FP7-ICT-2013-10

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Personalized health, active ageing, and independent living

CARRE

Visual Analytics for Health Monitoring and Risk Management in CARRE

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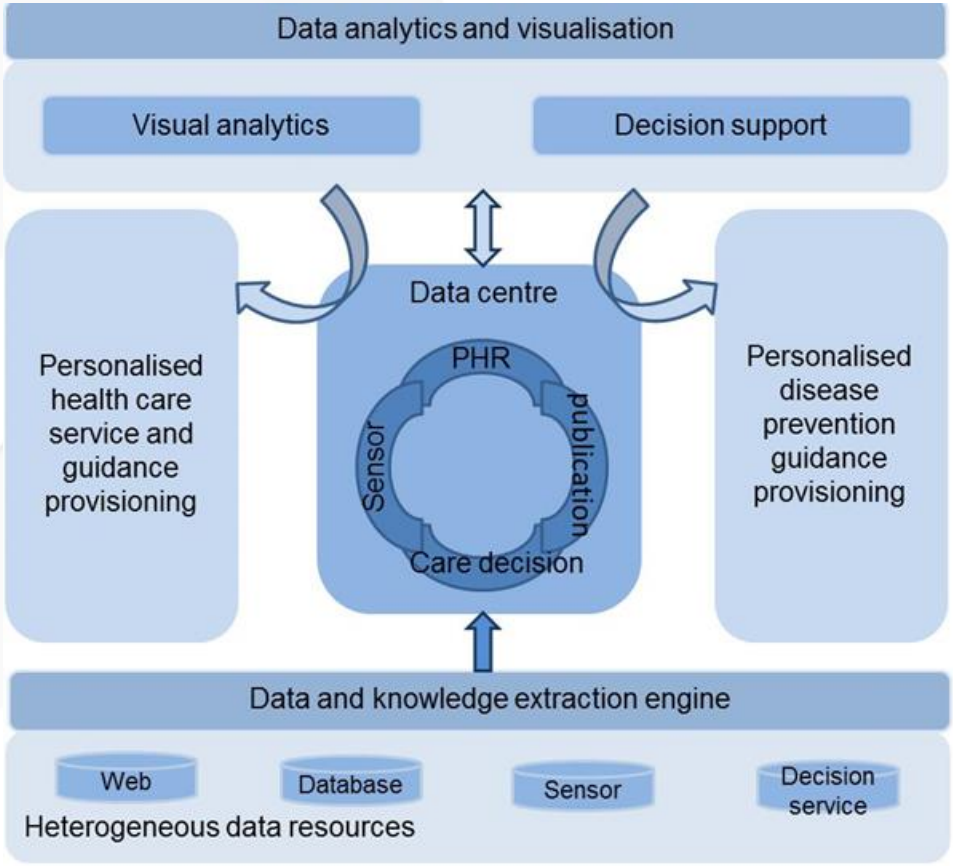
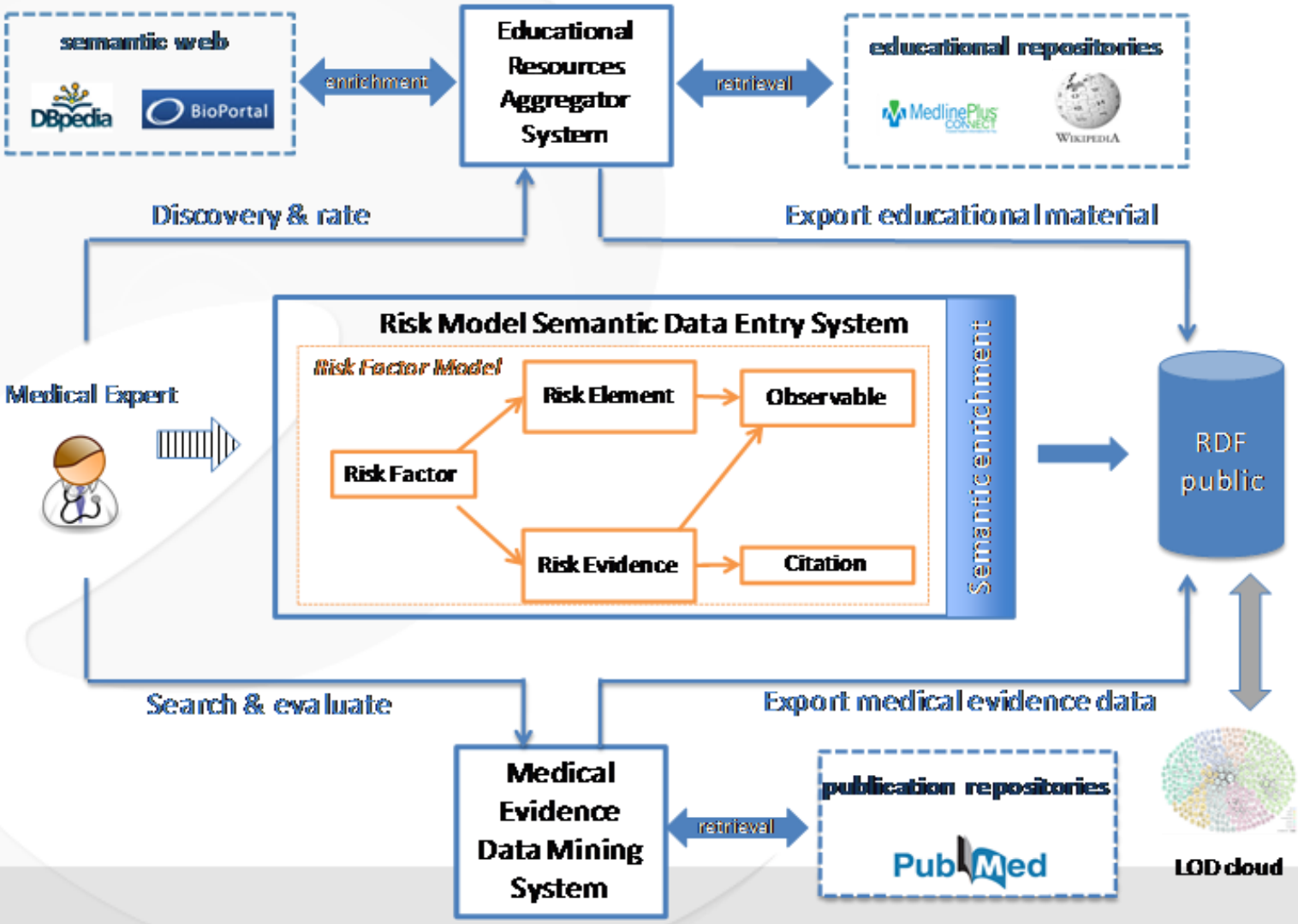
The CARRE Project

