Tackling healthcare workflows with behavioural models and natural language processing: a proposal

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Tackling healthcare workflows with behavioural models and natural language processing: a proposal

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Workflows = beh. models + NLP
Outline of the talk

- workflows (in healthcare)
- what are behavioral models
- natural language processing
- our proposal

...problems, rather than solutions; looking for feedback
A ubiquitous concept

**workflow**

*noun*  [C or U]

*uk* /ˈwɜːkfləʊ/  *us* /ˈwɜːkflɔːr/

the way that a particular type of work is organized, or the order of the stages in a particular work process:

Essentially a workflow is a description of some procedural knowledge used to:

- design, organize, coordinate
- communicate
- monitor
- measure effectiveness of some procedures, policies, protocols,

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RT-PCR is the laboratory test of choice to detect infected workers. It is the most sensitive test for this purpose. If not available we recommend:

- **many workflow users**
  - stakeholders
  - policy makers, experts...
  - actors
  - humans, institutions,SendMessage failed. Try again later.

- **resource management**

- **distributed choices**

- **no standard / precision**
  - ambiguity
  - no machine processable dataset

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Workflows in ICT/CS (aka business processes)

Industry
- standard practices
  - tools
  - lack of precision
  - minimal support to resource management

Academic
- behavioural models
  - precision
  - prototype tools
  - lack of intelligibility

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Example

Chandrabalan, Shanmugham: Automating clinical pathways using executable business process model and notation
Int. J. of Innovation in Health Informatics. 24(3), 2017
Behavioural models as type
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Behavioural models as type

- formal basic syntax/semantics
- several decidable properties
- tradeoff between control/resources
- operational & denotational semantics

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An audit panel may want to check:

a) $\Box \Box \Box$ P discharged

b) $\Box$ S requested $\rightarrow \Box$ E gets results but they would phrase these as:

1') Any patient will be discharged

2') The results of a specialist's examinations are sent to the emergency department

Can we "translate" (d) and (b) into (d') and (b')... and vice versa?
the emergency department

a. discharges patients immediately (if their conditions are good), or

b. requests for a specialist, or else
c. informs the patient about the exams to do and books the lab

the results of a specialist's examinations are sent to the emergency department

parsed as & S requested \rightarrow & E gets results
A proposal

We advocate a model-driven approach combining formal behavioural model & natural language processing to foster tool-supported static analysis of resource-aware workflows.
Goals

Accessibility

WUs must understand workflows
WUs do not share a common language
most WUs do not understand formal languages
Goals

Accessibility

Realisability

WUs must understand workflows
WUs do not share a common language
most WUs do not understand formal languages

WUs are heterogeneous
often the execution context is implicit
lack of internal consistency
composition may break properties
Goals

Accessibility

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Realisability

WUs are heterogeneous
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Lack of internal consistency
Composition may break properties

Compliance

Regulatory specs are hard to deal with
Regulatory specs may impose quantitative requirements
Simulations/monitoring are not enough
Harnessing workflows

- Developing a theory of resource-aware workflows
- Defining DSL, algorithms, and tools to
  - specify workflows and their properties
  - refine workflows
  - statically analyze workflows

Our guiding principle:

to deliver intelligible statically checked workflows
Theory

Attribute-based specification of \( WU \)

Preconditions:

- \( \text{charge} > 0 \)
- \( \text{bl} \geq eI \)
- \( \{\text{offer}, \text{id}, \text{qt}\} \wedge \{\text{offer}, \text{s}, r\} \wedge \text{reqEn} > 0 \wedge \text{id} \neq s \)
- \( \rho(e) \Rightarrow s \in \text{supp} \)
- \( e < qt \)

Postconditions:

- \( \{\text{confirm}, c, \lambda(e, qt)\} \wedge \{\text{confirm}, \text{id}, o\} \wedge \text{id} = c \)
- \( \{\cancel{\text{cancel}}, c\} \wedge \{\cancel{\text{cancel}}, c\} \wedge \text{id} = c \)

Resource-based interactions:

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- What are behavioral models?
- Natural language processing
- Our proposal
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Languages, algorithms, and tools

- Behavioral typing to statically enforce properties

- WU-friendly DSL to capture causal & resource-dependencies relevant (non-)functional properties

- "Interfaces" with industrial standards natural language machine processable
  - BPN, DCR solutions, KNIME, MAPs

Tools: besides the industrial platforms

(Ris)QFLan # DSLs for quantitative analysis
ChorGram # tool-chain for multiparty session types
AIOCJ # choreographic programming language
OKGraph # unsupervised language understanding
... # ...
Thank you!