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GRR – Generating Random RDF

Extended Semantic Web Conference 2011

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Motivation

- Testing Data-Intensive Applications is *hard*
  - Large volumes of data required
  - Expensive to create by hand
  - Not necessarily readily available
- Testing Semantic Web Data-Intensive Applications is *even harder*
  - Intricate format expected for input
- We focus on Semantic Web applications with well-defined data structure/distribution

The Goal

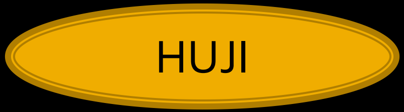
- To make testing easier by automatically generating data, when given
    - A schema
    - Data distributions

Presentation Outline

- Generating data example
- What’s available now?
- GRR – Generating Random RDF
- GRR Abstract & Concrete languages
  - Abstract Generation Language
  - Concrete Generation Language
- Optimization techniques
- Experimentation
- A glimpse to the system
- Conclusion

Generating Data Example

(C1) Create University



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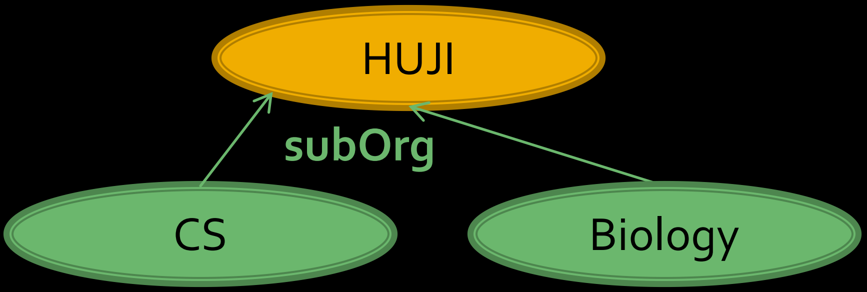
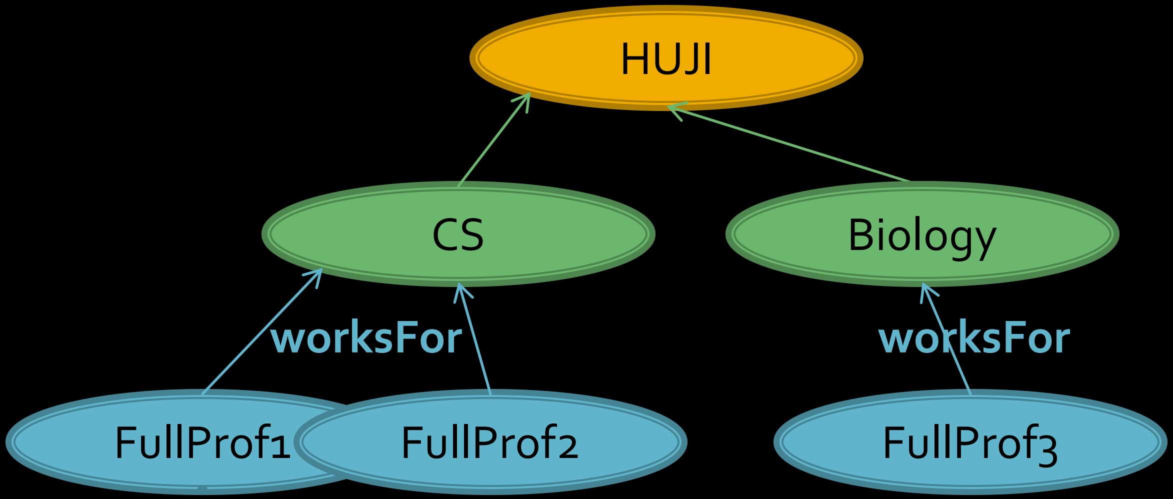
Generating Data Example