- Provide personalized empowerment and shared decision support services for cardiorenal disease comorbidities
- Risk models extracted from medical publications.
- Link sources of medical and other knowledge semantically linked with sensor outputs to provide clinical information personalised to the individual patient,
- Track the progression and interactions of diseases.
- Provide the means for patients to take an active role in care processes, including self-care and shared decision-making
- Support medical professionals in understanding and treating diseases via an integrative approach

System Architecture



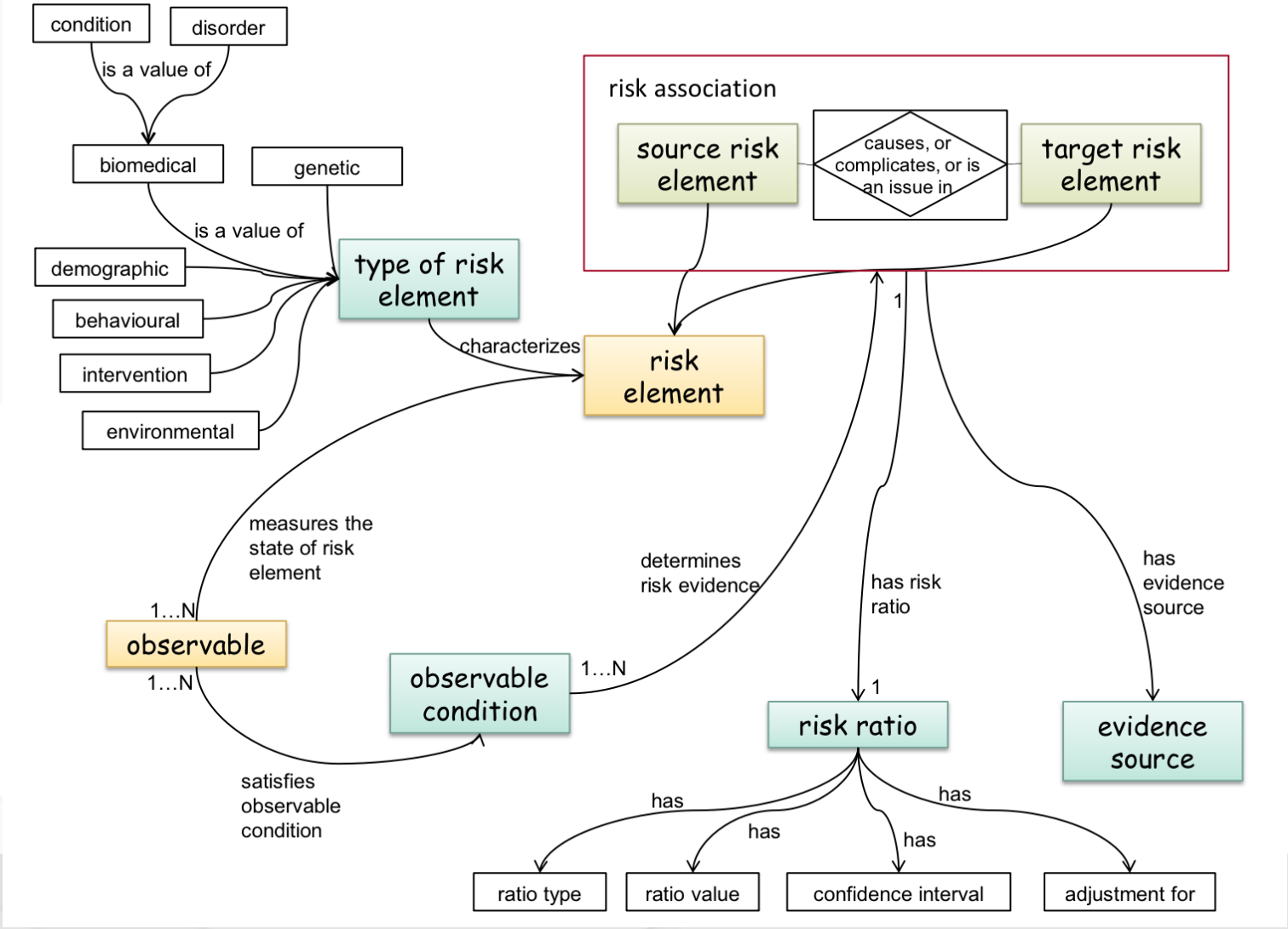
System Architecture



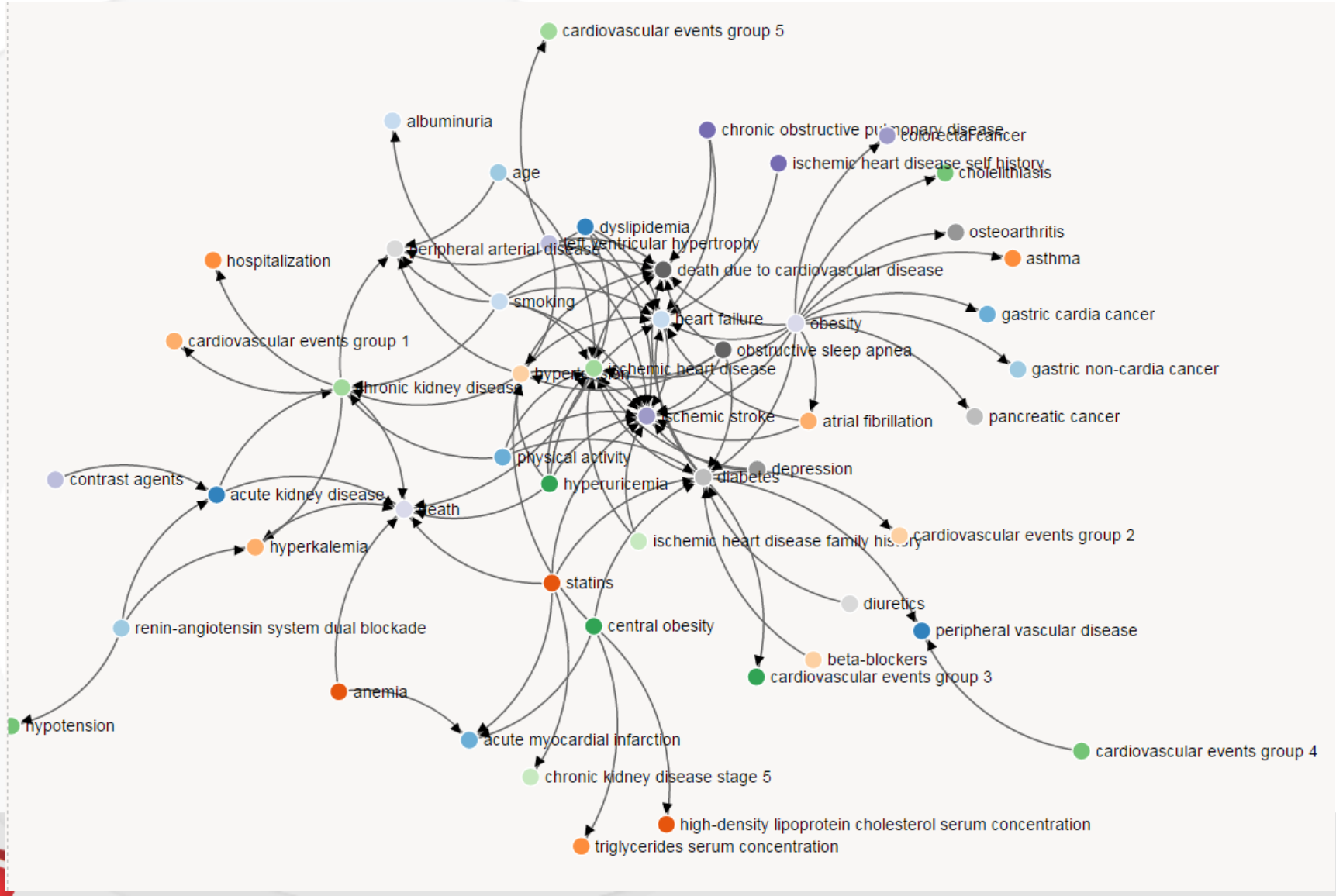
CARRE Risk Model

- Risk Element: Risk elements include all the disorders/diseases involved in the comorbidity under discussion as well as any other risk causing agent, e.g. demographic (e.g. age, sex, race), genetic (gene polymorphisms), behavioural (e.g. smoking, physical exercise), environmental (e.g. air pollution, allergens) or even an intervention (e.g. pharmaceutical substances, contrast agents).
- Risk Association: The association of one risk element as the risk source with another risk element, which is the negative outcome under certain conditions, is a 'risk association'. A source risk element can be associated with a target risk element with more than one risk association.
- Risk Observable: In a risk association the prerequisite circumstances relate directly to the existence of the risk agent (source risk target) and/or its severity, and/or any other specific conditions. These are reported via certain 'observables', that is, physical variables that can be measured or otherwise ascertained (e.g. biomarkers, biometric variables, biological signals and other non-biological factors, e.g. environmental).
- Risk Ratio: The association is always accompanied by the likelihood of the negative outcome occurring. This likelihood is expressed as a 'risk ratio', which is the ratio of the probability of the negative outcome when the person is exposed to the risk agent over the probability of the negative outcome when the person is not exposed to the risk agent.
- Currently there are 98 risk factors, 53 risk elements, 253 risk evidences, 63 observables and 60 evidence sources in the CARRE risk data repository.

