THE UNIVERSITY OF SYDNEY

From data to personal user models for life-long, life-wide learners

*links for L*earning and Assessment for Digital Citizenship project

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hct:.

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Some background about the paper

It was an invited contribution

BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY

50th Anniversary Special Issue

Learning Analytics and AI: Politics, Pedagogy and Practices

What is already known about this topic

- There is decades of Artificial Intelligence in Education (AIED) research on learner modelling, personalisation and Open Learner Models (OLMs).
- There is a growing body of work on Personal Informatics.

What this paper adds

Put these together ... a conceptual model for a Personal User Model for Life-long, Life-wide Learners (PUML).

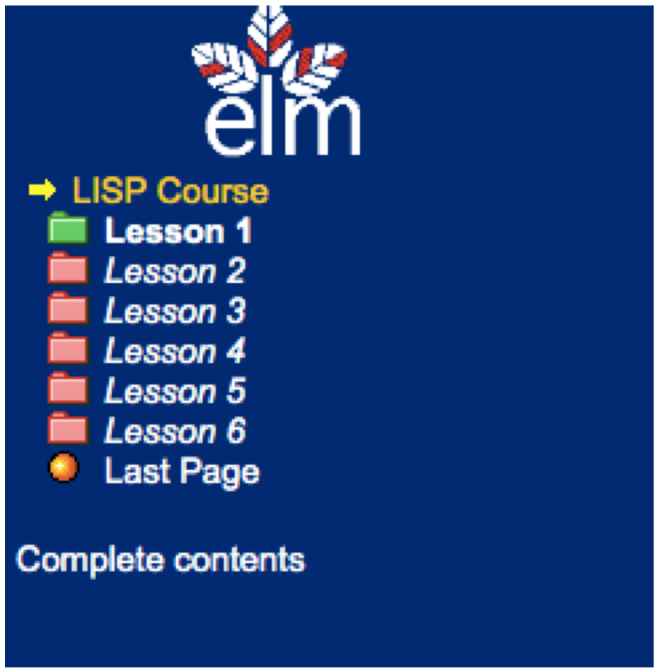
A set of *competency questions* to inform design and evaluation of PUMLs.

Guidelines for designing interfaces that enable learners to scrutinise and control their learning data and models.

Implications for practice and/or policy

- Our work complements institutional repositories of learning data,
- PUMLs support student's meta-cognitive processes.
- PUMLs go beyond simplistic views of data access and transparency of algorithmic processes ...
- Empowering learners to scrutinise their long-term data and its use.