(C2) Create 1-5 Department subOrg of University



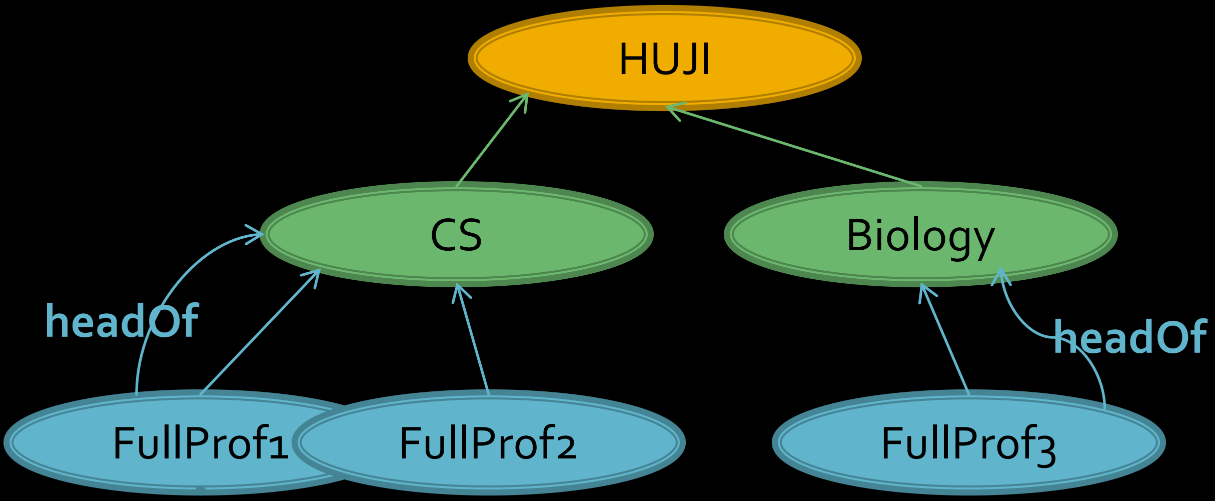
Generating Data Example

(C3) Create 0-3 FullProfessor (FacultyMember) worksFor Department



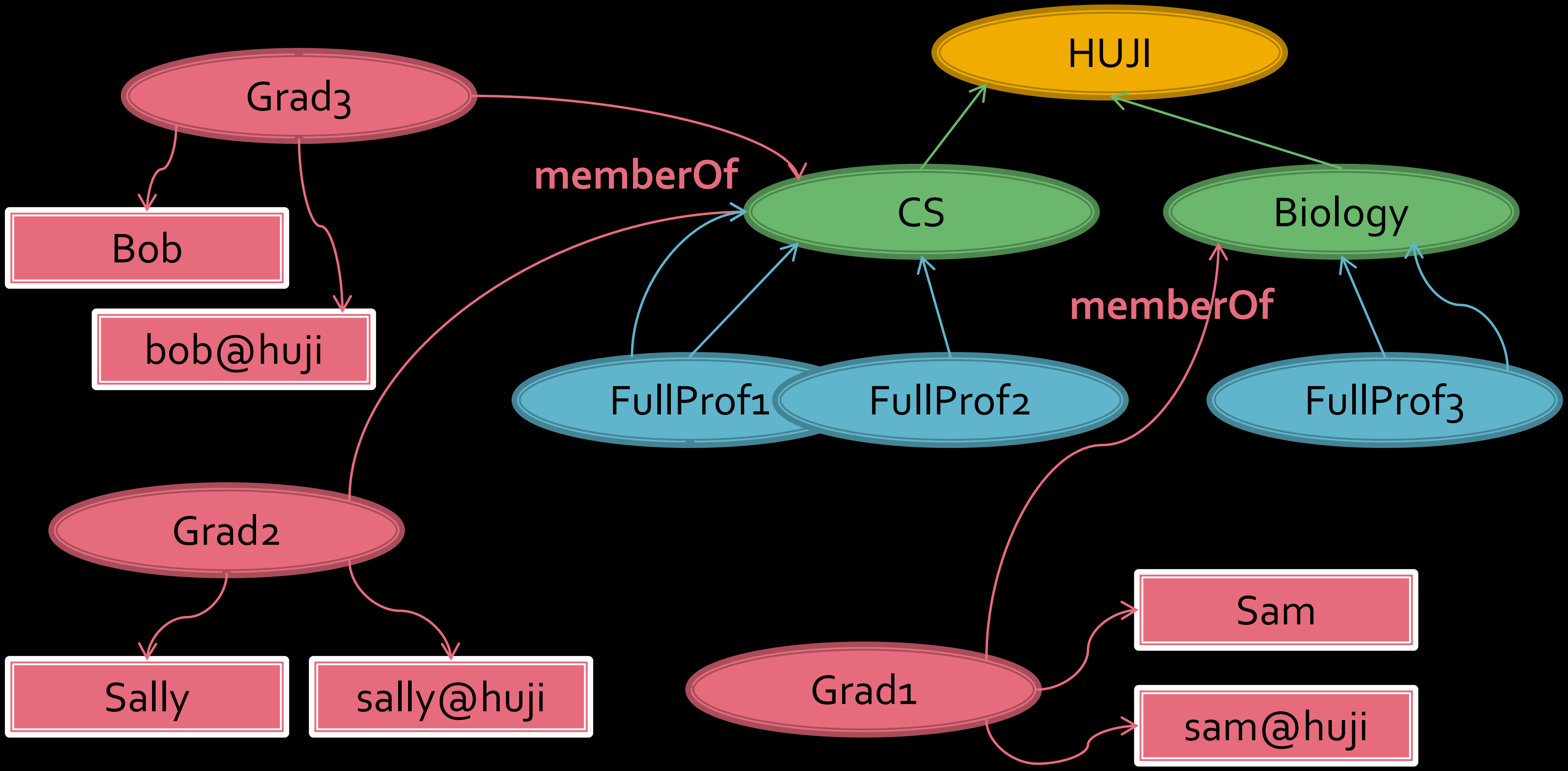
Generating Data Example

(C4) one of the FullProfessors is headOf the Department



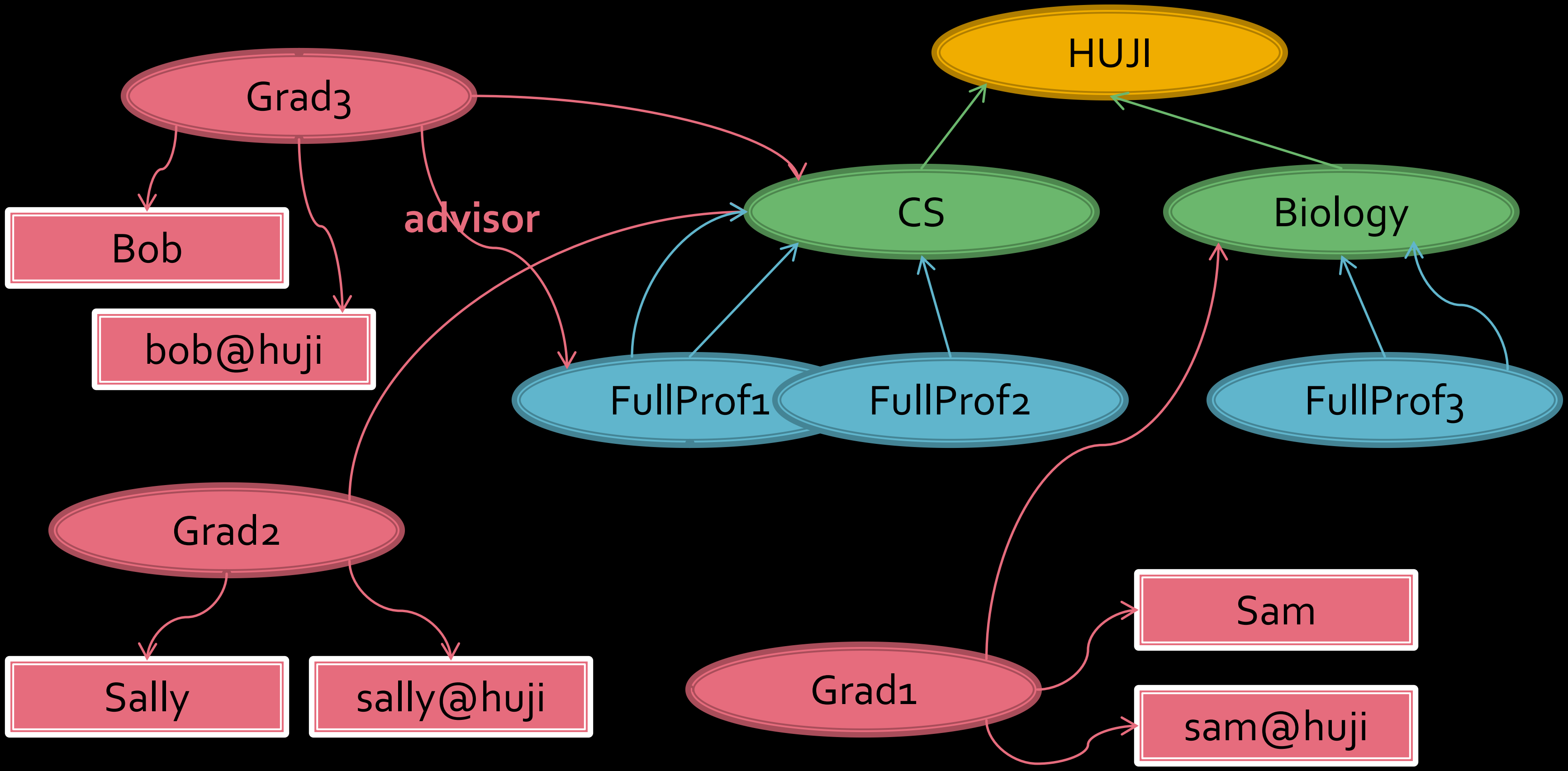
Generating Data Example

(C5) For each FacultyMember
create 1-4 UnderGrad memberOf Department



Generating Data Example

(C6) 20% of UndergGrad have a professor as Advisor



What's Available Now?

- Downloadable RDF datasets
  - Examples: Barton libraries, UniProt catalog, WordNet, LUBM, SP^{2}Bench, Berlin SPARQL Benchmark
  - Good for testing efficiency of RDF storage systems
- Data generators
  - Example: SIMILE Project (RDFizers), RBench
  - Generate data according to user constraints

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- Downloadable RDF datasets
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  - Good for tes f RDF storage systems
- Data generators
  - Example: SIMILE Project (RDFizers), RBench
  - Generate data according to user constraints

Do not match specific schemas/distributions

Our System: GRR

- *GRR = Generating Random RDF*

- Main Features
  - Produces data with complex graph structure
  - Intuitive SPARQL like syntax
  - Draws the data values from desirable domains
  - Commands are translated into SPARQL queries applied directly to the RDF storage system