CARRE Risk Model



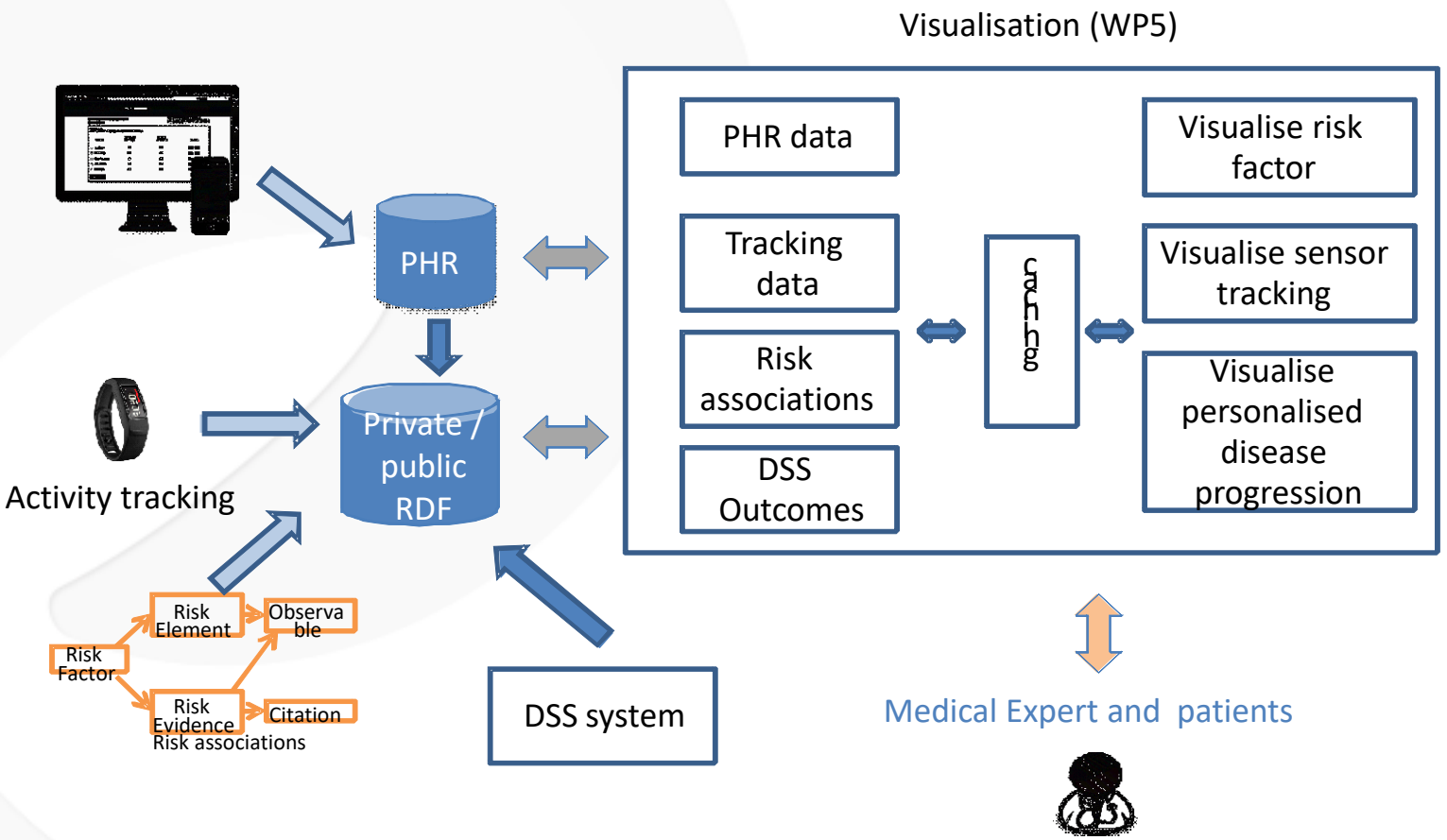
Visualisation of all risk factors



Visual Analytics Tasks in CARRE

- Monitoring of movement, step accounts, diet and other health-related behaviours and events, observables monitoring, such as blood pressure and blood glucose. The monitoring will make most use of sensors and mobile apps
- Visualisation of a variety of medical related measurements. Most of them are time series with different sampling intervals.
- Visualisation of the health status of the individual and their behaviours, including their locations, movements, diet, sleep quality, environment, mood, blood pressure, glucose, alcohol, smoking, and other symptoms, etc. Visual analytics will be used to display individual/aggregated data items to allow easy interpretation of the data from the patients.

VA Workflow


Visualisation (WP5)
PHR data
Tracking data
Risk associations
DSS Outcomes
Visualise risk factor
Visualise sensor tracking
Visualise personalised disease progression
PHR
Private / public RDF
Activity tracking
Risk Element
Observable
Risk Factor
Risk Evidence
Citation
Risk associations
DSS system
Medical Expert and patients