Some background on AIED and OLMs


elm
LISP Course
Lesson 1
Lesson 2
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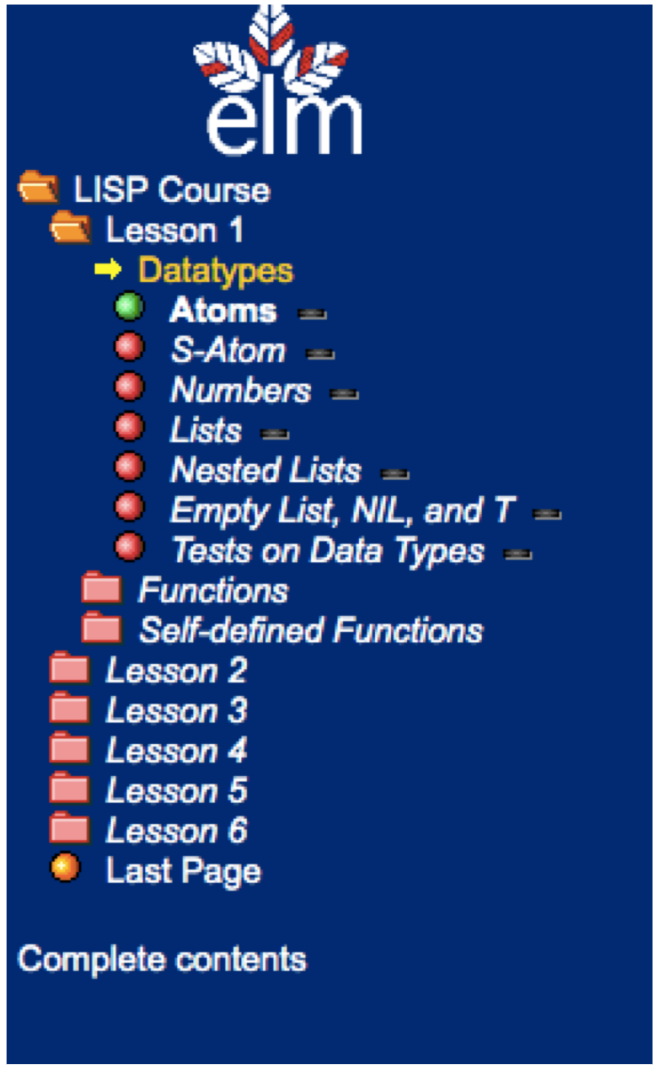
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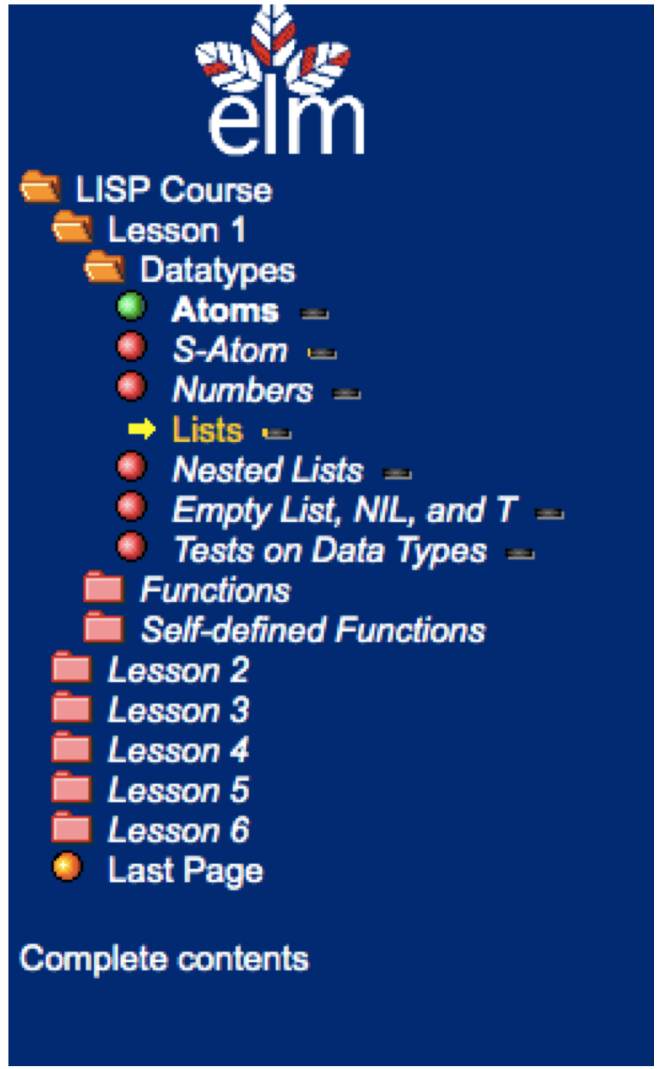
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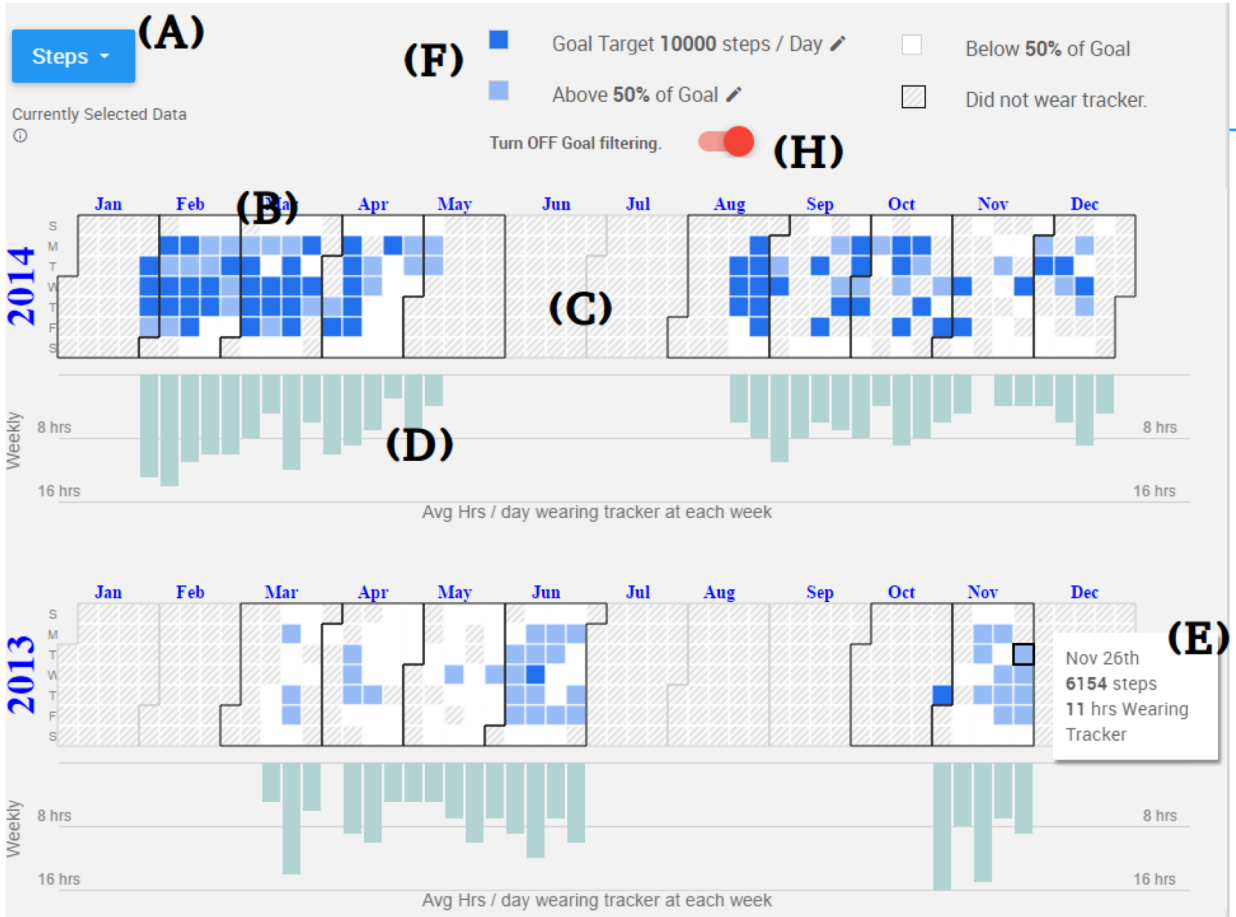
Some background on Personal Informatics and Quantified Self