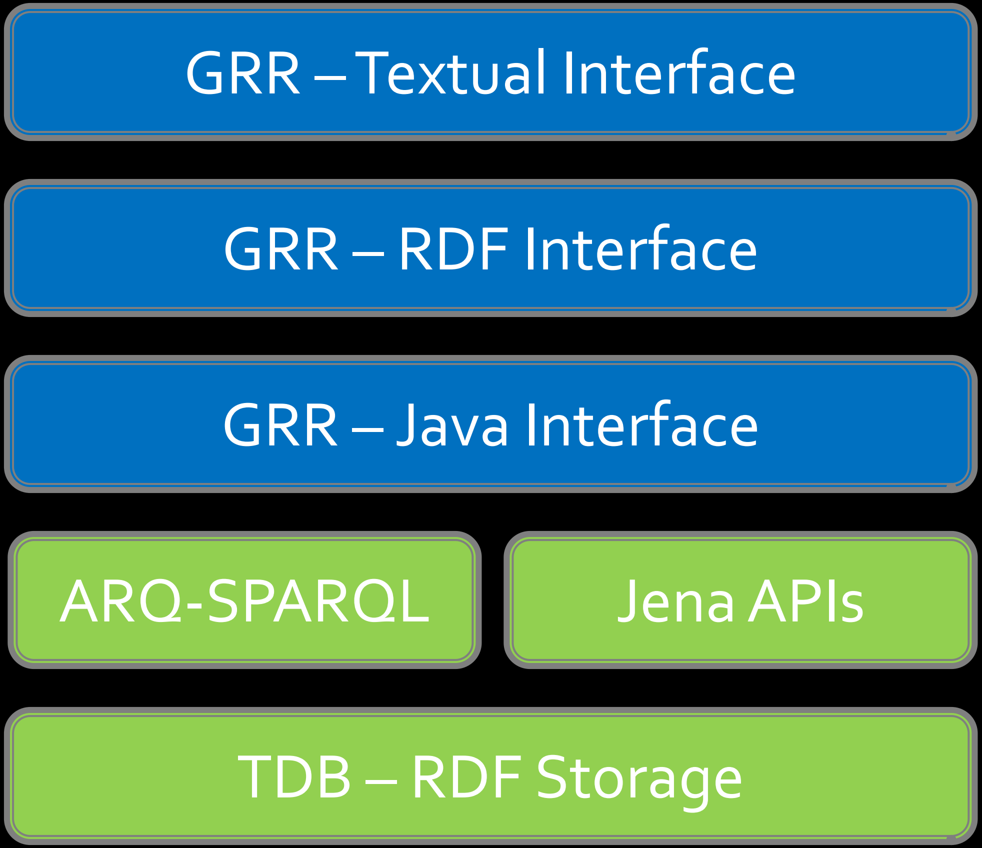
GRR: Abstract and Concrete Generation Languages

GRR: Abstract and Concrete Generation Languages

- The GRR system is built on an **abstract logic-based language**
  - Clearly defined expressive power
- Implemented as a multi-layer system
  - Different layers have varying levels of simplicity and expressiveness

Concrete Generation Language

- System overview
  - ***Textual Interface -*** Exposes intuitive way to generate the data
  - ***RDF Interface -*** A structured RDF based way to generate the data
  - ***Java Interface –*** The most flexible interface, but is implementation-oriented


GRR – Textual Interface

GRR – RDF Interface

GRR – Java Interface

ARQ-SPARQL

Jena APIs

TDB – RDF Storage

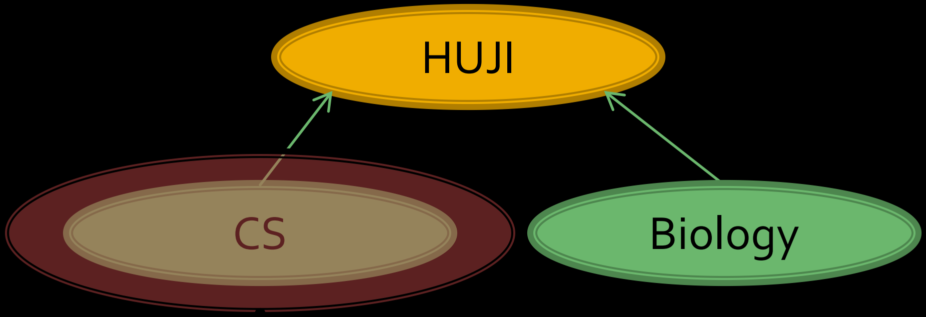
Abstract Generation Language

Abstract Generation Language

- A data generation command:
  - Maps/chooses existing parts of the graph by using queries
  - Adds new nodes and/or new edges
  - Iterates as needed

Abstract Generation Language

- Queries – Mapping the relevant nodes
  - Get Department subOrg University



Query maps Department

Abstract Generation Language

- How do we choose numbers and values ?
  - Number of nodes to be created – Number samplers returning values from a given range and distribution
  - Node Values and Attributes – Value samplers can return random or from a set with given values and distributions. For a newly generated node we can add set of attributes, also with random values

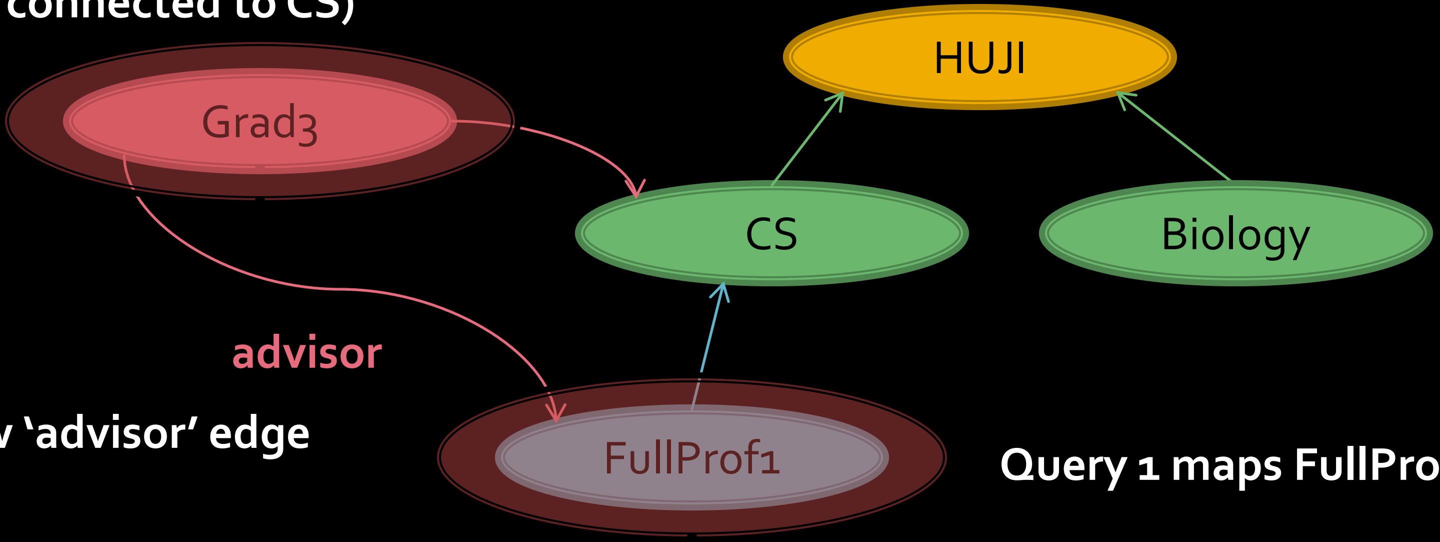
Abstract Generation Language

- Query results manipulation and usage
  - A Query-Sampler defines how many mappings will be returned
    - Example: %20 of all FullProf nodes
  - A Query-Sampler defines if a mapping can be returned more than once
    - Never return the same result
    - Return results that are distinct within the present inner queries
    - Allow all types of repetition

Abstract Generation Language

- Composite Queries – Mapping different areas
  - Connect GradStud with FullProf as advisor

Query 2 maps GradStud
(must be connected to CS)

