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Logic Programming for Data Tagging

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Privacy Tools Project NSF Site Visit
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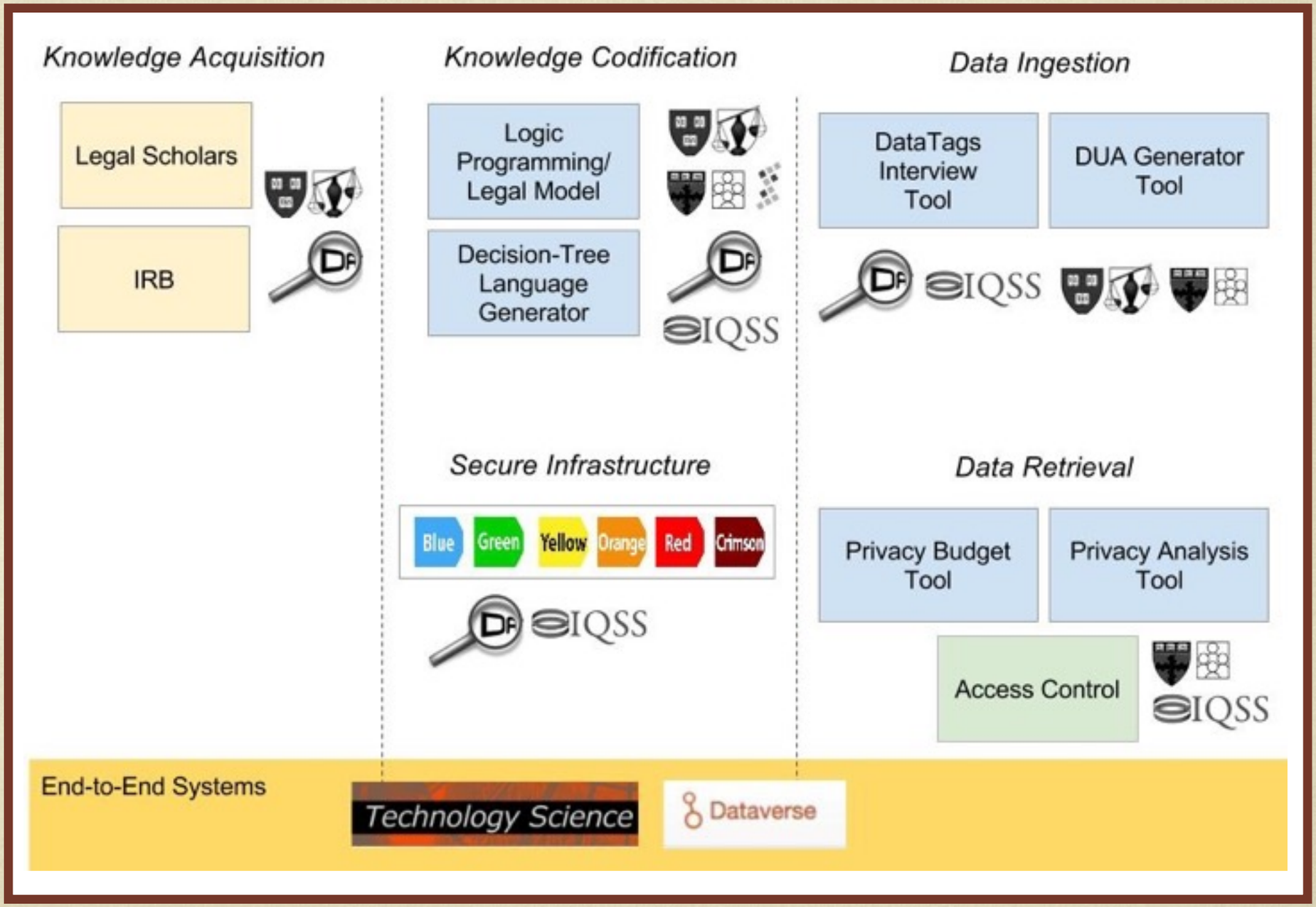
Logic Programming for Data Tagging