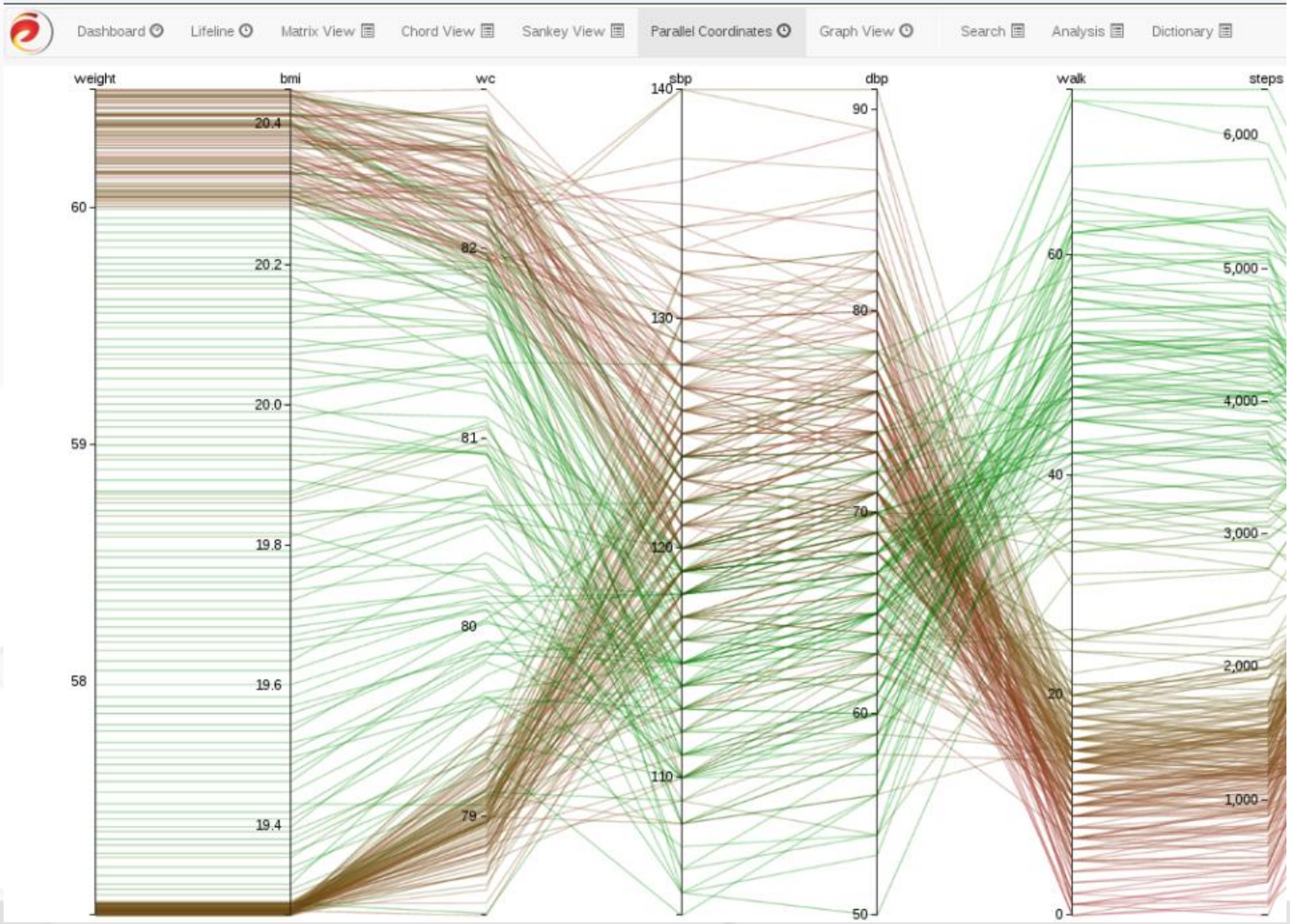
Measurement (observable) data

- Healthline
  - Show multi-series sensor and PHR data that collected
- Multi-axis and multi-series
  - Show multiple data, with possibility to identify correlation
- Data correlation analysis with parallel coordinates
  - Clearly identify coordinates between multiple data

Healthline


Variable List
distance
steps
calories_metabolised
tracked_activity_distance
moderate_activity_duration
intense_activity_distance
moderate_activity_distance
light_activity_distance
sedentary_activity_duration
light_activity_duration
intense_activity_duration
calories_b_m_r
activity_calories
marginal_calories
blood_pressure_systolic
who_b_p_level
blood_pressure_diastolic
logged_activity_duration
logged_activity_name
logged_activity_distance
provenance
actuality
height
weight
timezone
elevation
sedentary_activity_distance
bmi
pulse
steps
calories_metabolised
light_activity_distance