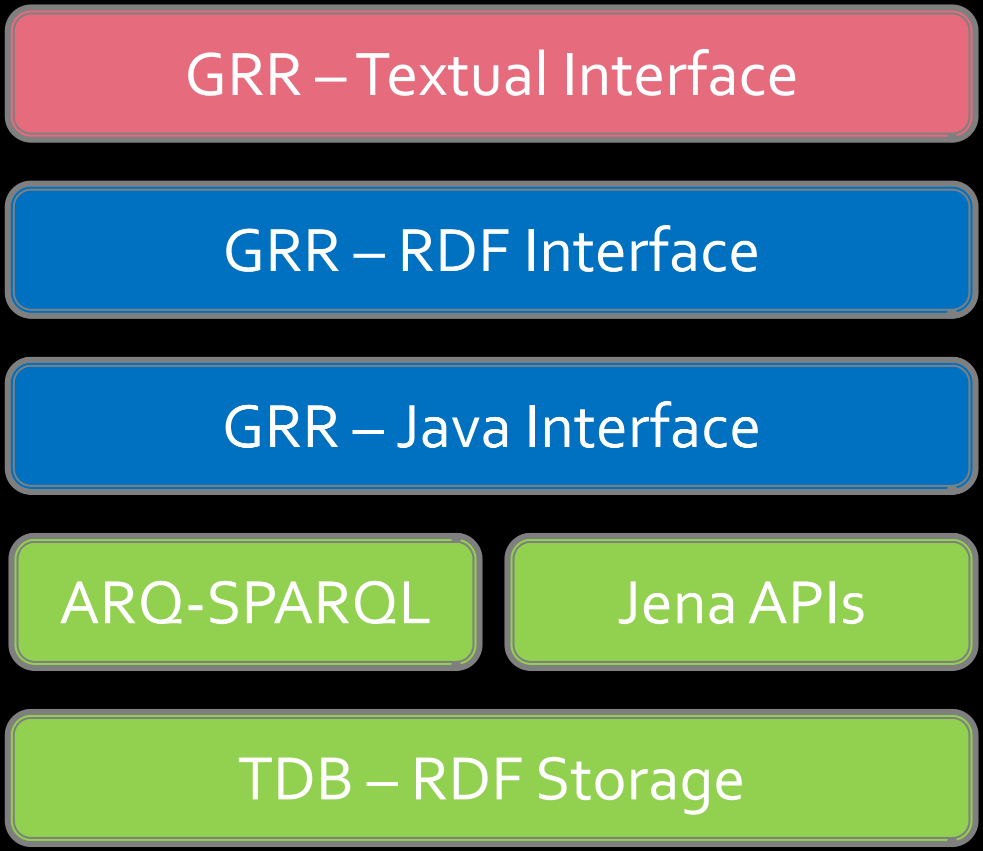


Add new 'advisor' edge

Query 1 maps FullProf

Concrete Generation Language

Concrete Generation Language



GRR – Textual Interface

GRR – RDF Interface

GRR – Java Interface

ARQ-SPARQL

Jena APIs

TDB – RDF Storage

Concrete Generation Language

- Textual interface – Data Generation Template
  - (FOR *query sampling method*

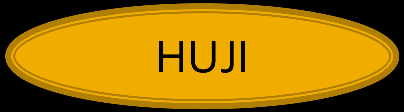
    [WITH (GLOBAL DISTINCT | LOCAL DISTINCT | REPEATABLE)]

    { list of classes }

    [WHERE { list of conditions }])*
  - [CREATE n-sampler { list of classes }]
  - [CONNECT { list of connections }]

Generating Data Example

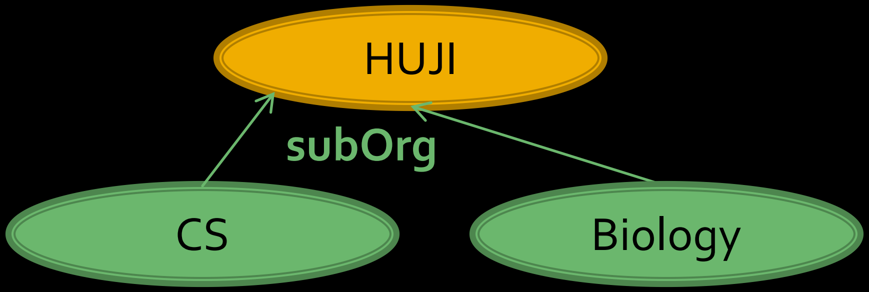
(C1) Create University



(C1) CREATE 1 {ub:Univ}

Generating Data Example

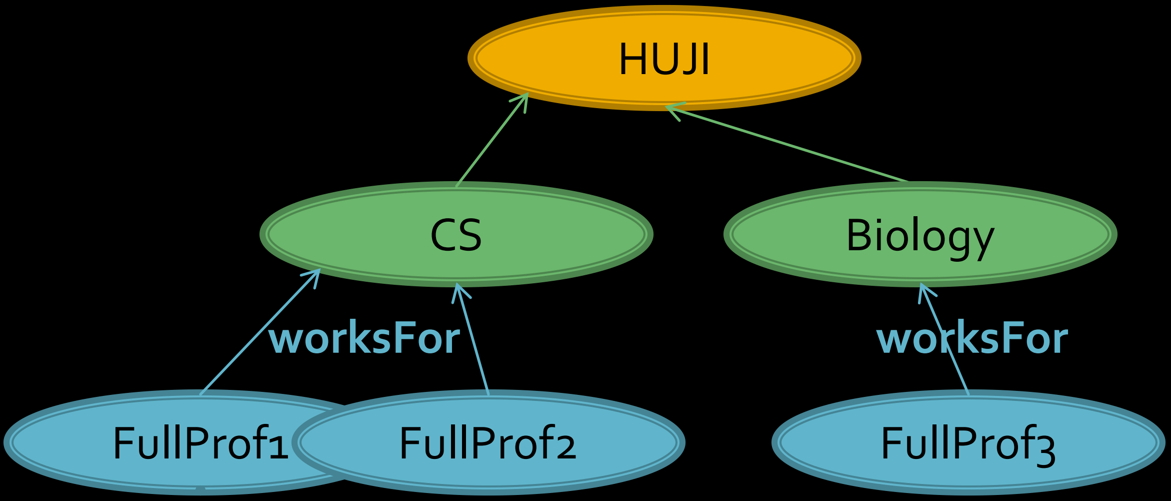
(C2) Create 1-5 Department subOrg of University



(C2) FOR EACH {ub:Univ} CREATE 1-5 {ub:Dept}
CONNECT {ub:Dept ub:subOrg ub:Univ}

Generating Data Example

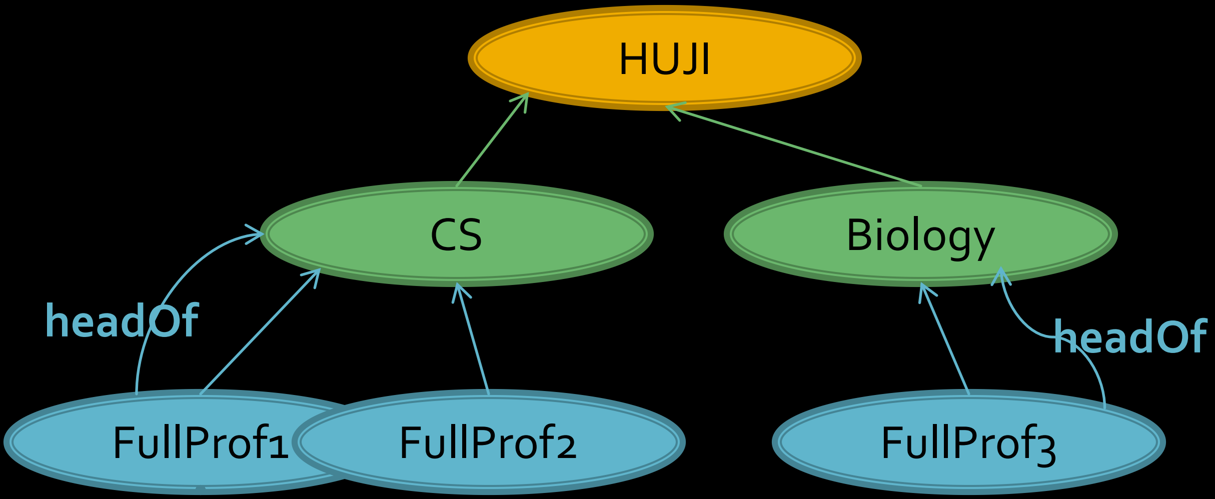
(C3) Create 0-3 FullProfessor (FacultyMember) worksFor Department



**(C3) FOR EACH { ub:Dept } CREATE 0-3 { ub:FullProf }
CONNECT { ub:FullProf ub:worksFor ub:Dept }**

Generating Data Example

(C4) one of the FullProfessors is headOf the Department



(C4) FOR EACH { ub:Dept } FOR 1 { ub:FullProf }
WHERE { ub:FullProf ub:worksFor ub:Dept }
CONNECT { ub:FullProf ub:headOf ub:Dept }