Enter new goal

ADD

GOAL NOTES | OTHER NOTES

— 10,000 steps per day (G)

+ Am I on track?

+ Should I CHANGE my goal?

+ How am I on WEEKENDS?

+ How am I when WORKING?

+ How do I do when I'm on HOLIDAY?

EDIT

Take aways from background:

- learner/user models provide a way to interpret data about the learner;
- there are multiple possible interpretations of learning data;
- scaffolding is important for metacognitive processes like reflection and goal setting.

Our goal is to create interfaces that enable learners to scrutinise and control their personal learning data and to support these important metacognitive processes for life-long life-wide learning.

Personal User Model for life-long, life-wide Learners (PUML).

PUML

This a personal repository of “raw data” and inferences from that data to support life-long and life-wide learning.

It can be accessed by authorised programs.

It has an interface that scaffolds the learner in scrutinising and controlling their model.

Student models, learner models, user models

We prefer the term ***user model*** over learner or student model.

We want to support life-long and life-wide learning.

Our PUML includes broad aspects:

- long term stable personal attributes and traits e.g., name, birthdate, height as well as personality, preferences, interests;
- context dependent aspects e.g., goals, attitudes, motivation to learn this topic, mood;
- models of behaviour e.g., physical activity, food intake, energy saving actions;

The many meanings of user and learner models.

There are three common uses of the term, user model. Two of these are widely used in Human Computer Interaction (HCI) research:

- the model of the learner in the **mind(s) of the teacher(s**);
- an implicit user model **frozen within the software design**;

and

- A **machine representation of the user** – a set of beliefs about the user

The many ways to interpret data about learners

There are deep challenges in modelling a learner's mind-state because:

- many aspects are not directly observable;
- and this means that the model is typically incomplete and has inaccuracies;
- people change over time, and so old data may give unreliable evidence of the learner's current mind-state;
- a learner's mind-state is deeply affected by the context, which changes over time;
- people have limited self-awareness for key aspects of their mind-state – so, questions intended to elicit information about it may not match their actual knowledge and behaviour (and even if the user can answer a question, they may choose not to do so honestly).

Data Repositories

There is an emerging trend for data warehousing or data repositories at tertiary institutions (Williamson 2019).

> For example, University of Michigan's LARC (Learning Analytics Data Architecture) is designed to track aspects that are stable (eg SAT scores), aspects that change per term (eg majors) and those linked to classes (eg grade). It is intended to hold data for students since the 1990's, refreshed four times a year. It is accessible from a range of tools.

The people: learner, teacher and data analyst

Overview

Learner

Learner's ***actual*** mind state and their attributes.

This varies over time and contexts.

It includes knowledge, skills, goals, beliefs,

preferences ...

“Teacher”

Teacher's ***actual*** knowledge of the domain, of teaching, …

Teacher’ model of the student(s). ***Implicit*** user model.

"Data Analyst"

Expertise in analysis methods, domain, context...

Learner

Learner's ***actual*** mind state and their attributes.

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Learning application

"Raw data"

Explicit user model

Software embodying an ***implicit*** user model

"Teacher"

Teacher's ***actual*** knowledge of the domain, of teaching, …

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Many users, many applications
- "raw data"
- user models

Learning Data Repository

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Learning application

"Raw data":
- Data from user
- User's digital footprints
- System footprints.

Explicit user model
- ontology
- evidence from application
- inference mechanisms