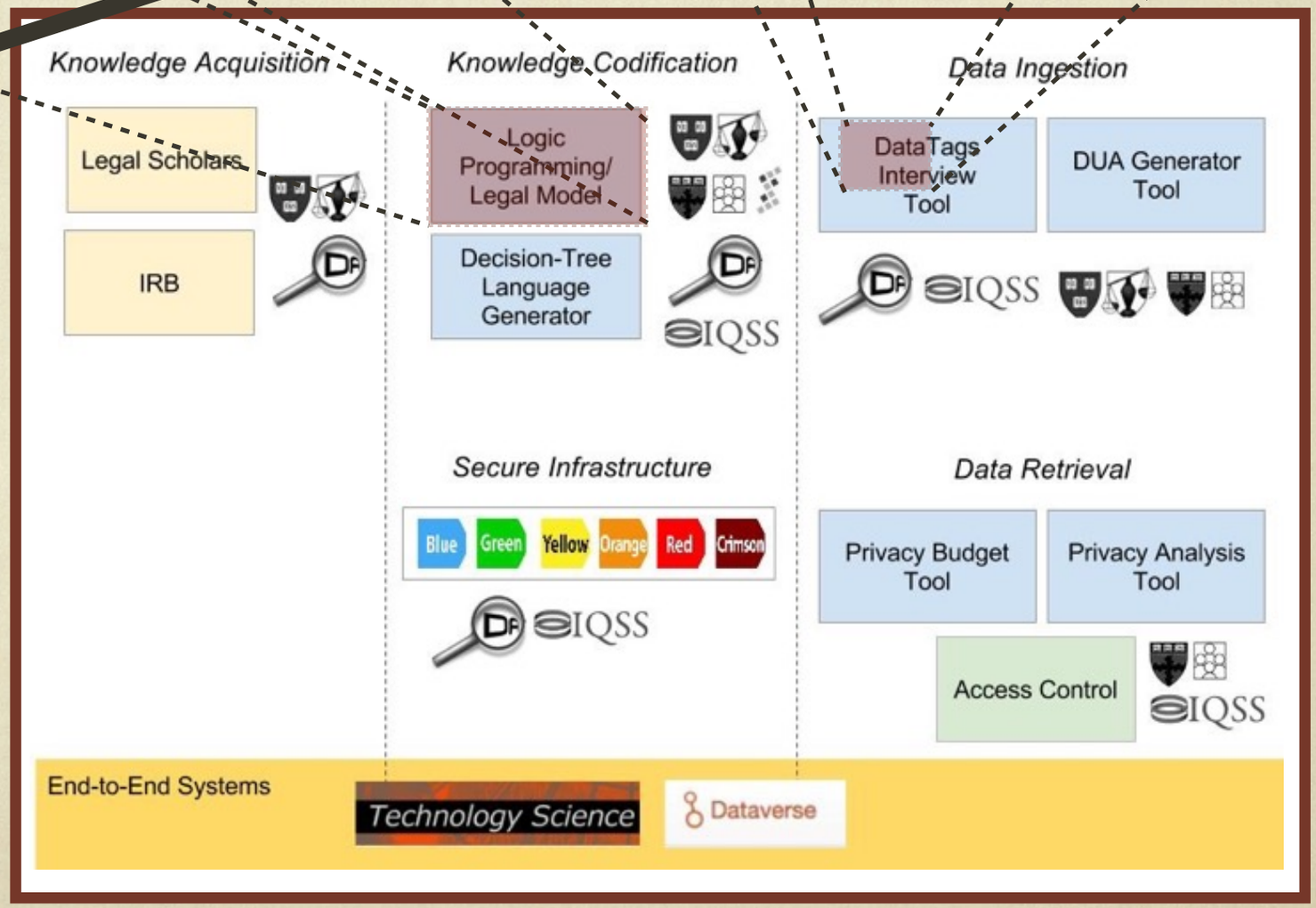


Logic Programming for Data Tagging

Formal legal model for tag recommendation and license generation

Optimization of DataTags Questionnaires

Datalog implementation



Tag Recommendations and Licenses

Social Scientist

Use and share data

Data Tags

This Work

Tag characterization

Formal model of regulatory requirements

Permitted/denied actions

Analysis in legal memos

Statutory text

Privacy Legislation

Tag Recommendations and Licenses

- Motivation and context
  - Formalize aspects of privacy legislation
    - Using a logic programming language
  - Answer whether legislation/best practice permits or denies specific actions on data sets
    - Expert-system-like ability
  - Explore legislation
    - e.g., find conditions where best practice contradictory
- Combines
  - computer science (formal modeling),
  - law (legal research & analysis),
  - social science (survey design),
  - information science (taxonomies)