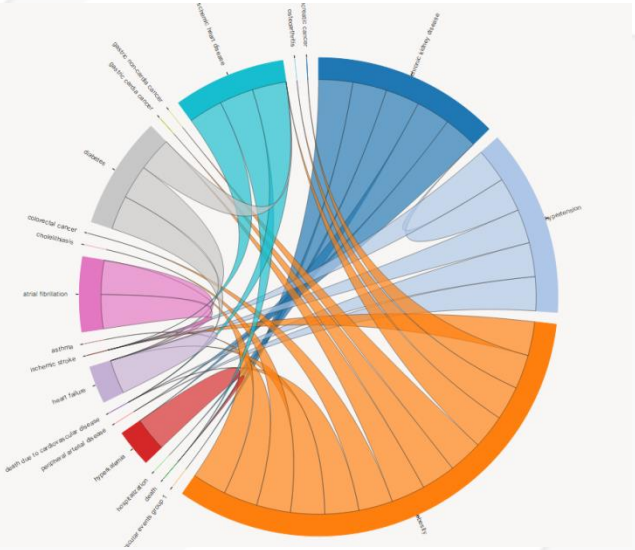
Parallel Coordinates

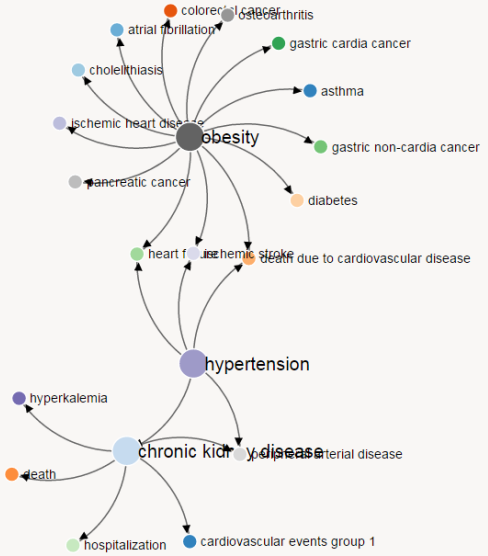


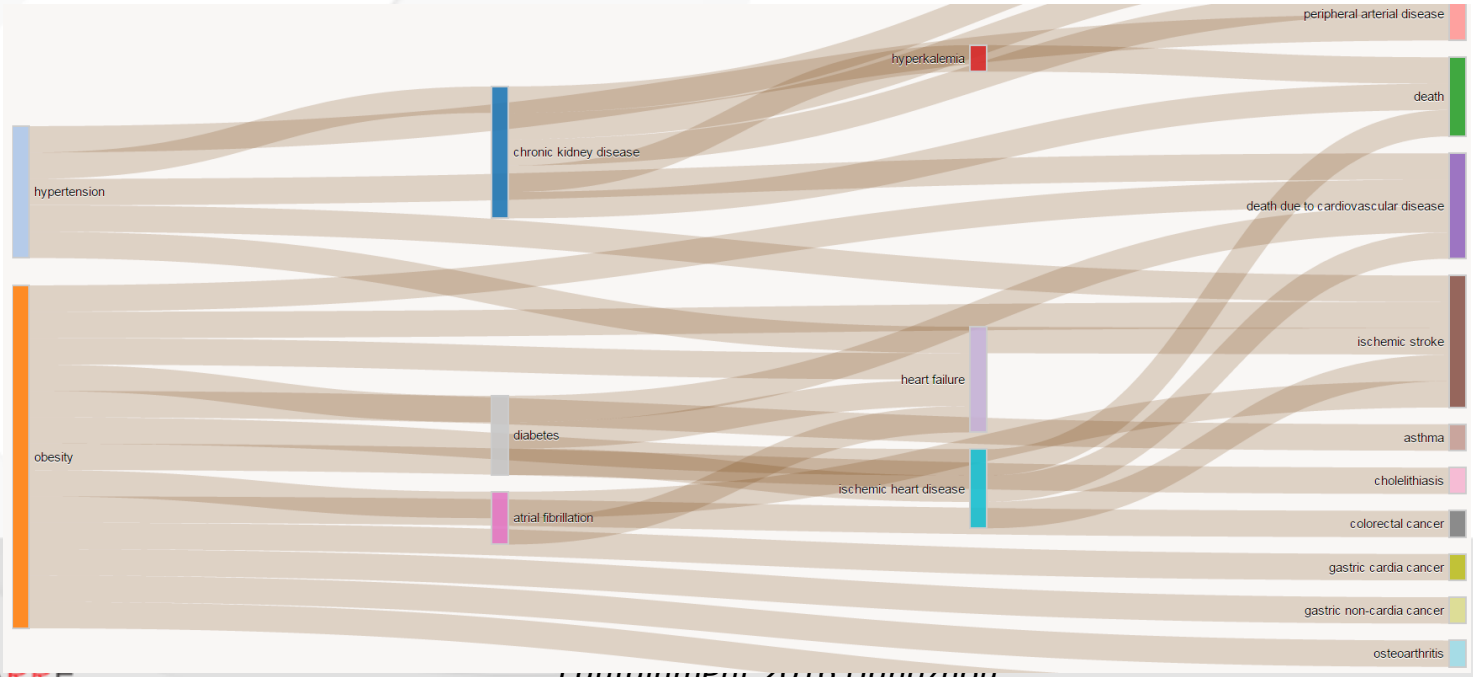
General risk associations

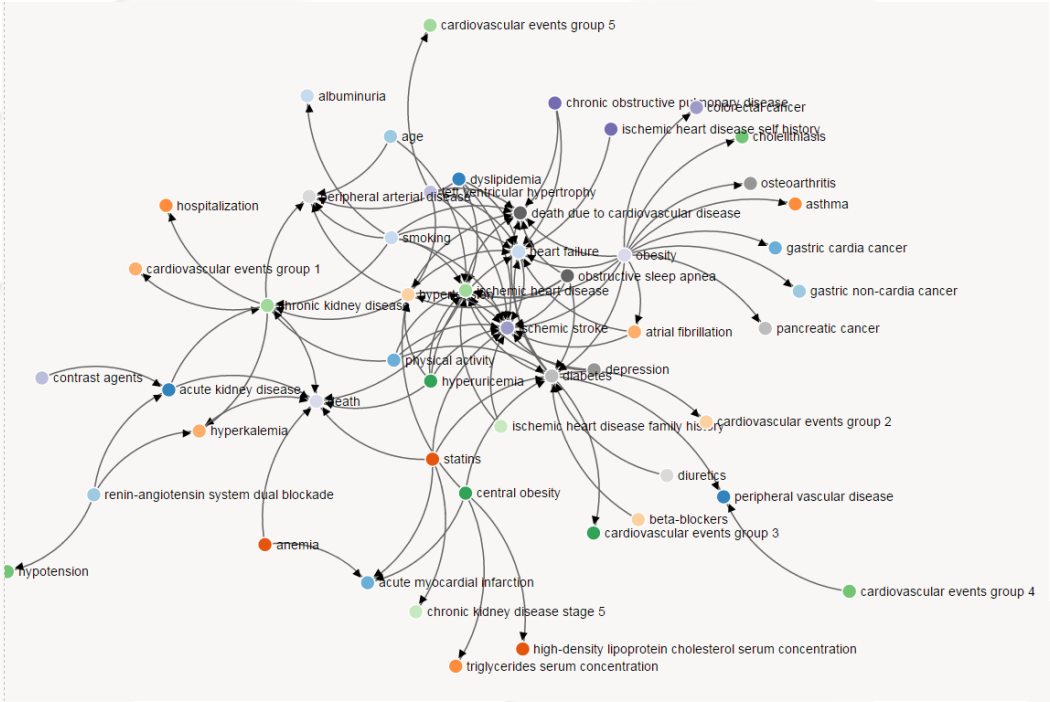
- Matrix view
  - Show relations between risk elements
- Node-link view
  - Show relations with effect of changes of measureable
- Chord view
  - Show risk associations with risk ratios
- Sankey view
  - Show progression risk elements

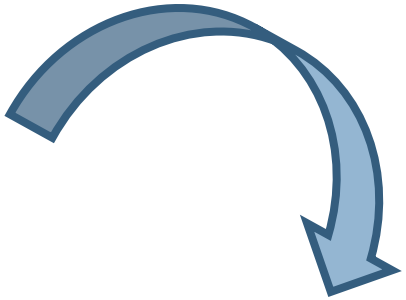