Software embodying an ***implicit*** user model

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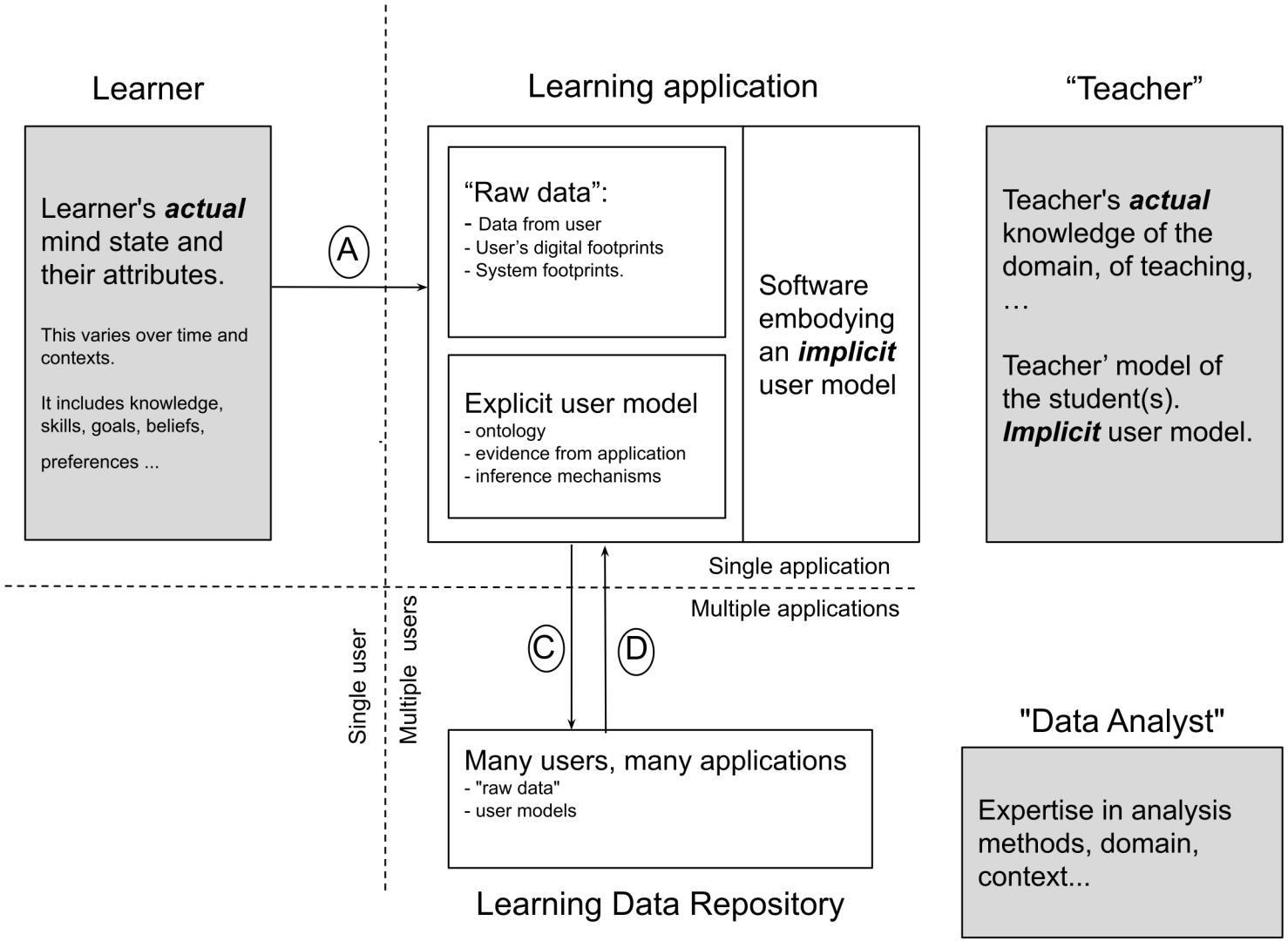
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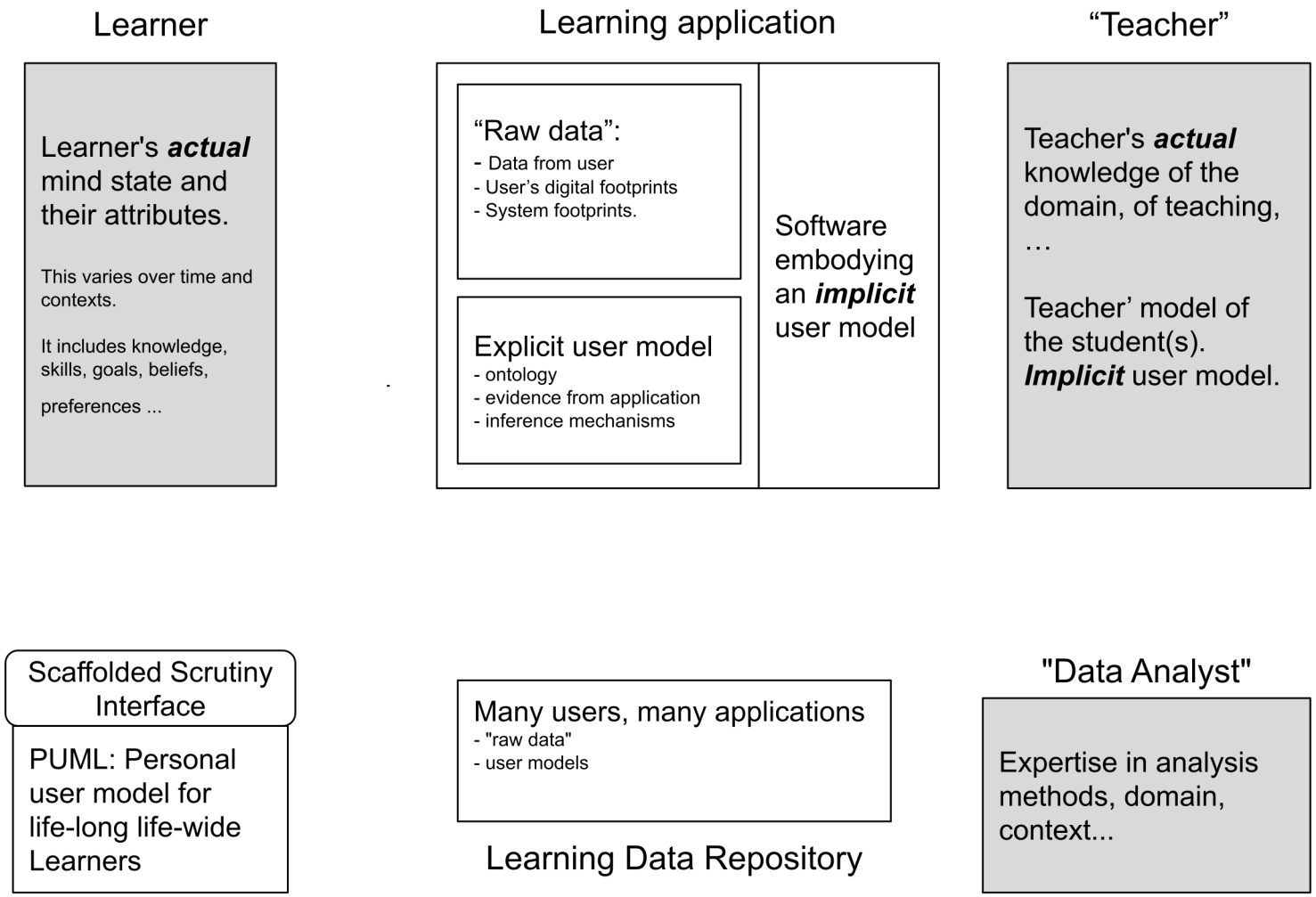