Generating Data Example

(C5) For each FacultyMember
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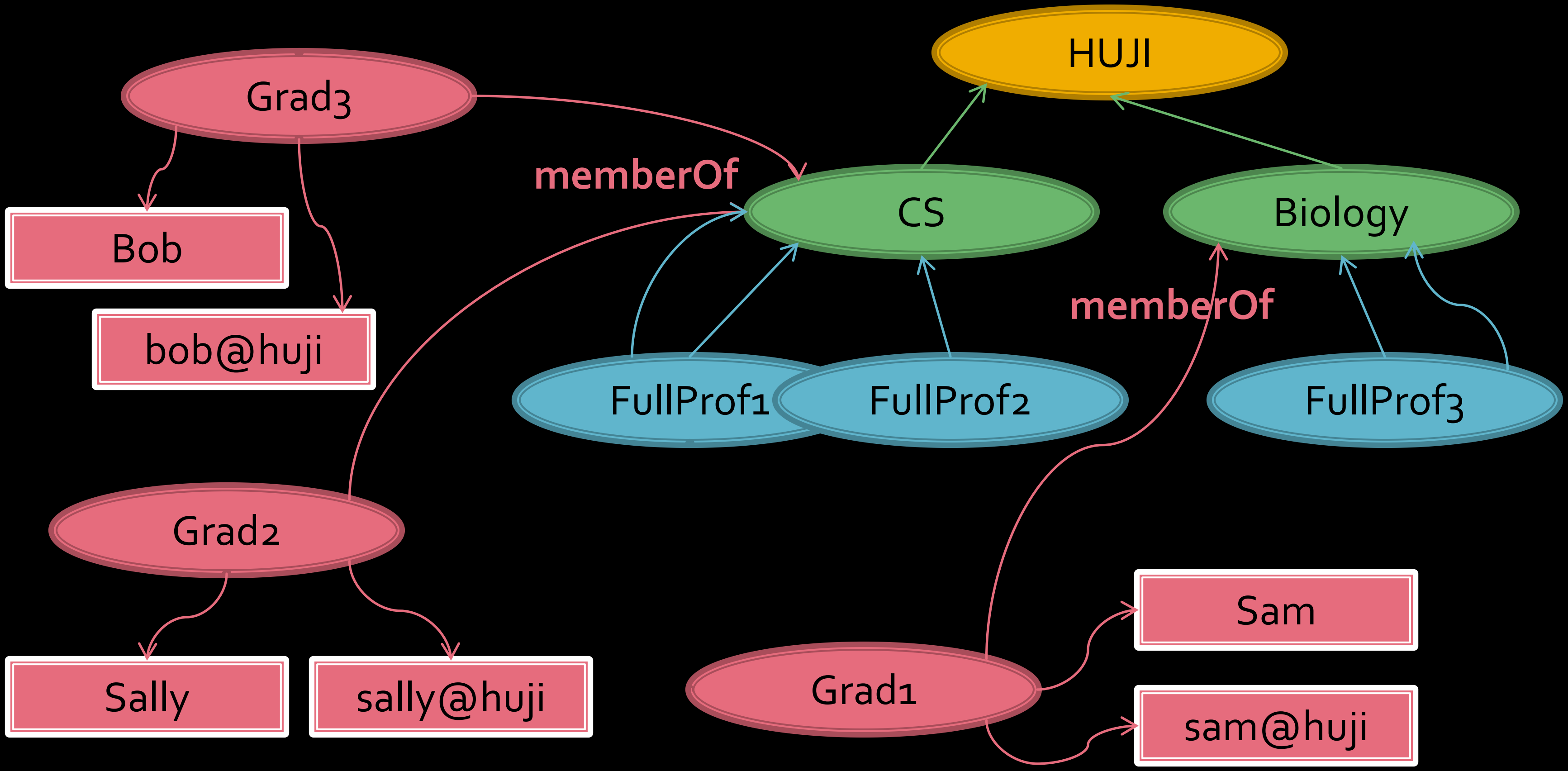

Generating Data Example

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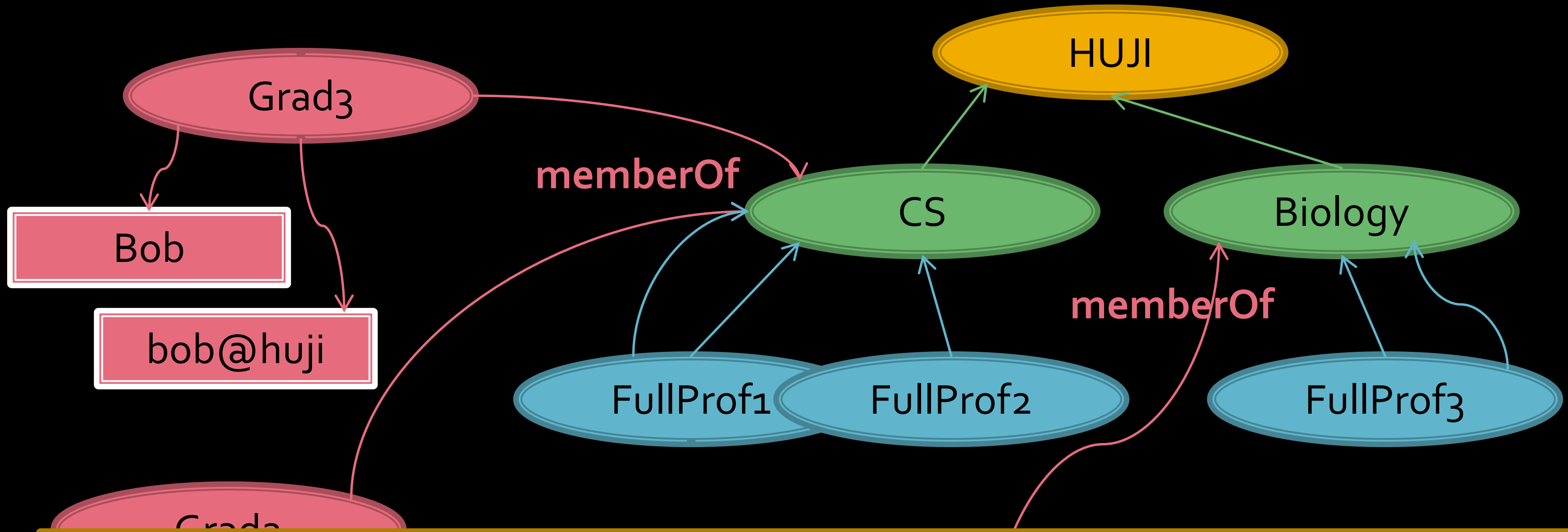

(C5) FOR EACH {ub:Faculty, ub:Dept} WHERE {ub:Faculty ub:worksFor ub:Dept} CREATE 1-4 {ub:Undergrad} CONNECT {ub:Undergrad ub:memberOf ub:Dept}