Risk associations

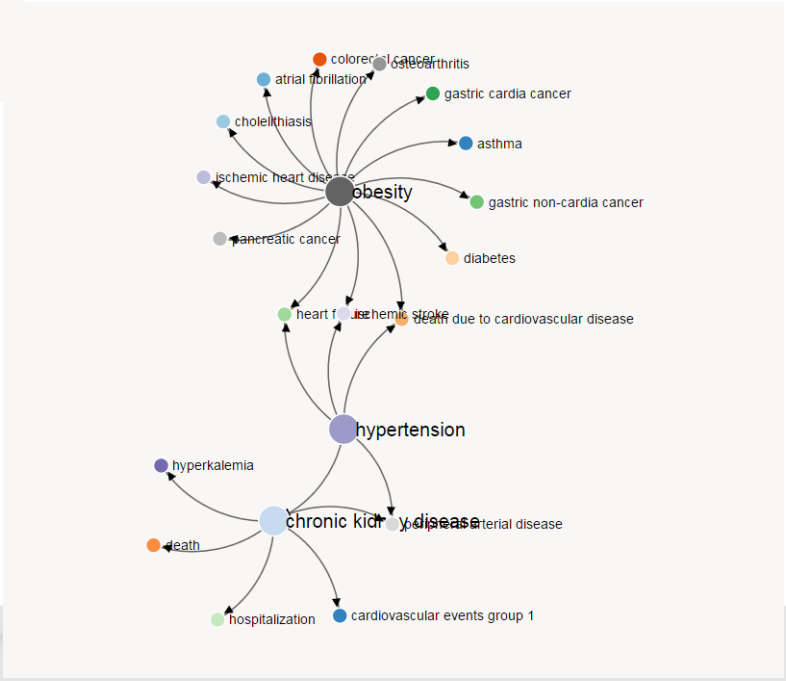












Personalised risks

Future work

- Enhance functions
- Make visualisation user-friendly, especially for end patients, such as *set-menu*
- Enhance functionalities based on users' feedback

acknowledgment

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CARRE: Personalized patient empowerment
and shared decision support
for cardiorenal disease and comorbidities

http://www.carre-project.eu/