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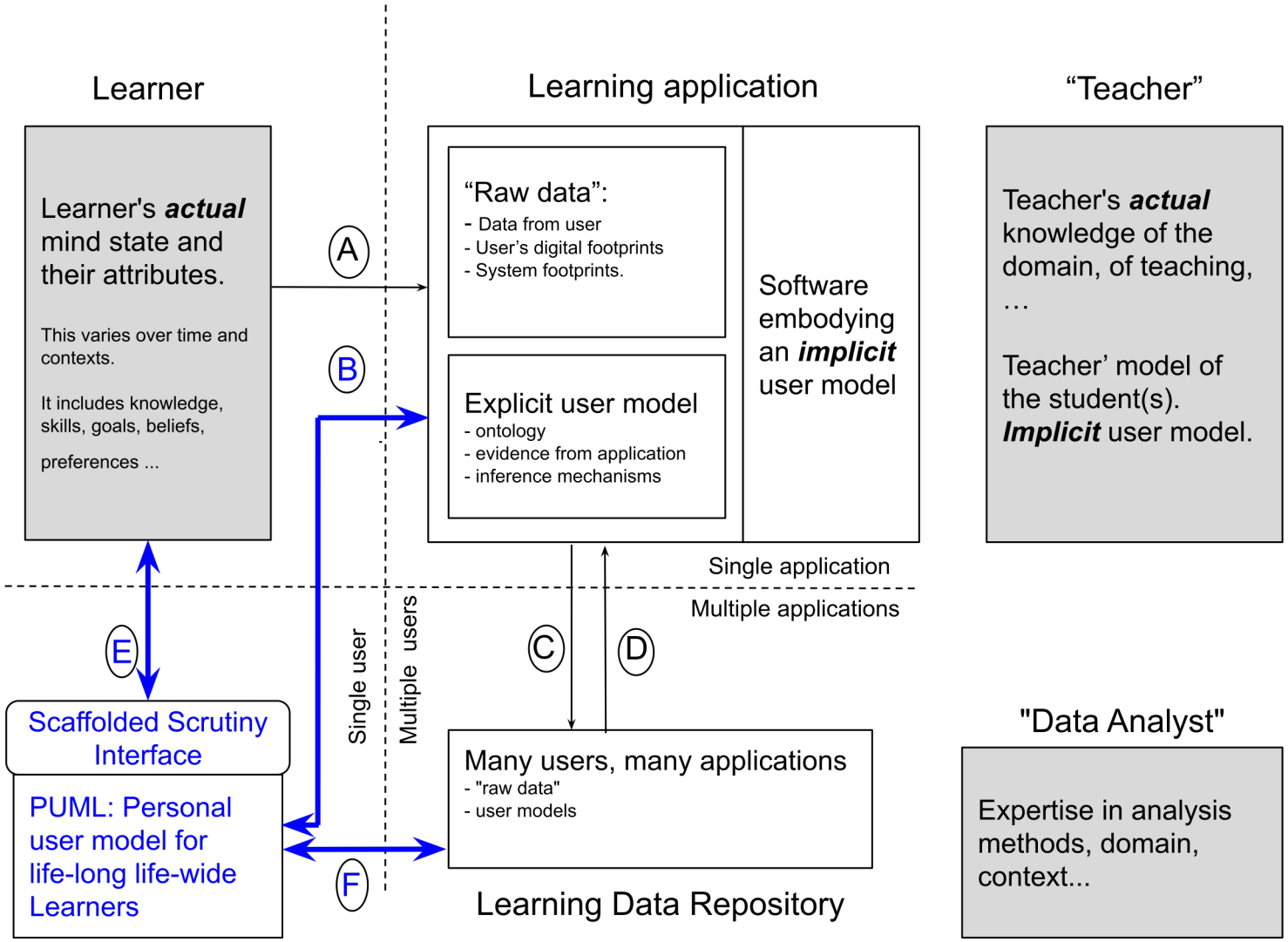
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Design foundations: competency questions

