A Vision on Algebraic Flows for Declarative Resource Descriptions

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Overview

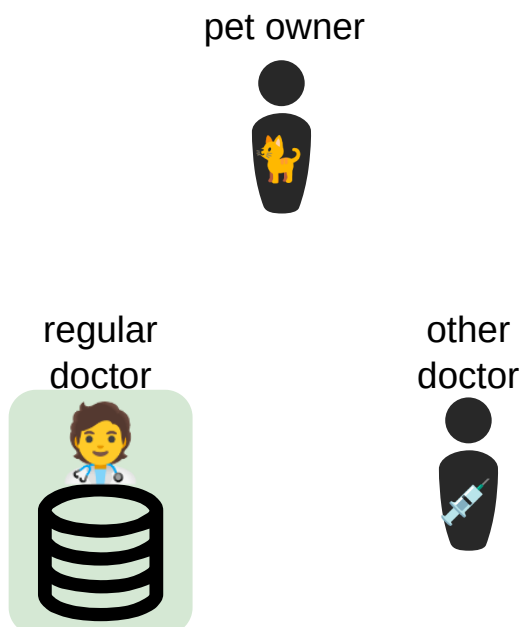
Veterinarian use case

Related Work

Vision

Conclusion

Veterinarian use case



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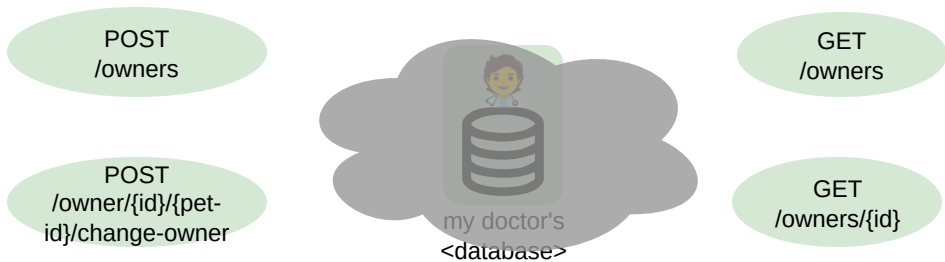
RPC/ Syntactic descriptions fail to describe relationships

- WADL
- OpenAPI/ Swagger
- AsyncAPI

Can be used as documentation and to generate skeleton of client side code.



MCP introduces ambiguity

Standard for connecting AI applications to external systems

Builds on JSON-RPC spec

Example interface description:


```
{
  "jsonrpc": "2.0",
  "id": 2,
  "result": {
    "tools": [
      {
        "name": "get_owner_and_pets",
        "title": "Owner Information",
        "description": "Retrieves all information about an owner and their pets registered with 'heathy pet co.'",
        "inputSchema": {
          "type": "object",
          "properties": {
            "id": {
              "type": "string",
              "description": "The systems uuid-v4 used to represent the owner as registered in the system"
            }
          },
          "required": ["id"]
        }
      },
    ]
  }
} (docs)
```

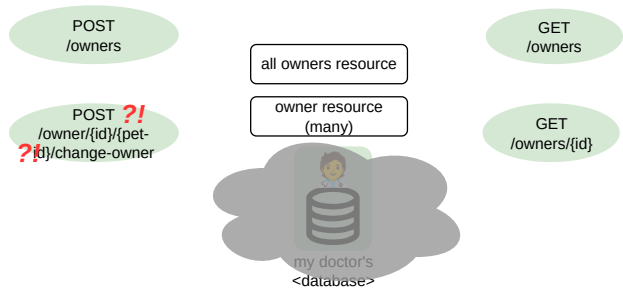
Model Context Protocol

Semantic Web Descriptions cannot model underlying resources

Hydra, OWL-S, RESTdesc

Model RESTful interactions well
(GET, PUT, PATCH, DELETE, POST)

Do not model underlying resources



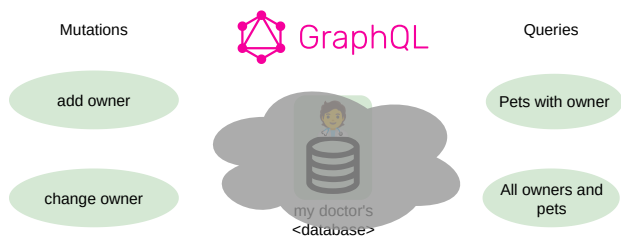
Query-Based interfaces can be cost heavy, inherently symmetrical, or resemble RPC