Generating Data Example

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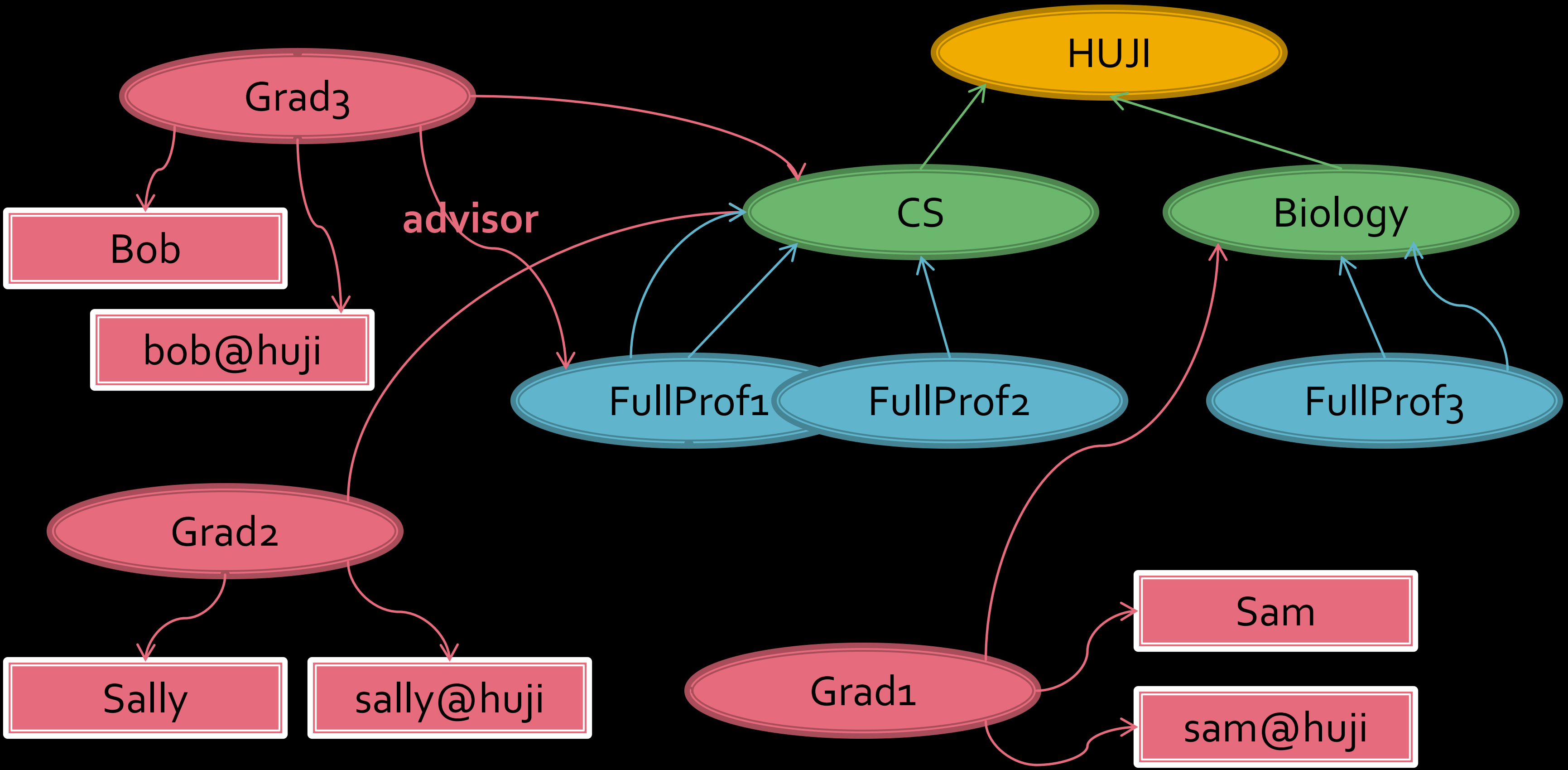

Generating Data Example

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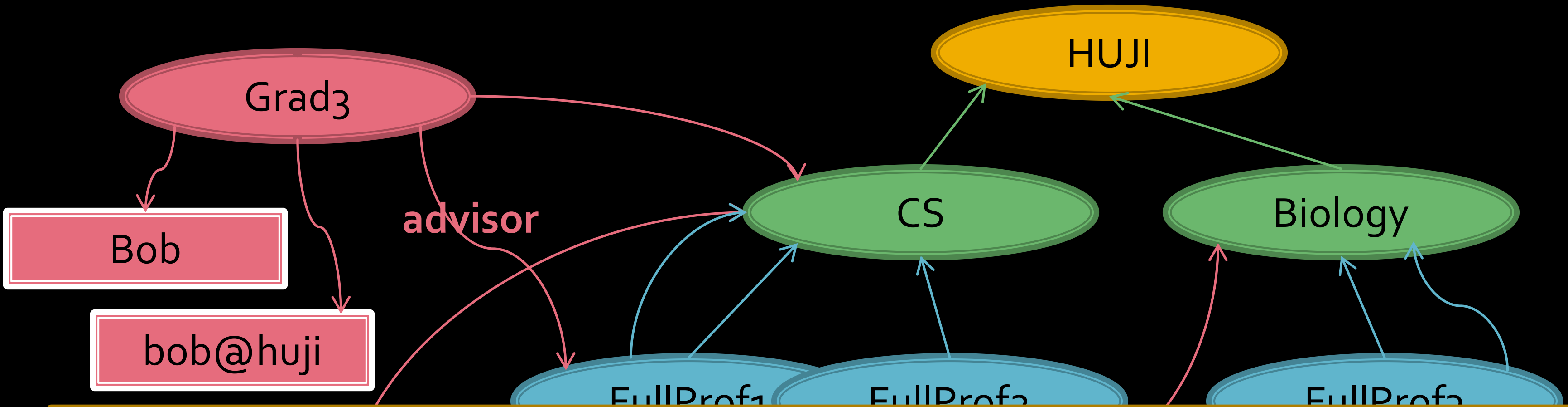


(C6) FOR 20%-20% { ub:Undergrad, ub:Dept }
WHERE { ub:Undergrad ub:memberOf ub:Dept }
FOR 1 with repeatable repetitions { ub:Prof }
WHERE { ub:Prof ub:worksFor ub:Dept }
CONNECT { ub:Undergrad ub:advisor ub:Prof }

Concrete Generation Language

- Textual interface – FOAF Example
  - namespace foaf: <http://xmlns.com/foaf/0.1/>
  - CREATE 250000 { foaf:Person }
  - FOR EACH { foaf:Person ?p1 }
  - FOR 15-25 { foaf:Person ?p2 }
  - WHERE { FILTER(?p1 != ?p2) }
  - CONNECT { ?p1 foaf:knows ?p2 }

Optimization Techniques

Optimization Techniques

- Caching Query Results
  - We are using composite queries that might be called several times
  - The same query can be executed several times therefore we cache query results

Optimization Techniques

- Avoiding Unnecessary Caching ('Smart Cache')
  - Caching reduces the number of times a query will be applied, but it incurs a significant storage overhead
  - In GRR, we avoid caching of results when caching is guaranteed to be useless