System design

This work

FERPA formalization

CMR formalization

Local practices

Question text
License text
Logic rules

Logic program

Questions

Answers

Recommended privacy attributes
Recommended Tags
Recommended license text

Data Owner

Data deposit

Deposit license

The Dataverse Project

Transformations

Access Control

Data User

Formal model: Actions

`dd` : Data depositor

`r` : Repository

```
Deposit(dd, ds, r, cs)
Accept(r, ds, dd, cs)
Release(r, ds, du, dd, cs)
...
```

`ds` : Dataset

`du` : Data user

`cs` : Condition set
(provides further details about action)

Permitted or Denied

- Actions can be **permitted** or **denied**

```
Permitted(leg, a)
Denied(leg, a)
```

`leg` : Legislation

`a` : Action

  - Or neither permitted or denied
- E.g., `Denied(ferpa,`

```
        Release(harvardDataverse,
                cs152grades-2015sp,
                jon@doe.com,
                chong@seas.harvard.edu,
                [dataverseClickthrough]))
```

Example formalization

```
Let dd be the data depositor
Let du be the data user
Let ds be the data set
Let r be the repository
Let cs be a set of conditions

IF  CMR:depositorInScope(dd, ds)
AND CMR:identifiable(ds)
AND NOT (CMR:secure(r)
         AND CMR:isAcceptableConditionsForRelease(cs))
THEN DENIED(Release(r, ds, du, dd, cs))


Let l be a license
Let cs be a set of conditions
IF  License(l) ∈ cs
AND licenseImplies(l, CMR:TransmissionEncrypted)
THEN CMR:isAcceptableConditionsForRelease(cs)
```

Formalization process

Define Use Cases In Scope	Data Deposit	Retention	Transformation	Dissemination
Parse Use Case Components	Actors: data controller, repository, user	Actions: accept data, store, release,…	Entities: Data set, Record,…	
Legal Review of Law	Identify Restrictions on Use Cases	Identify Restrictions on Actors, Actions, Entities		
Expert Coding of Use Case Actions	Map rules permitting and restricting action to law-specific characteristics	Map law-specific characteristics to license text affirmations	Map law-specific characterstics to general properties	

Demo

DataTags

- Permitted and denied actions are the interface between DataTags and legislation
  - May require more powerful language than Prolog...

```
Let dd be the data depositor
Let du be the data user
Let ds be the data set
Let r be the repository
Let t be the data tag

IF isDataTag(t, r, ds)
AND FOR ALL condition sets cs
      PERMITTED(Release(r, ds, du, dd, cs))
        IMPLIES conditionsRequire(cs, ReidentificationProhibited)
THEN atLeast(t, Yellow)
```