SPARQL endpoint, GraphQL

SPARQL endpoint only models 1 resource, the data

GraphQL functions describes like RPC

Both tie into an 'expensive' execution environment



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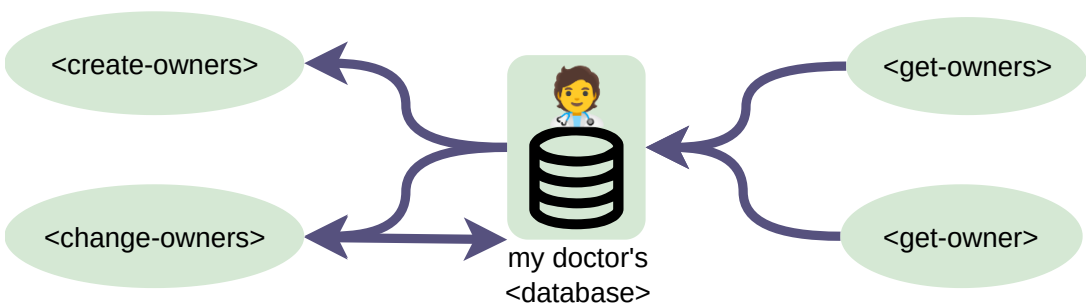
Goals

1. Execution environment independent
2. Models intermediate resources (asymmetric interfaces)
3. Deterministic description of relationship between resources
4. Standing on the shoulders of giants

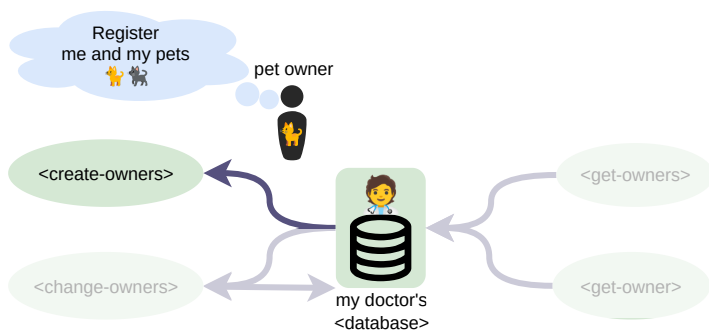


Algebraic Descriptions over RDF data

Get Interface Description, discover `<create-owner>` with:

1. **Interaction method**: `POST` to `/owners`
2. **Resource representation**: `Turtle`
3. **Expected data shape**: `SPARQL ASK`
4. **Consequence of success**: `SPARQL update` on `<database>`

```
INSERT {
    GRAPH <database> {
        ?ownerBound a ex:owner ;
            ex:name ?name ; ex:pet ?petBound .
        ?petBound a ex:pet ;
            ex:name ?petName ; ex:age ?age .
    }
} WHERE {
    ?resource ex:name ?name ;
    BIND( UUID() AS ?ownerUuid ) .
    ?resource ex:pet ?pet .
    BIND( UUID() AS ?petUuid ).
    ?pet ex:name ?petName ;
        ex:age ?age ;
    BIND( URI(CONCAT(ex:owners, '/', ?ownerUuid)) AS ?ownerBound ) .
    BIND( URI(CONCAT(?ownerBound, '/', ?petUuid)) AS ?petBound ) .
}
```



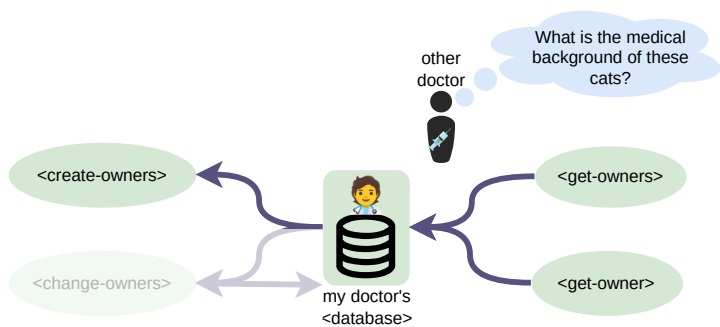
Derivation over an underlying resource

Get Interface Description, discover `<get-owners>` and `<get-owner>` with:

1. Interaction method: `GET` to `/owners` and `GET` to `/owner/{id}`
2. Resource representation: `Turtle`
3. No expected data, but consequence of success a `SPARQL CONSTRUCT`

```
CONSTRUCT { [] ex:item ?owner . } WHERE {
    GRAPH <database> {
        ?owner a ex:owner .
    }
}

CONSTRUCT {
    ?id a ex:owner ;
        ?ownerP ?ownerO ;
    ?ownerO ?petP ?petO ;
} WHERE {
    GRAPH <database> {
        ?id a ex:owner ;
            ?ownerP ?ownerO ;
        OPTIONAL { ?ownerO ?petP ?petO . }
    }
}
```

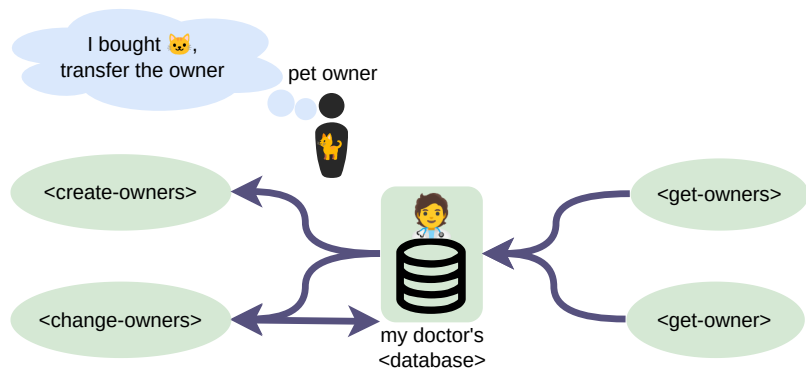


Beyond REST: consistency boundary

Get Interface Description, discover `<change-owner>` using interaction method:

`POST` to `/change-owners/{id}/{pet-id}`

```
DELETE {
    GRAPH <database> {
        ?origOwner ex:pet ?orig-pet .
        ?origPet a ex:pet ;
            ex:age ?age ;
            ex:name ?name .
    }
} INSERT {
    GRAPH <database> {
        ?newOwner ex:pet ?movedIri .
        ?movedIri a ex:pet ;
            ex:age ?age
            ex:name ?name
    }
} WHERE {
    # From received data:
    ?o ex:new-owner ?newOwner .
    BIND( URI( CONCAT(ex:owners, '/', ?id) ) AS ?origOwner ) .
    BIND( URI( CONCAT(?origOwner, '/', ?petId) ) AS ?origPet ) .
    BIND( URI( CONCAT(?newOwner, '/', ?petId) ) AS ?movedIri ) .
    # Go look in the current state of the database for whether the owner and pet exist.
    GRAPH <database> {
        ?origOwner ex:pet ?origPet .
        ?origPet a ex:pet ;
            ex:age ?age ;
            ex:name ?name .
        ?newOwner a ex:owner ;
    }
}
```

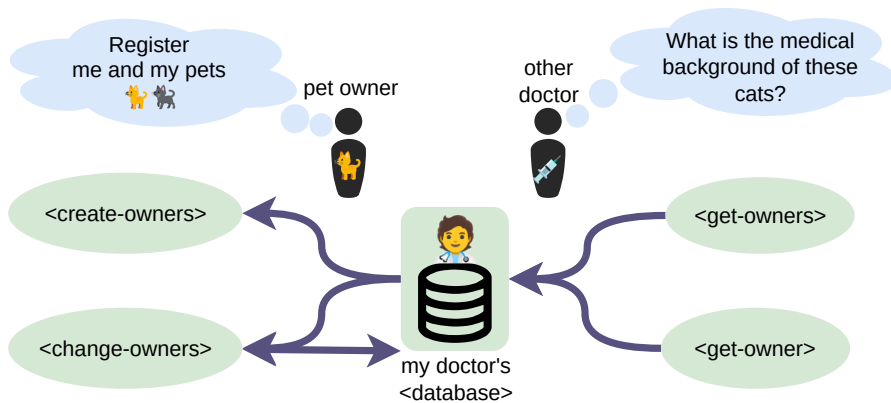


Conclusion

1. Endpoint discovery
2. Infer downstream effect of modifications
3. Using existing query writing skills

Future work

1. Formalization
2. Fine-grained, policy aware semantics
3. Proof of Concept



Additional

Related Issues

By explicitly describing the algebraic mappings, you enter the database realm:

1. View selection (what to materialize)
2. Schema transformation/ migration (when original resource is not accessible)
3. Query rewriting using materialized views

   (targeting some resource, can you rewrite using views)
4. The View Update Problem (when you target non-materialized resources)
5. Incremental view maintenance (can be interesting for large views)
6. New stuff too: what endpoints to call and how, given an update