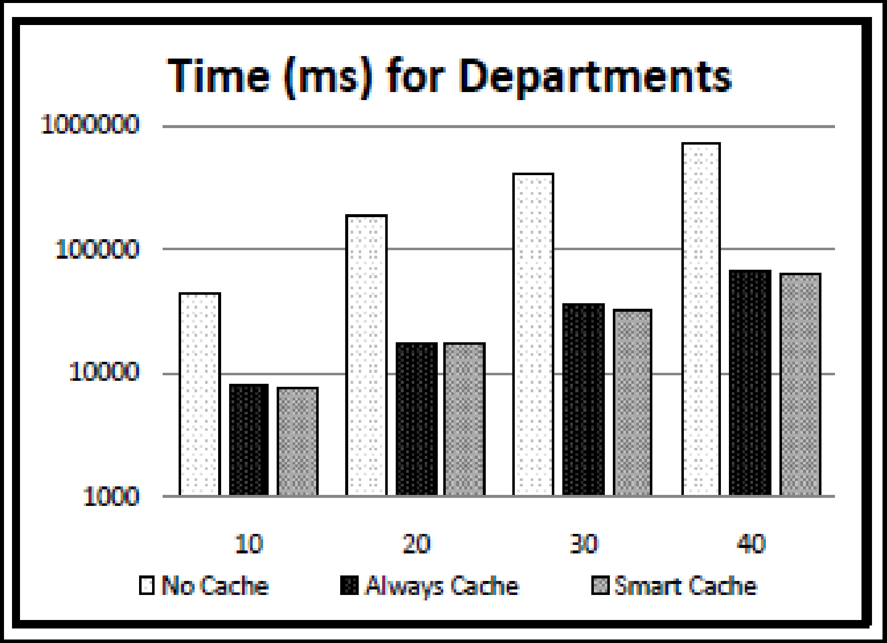
Experimentation

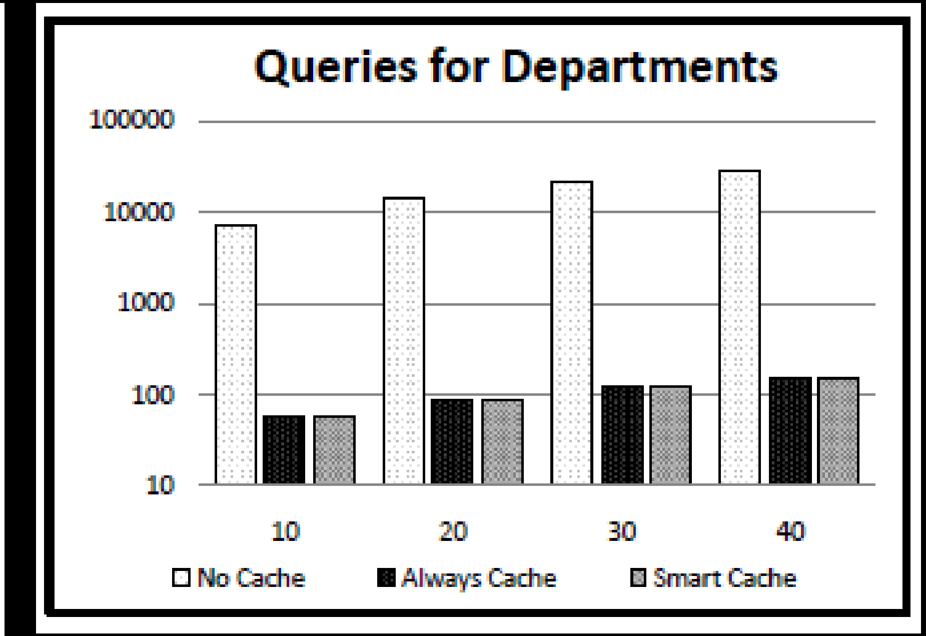
Experimentation

- Setup
  - GRR uses Jena's TDB database (pure Java non-SQL storage system)
  - Desktop running Windows Vista x64 with 4GB RAM (2GB allocated for the Java runtime heap)

Experimentation

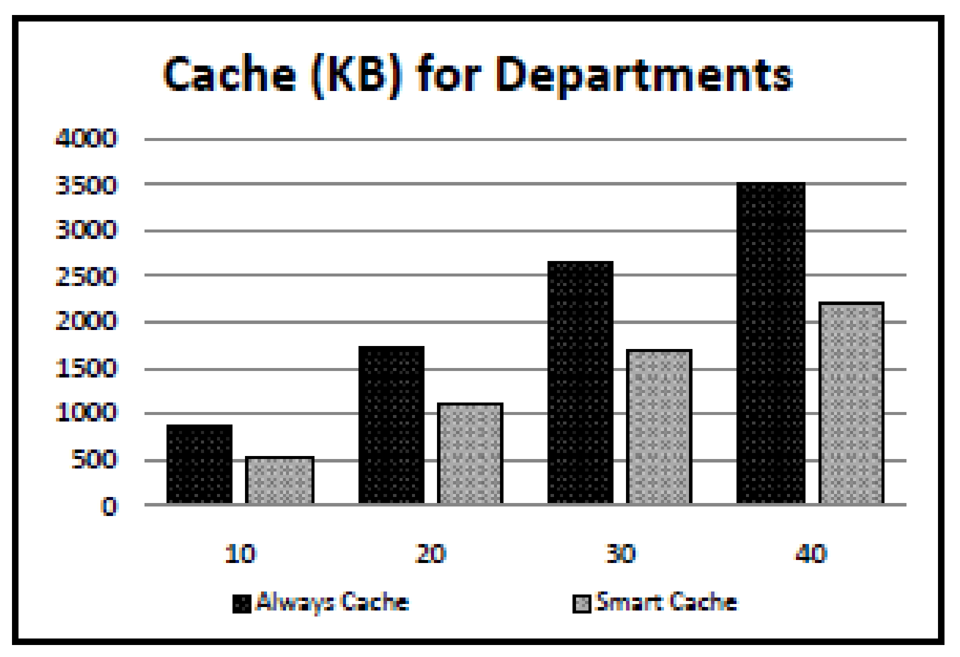
- Recreating the LUBM benchmark
  - Time / Queries measurements





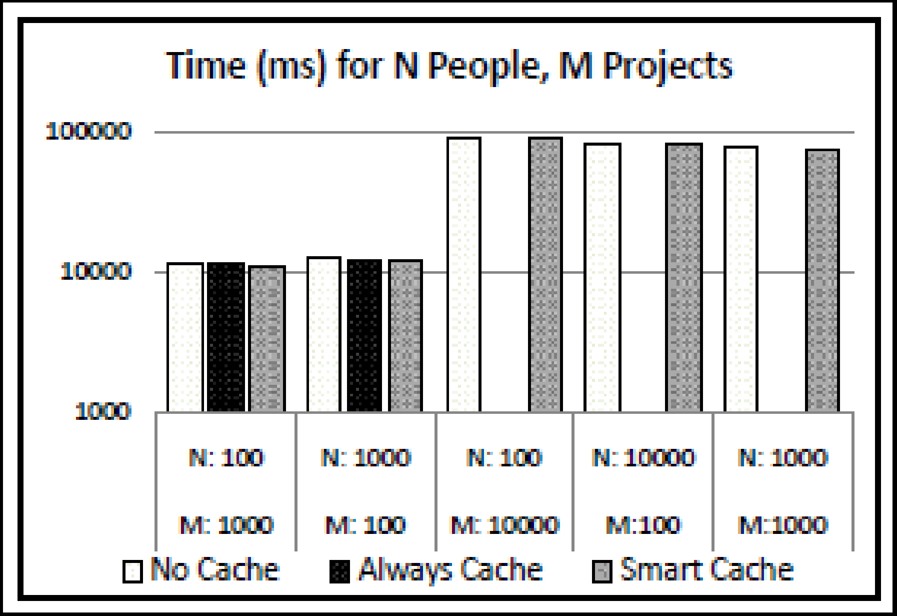
Experimentation

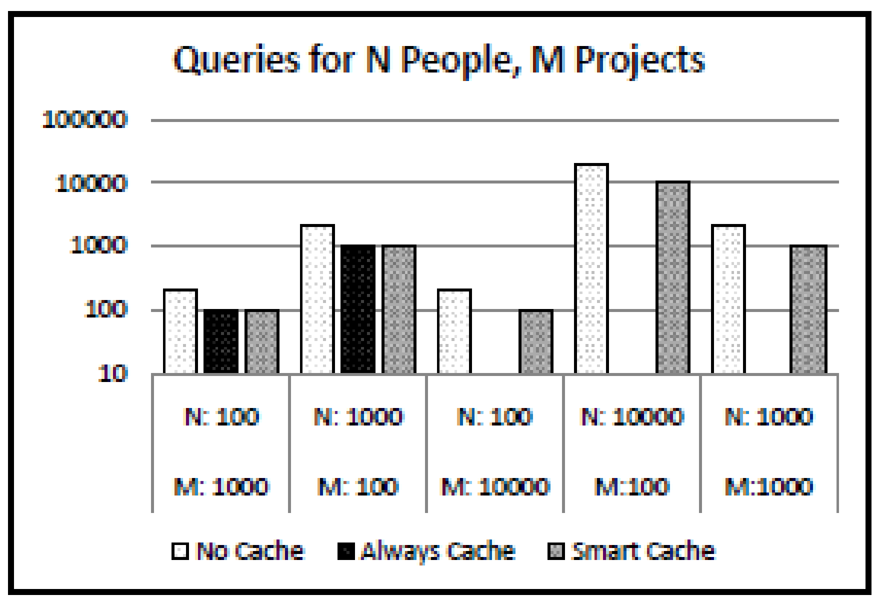
- Recreating the LUBM benchmark
  - Cache size measurements



