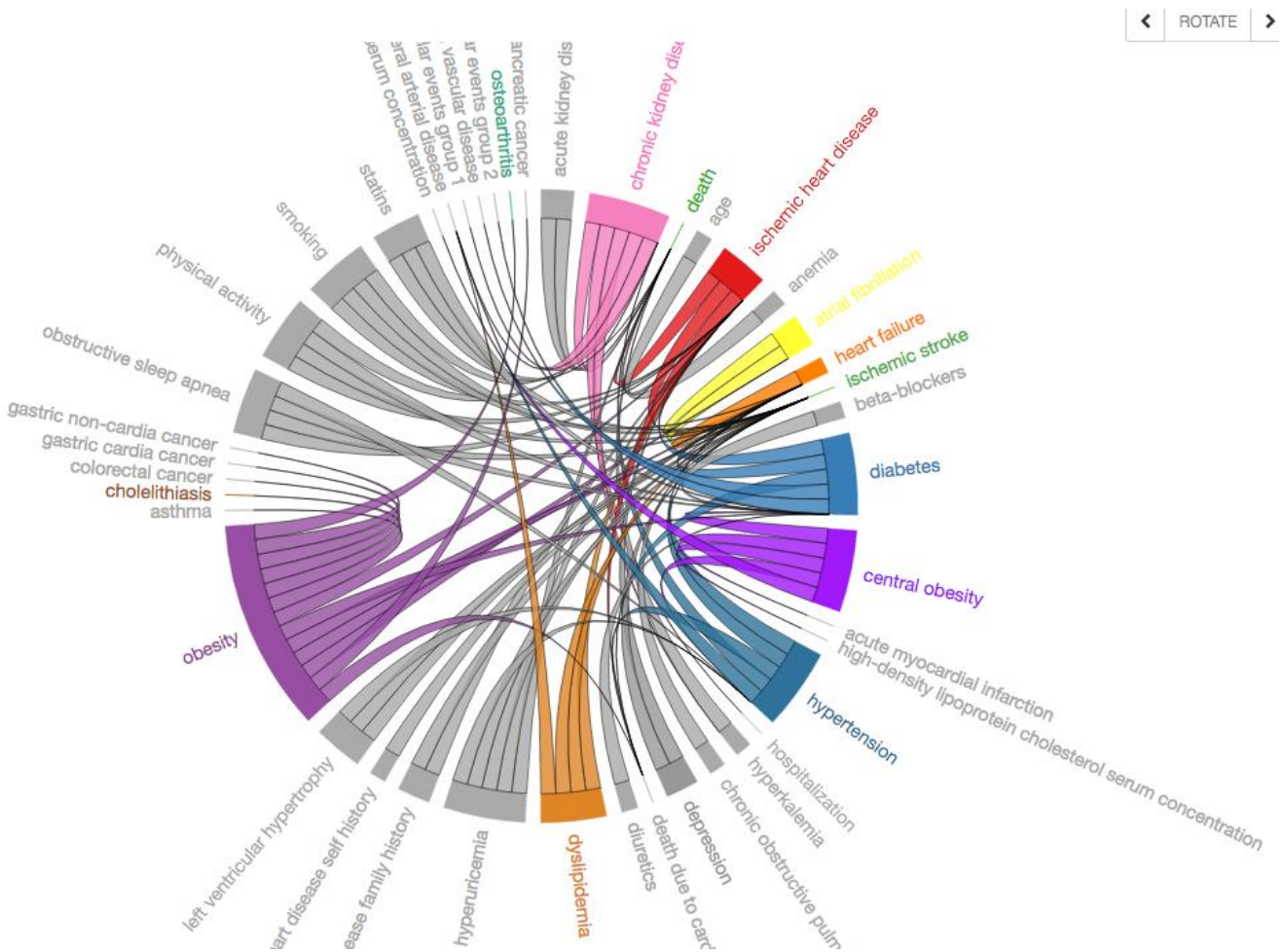

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Quantified Self data capture

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- 10 pilot users
  - Activity, blood pressure, weight, sleep quality