Competency questions:

The scrutiny interface is only successful if it enables the user to answer:

- Am I making progress?
- Am I meeting my own goals - over the short and long term?
- Am I meeting external goals eg, teacher expectations, whole class performance, relevant sub-group performance
- What changes might help me reach my goals?
- What is the meaning of the data and components modelled?
- Can I trust the accuracy of the model?

Competency questions for meta-cognitive processes: (M) Self-monitor; (R) Self-reflect; (P) Plan

ID	Meta-cognitive processes	Question should be able to answer by the user
M1	M	Am I making progress?
M2	MR	Am I meeting my own goals - over the short and long term?
M3	MR	Am I meeting external goals eg, teacher expectations, whole class performance, relevant sub-group performance
M4	RP	What changes might help me reach my goals?
M5	MRP	What is the meaning of the data and components modelled?
M6	MRP	Can I trust the accuracy of the model?

Competency questions for *control of the PUML:*

Questions about "Raw data"

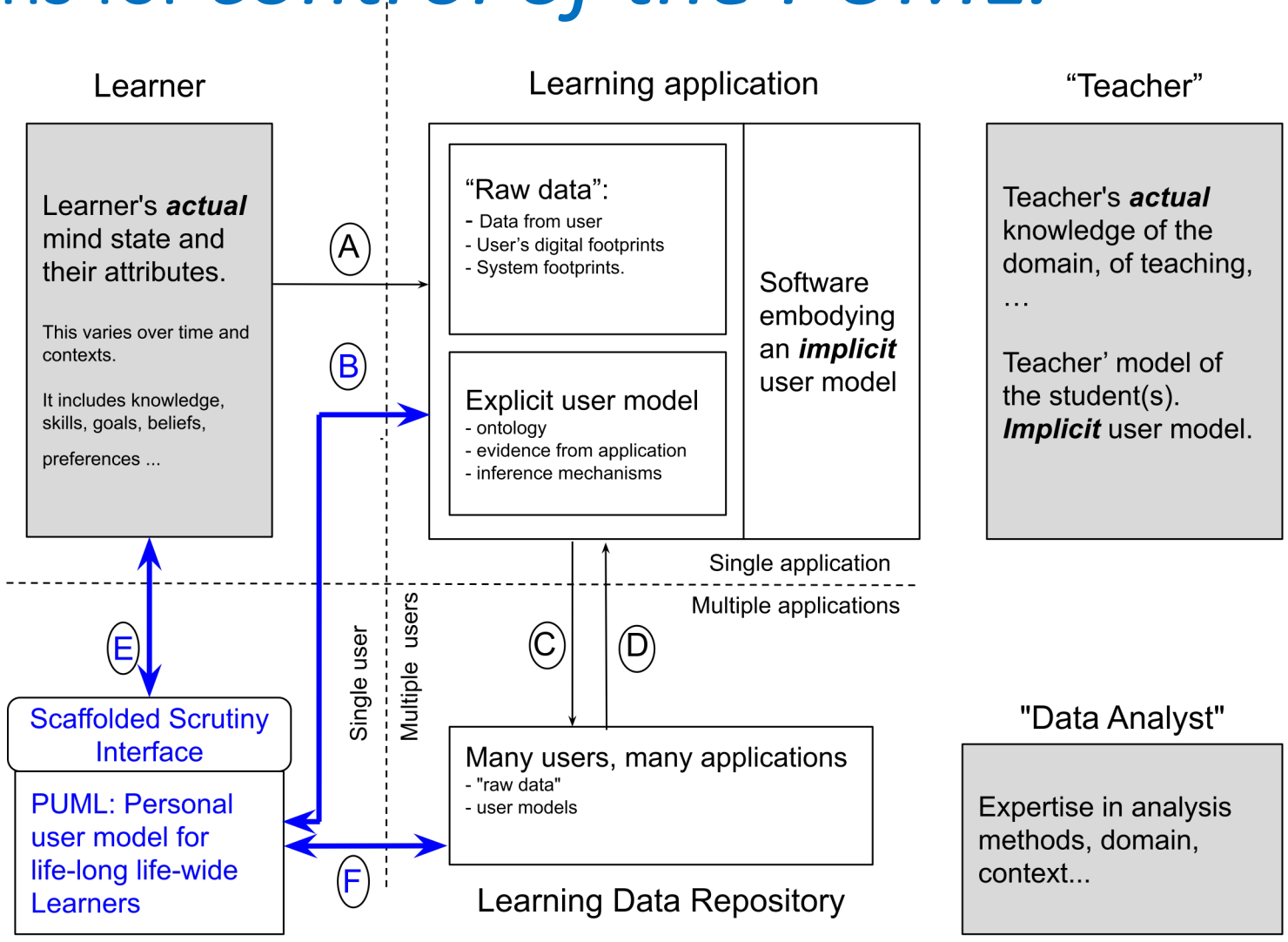
What "raw data" is kept about me?