Experimentation

- GRR scalability while using FOAF schema
  - Time / Queries measurements





Experimentation

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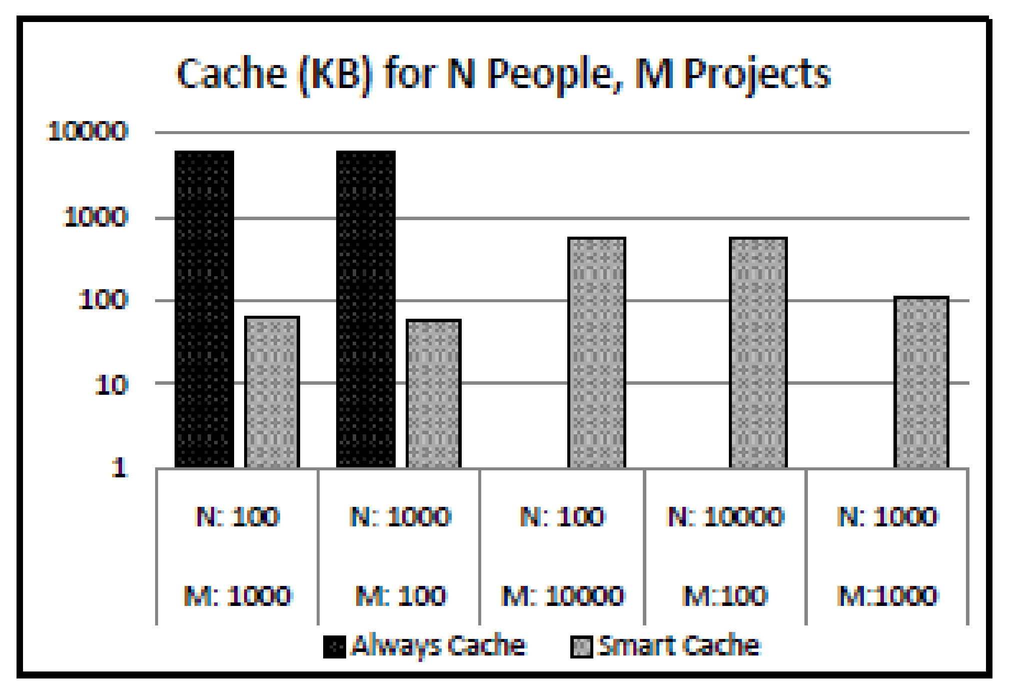
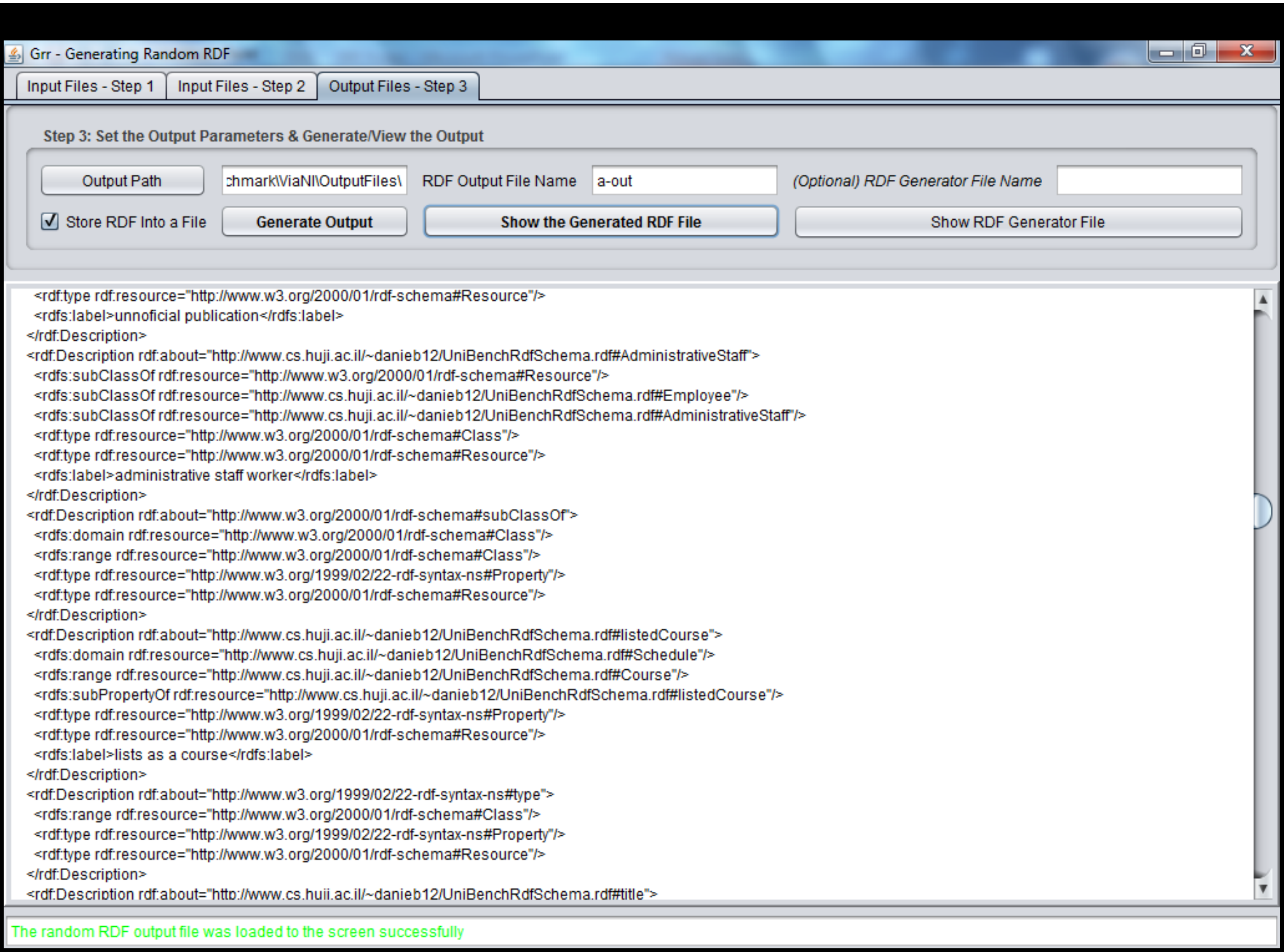


System Implementation - GUI



Step 3: Set the Output Parameters & Generate/View the Output

Output Path: chmark\ViaNI\OutputFiles\

RDF Output File Name: a-out

(Optional) RDF Generator File Name:

☑ Store RDF Into a File

```
  <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
  <rdfs:label>unnoficial publication</rdfs:label>
</rdf:Description>
<rdf:Description rdf:about="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#AdministrativeStaff">
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
  <rdfs:subClassOf rdf:resource="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#Employee"/>
  <rdfs:subClassOf rdf:resource="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#AdministrativeStaff"/>
  <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
  <rdfs:label>administrative staff worker</rdfs:label>
</rdf:Description>
<rdf:Description rdf:about="http://www.w3.org/2000/01/rdf-schema#subClassOf">
  <rdfs:domain rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
  <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
</rdf:Description>
<rdf:Description rdf:about="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#listedCourse">
  <rdfs:domain rdf:resource="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#Schedule"/>
  <rdfs:range rdf:resource="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#Course"/>
  <rdfs:subPropertyOf rdf:resource="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#listedCourse"/>
  <rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
  <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
  <rdfs:label>lists as a course</rdfs:label>
</rdf:Description>
<rdf:Description rdf:about="http://www.w3.org/1999/02/22-rdf-syntax-ns#type">
  <rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
  <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
</rdf:Description>
<rdf:Description rdf:about="http://www.cs.huji.ac.il/~danieb12/UniBenchRdfSchema.rdf#title">
```

The random RDF output file was loaded to the screen successfully

Conclusion

Conclusion

- GRR – System for generating random RDF data
- Useful for generating test data for Semantic Web applications
- Unique since it can create arbitrary structures
- Presents a method to create data that is both natural and powerful

Learn more / Contact us

- www.cs.huji.ac.il/~danieb12
- daniel.blum@mail.huji.ac.il
- GRR in GITHUB: Repository- danieb12/GRR

Questions?

Thanks for listening