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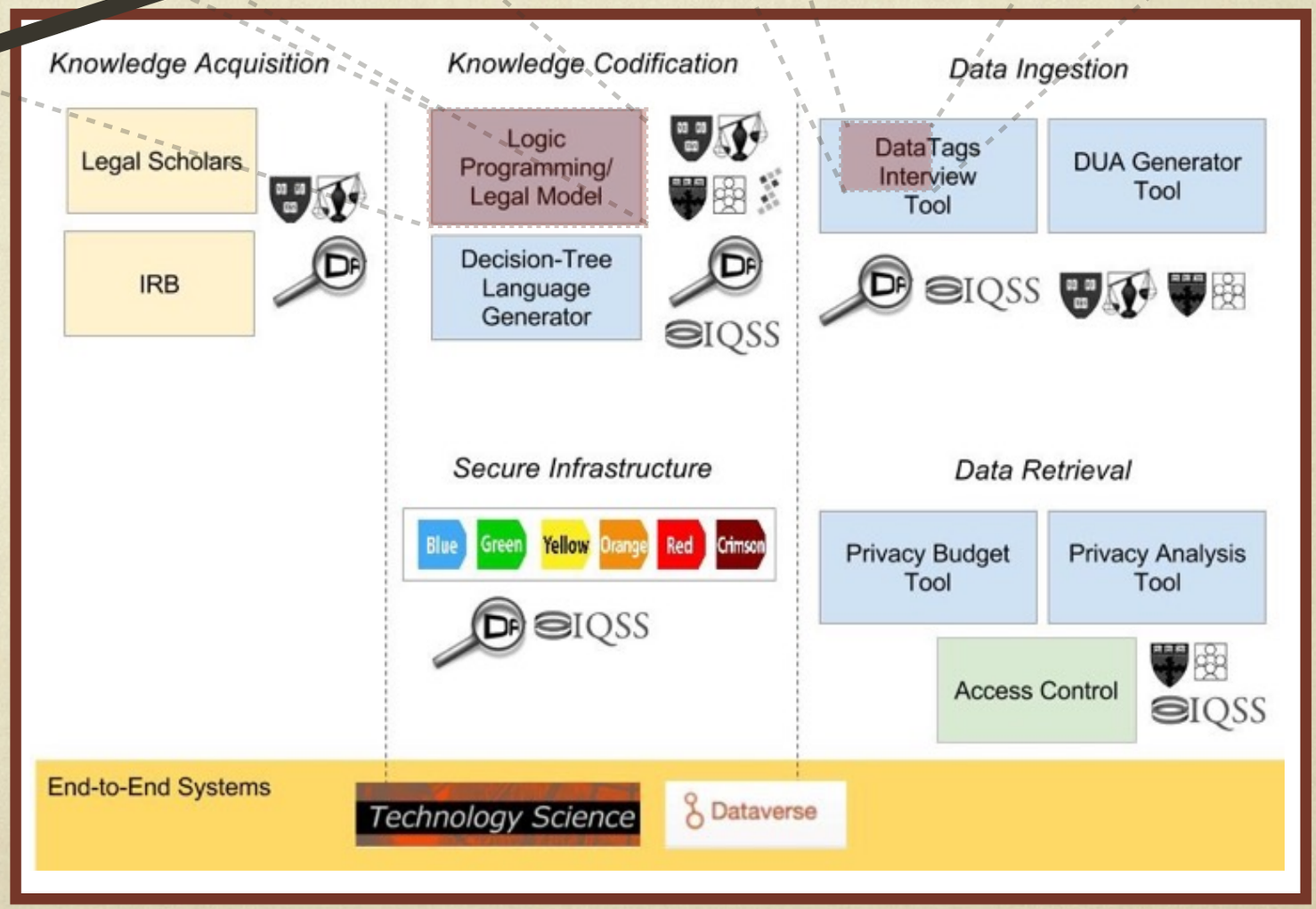

DataTags Questionnaire in Datalog

- When accepting dataset, ask depositor series of questions to determine DataTag
- Currently: nice domain specific language
  - But imperative with explicit control flow (i.e., `gotos`)
- Goal: express more **declaratively** using Datalog
  - Separate questions from control flow
  - Facilitate composition of questionnaires
  - Re-run old answers when questionnaire changes
  - ...

"Optimize" question order

- Given declarative questionnaire, what is "best" order to ask questions?
  - Fewest questions to reach decision?
  - Ask questions from general to specific?
  - Ask related questions at same time?
- Assume some cost function for the question order

- Characterize as a **game**
  - Player asks question, opponent gives answer
  - Player's goal: reach decision with lowest cost
  - Determine strategy with lowest (expected) cost
- Game tree too big to explore exhaustively
  - E.g., with *n* questions, 3 answers per question, there are $n! \times 3^n$ paths/final states
  - But analysis of Datalog program can significantly reduce search