— Where does that data come from?

— How do I control this inflow?

remove data, add/bar a data source.

— How do I volunteer data about a component?



Competency questions for *control of the PUML:*

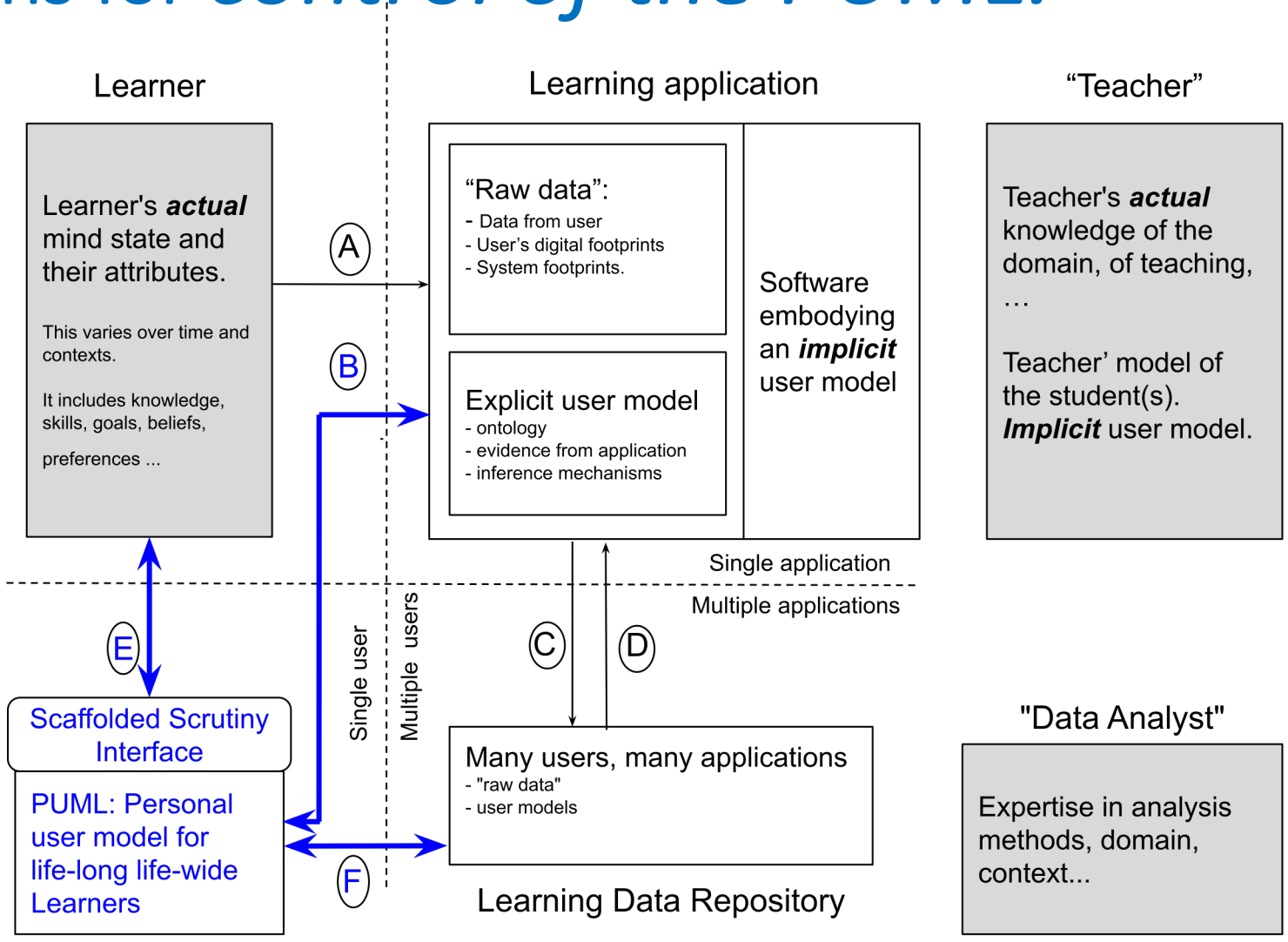
Questions about Explicit user model

What is modelled about me?

— How does the modelling *process* work?

— How do I add/alter/remove an inference process?