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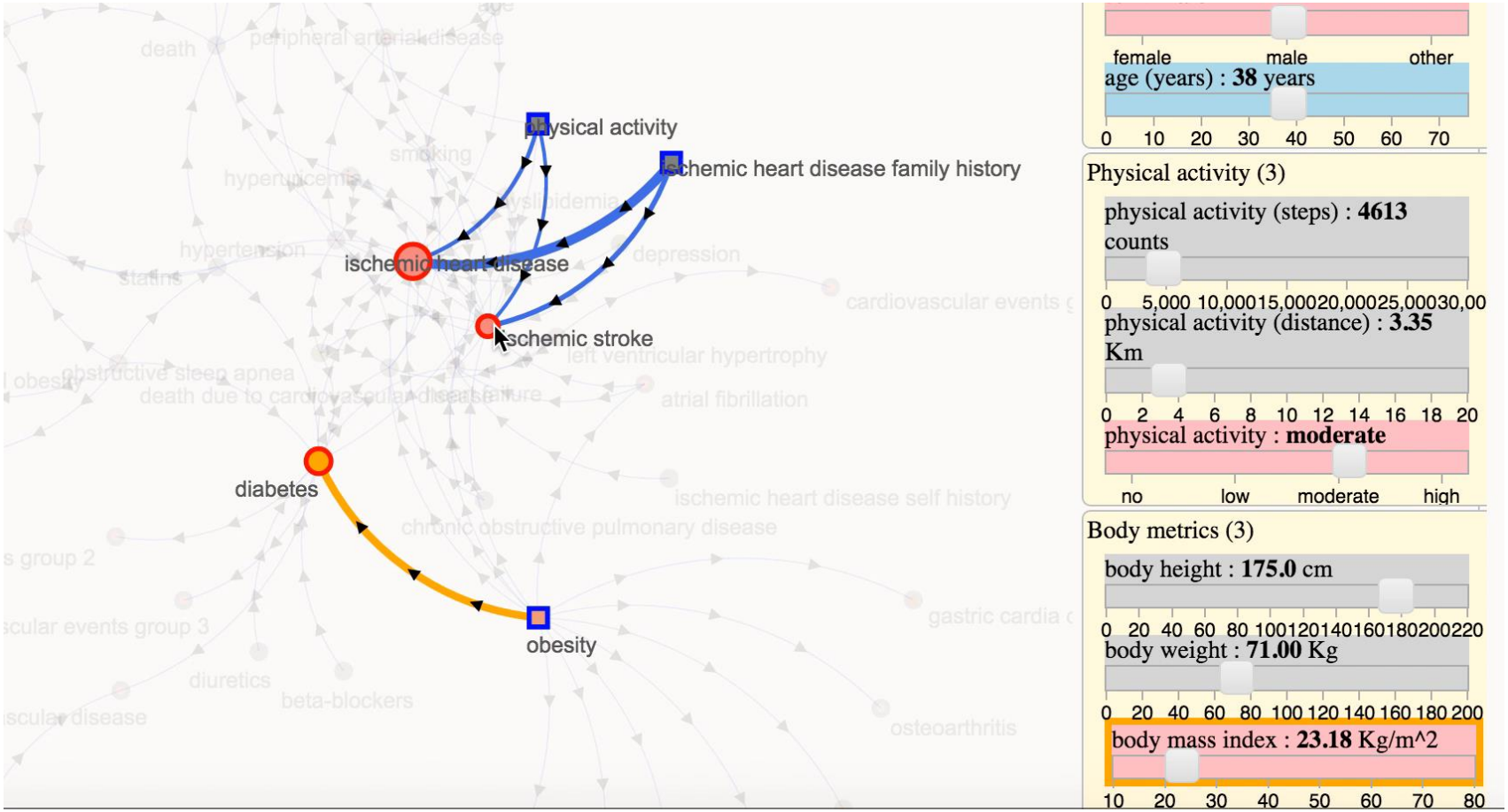
- Range of health profiles/risk status

Personalised risk prediction



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Patient evaluation

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Patient evaluation

- Ongoing clinical trials with ~80 patients

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- User experience

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- Changing outcomes

Evaluation

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Evaluation

- Risk factor formalisation
  - Clinical language obscures model generalities
    - “Risk factor” vs. “intervention effectiveness”
  - Clinical literature ambiguities
    - “cardiovascular disease” vs. “angina pectoris”, “ischemic heart disease”, etc.

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  - Clinical language obscures model generalities
    - “Risk factor” vs. “intervention effectiveness”
  - Clinical literature ambiguities
    - “cardiovascular disease” vs. “angina pectoris”, “ischemic heart disease”, etc.
- Grounding expressions
  - Technical difficulties overcome by training

Gaps in clinical evidence

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Gaps in clinical evidence

- Automatic & ***literature-based*** risk calculation agrees everywhere

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Gaps in clinical evidence

- Automatic & ***literature-based*** risk calculation agrees everywhere
- ***Clinical practice-based*** risk calculation shows gaps
  - e.g., BMI > 34.5: no diabetes risk
- No grade I clinical evidence about some "common knowledge"

Resources & Future work

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- Risk data explorable at:
  - https://entry.carre-project.eu

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- Incorporate other sources of data
  - E.g., environmental, nutritional

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- Extend to other areas of medicine
- Incorporate other sources of data
  - E.g., environmental, nutritional
- Deeper analysis of clinical research areas

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Thank you!

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Thank you!

- Any questions?

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