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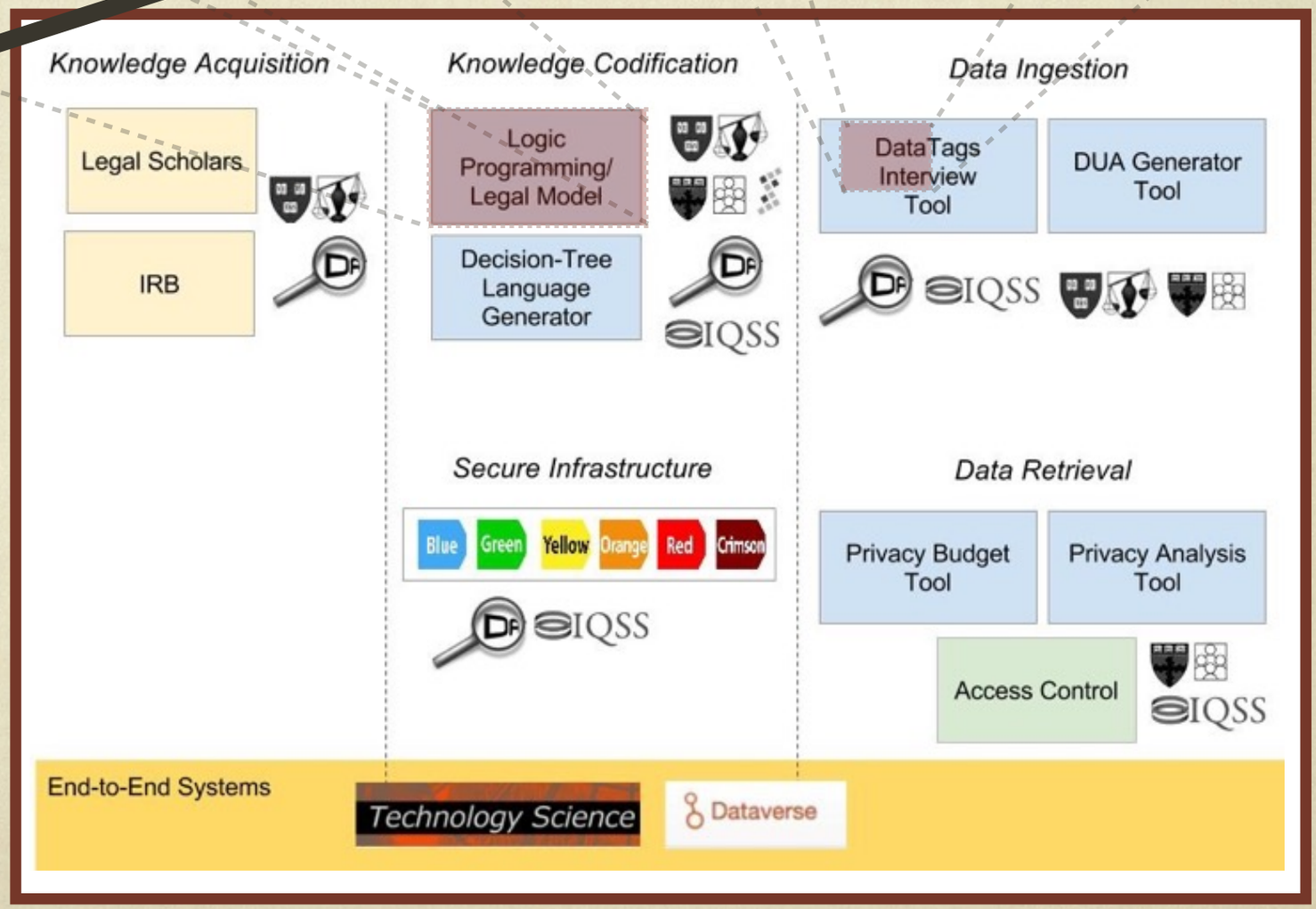

Our very own Datalog...

- Developed our own Datalog implementation
  - Can extend with language features
  - More flexible interface/efficient interaction
  - Make use of modern concurrent hardware
  - Will be used in Harvard undergrad PL course
  - ...
- Will be released open source

Current state

- Current state:
  - Six evaluation engines
    - Top-down, bottom up, concurrent bottom up, ...
    - Exploring different concurrent techniques to improve scalability
      - Preliminary results: 1.2–5.5× speedup over XSB Prolog on OpenRuleBench transitive closure tests
  - Implemented hypotheticals
  - Graphical user interface
    - Suitable for use by undergrad class!

Moving forward

- Formal legal model
  - License generation (from required conditions)
  - Review/independent validation of rules and license text
  - Independent validation of formalization process
  - Engagement with practitioners
    - IRBs, state and local govt. agencies, educational data controllers, ...
- Questionnaire representation and optimization
- Datalog
  - Release and use
  - Develop right logical extension for, e.g., connecting to DataTags

Questions?

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Optimization of DataTags Questionnaires

Datalog implementation