— How do I control the interpretation of evidence about a component?



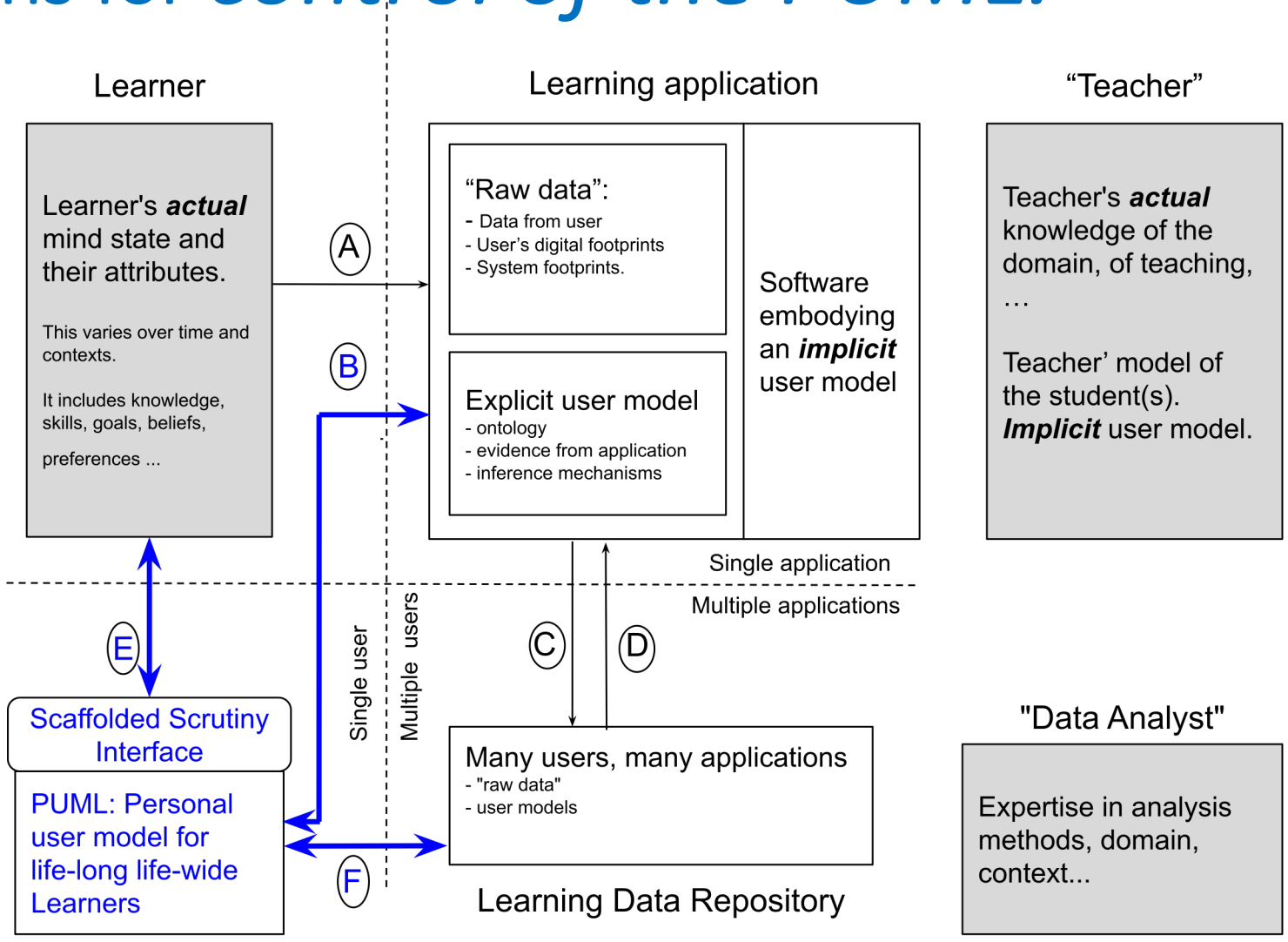
Competency questions for *control of the PUML:*

Exported data and user models

Where do my data and user model go

— How do I control this? add/bar a user model source?

— How has this component been used in an application and when?



Pragmatics

Technical

- Data interoperability (beyond xAPI, Calliper, W3C “activity streams”

Human aspects

- Who will build and support the PUML software?
- Will developers systematically define the “ontology” of each teaching application, with meaningful metadata?
- Will developers systematically store the “raw data” with meaningful metadata?

Design foundations: guidelines

Design guidelines

- The self-monitoring interface should be minimalist
- The self-monitoring interface should scaffold self-monitoring
- Reflection interfaces should scaffold goal setting
- Scaffold the learner to scrutinise the user model ontology, evidence and reasoning
- The interface should scaffold the learner to control what an application can add to the PUML or access from it
- Interfaces should support teachers to create the explanations and scaffolds used in the PUML

Contributions

- *A vision for a Personal User Model for Life-long, Life- wide Learners*
- *A set of competency questions to inform design and evaluation of PUMLs.*
- *Guidelines for designing interfaces so that learners can scrutinise the learning data and models.*