Semantics and Complexity of SPARQL

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Chilean Center for Semantic Web Research

ISWC 2016

SPARQL

SPARQL

Simple

SPARQL

Simple **P**rotocol

SPARQL

Simple **P**rotocol **A**nd **R**DF

SPARQL

Simple **P**rotocol **A**nd **R**DF **Q**uery **L**anguage

But things became more complex...

```
SELECT ?x ?y
WHERE
  { ?x :a ?y .
    ?x :b ?z .
    ?z :d :p }
```

But things became more complex...

- Grouping

```
SELECT ?x ?y
WHERE
{ { ?x :a ?y .
    ?x :b ?z .
    ?z :d :p }


  { ?x :d ?y .
    ?y :a ?v }


}
```

But things became more complex...

- Grouping
- Optional parts

```
SELECT ?x ?y
WHERE
{ { ?x :a ?y .
    ?x :b ?z .
    ?z :d :p
    OPTIONAL { ?y :c ?u }}

  { ?x :d ?y .
    ?y :a ?v
    OPTIONAL { ?y :e ?w } }

}
```

But things became more complex...

- Grouping
- Optional parts
- Nesting

```
SELECT ?x ?y
WHERE
{ { ?x :a ?y .
    ?x :b ?z .
    ?z :d :p
    OPTIONAL { ?y :c ?u }}

  { ?x :d ?y .
    ?y :a ?v
    OPTIONAL { ?y :e ?w
      OPTIONAL { ?y :a ?z }}}
}
```

But things became more complex...

- Grouping
- Optional parts
- Nesting
- Union of patterns

```
SELECT ?x ?y
WHERE
{ { ?x :a ?y .
    ?x :b ?z .
    ?z :d :p
    OPTIONAL { ?y :c ?u }}

  { ?x :d ?y .
    ?y :a ?v
    OPTIONAL { ?y :e ?w
      OPTIONAL { ?y :a ?z }}}
}
UNION
{ ?x :d ?y }
```

But things became more complex...

- Grouping
- Optional parts
- Nesting
- Union of patterns
- Filtering
- ...

```
SELECT ?x ?y
WHERE
{ { ?x :a ?y .
    ?x :b ?z .
    ?z :d :p
    OPTIONAL { ?y :c ?u }}

  { ?x :d ?y .
    ?y :a ?v
    OPTIONAL { ?y :e ?w
      OPTIONAL { ?y :a ?z }}}
}
UNION
{ ?x :d ?y
  FILTER ( ?x > 10 ) }
```

SPARQL

Simple **P**rotocol **A**nd **R**DF **Q**uery **L**anguage

SPARQL

S~~imple~~ **P**rotocol **A**nd **R**DF **Q**uery **L**anguage

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SPARQL

SPARQL

S̶i̶m̶p̶l̶e̶ **P**rotocol **A**nd **R**DF **Q**uery **L**anguage
SPARQL

What is the *meaning* of a general SPARQL query?

Semantics and Complexity of SPARQL at ISWC 2006

Main contribution:

- ▶ formal and clean semantics for SPARQL

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- ▶ formal and clean semantics for SPARQL

Technical contributions:

- ▶ complexity bounds (SPARQL is PSPACE complete)
- ▶ normal forms and optimization procedures
- ▶ well-designed SPARQL patterns

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Main impact in practice:

- ▶ W3C candidate recommendation for SPARQL (2008) considered our formalization as input

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Main impact in practice:

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Main impact in theory:

- solid database foundations for SPARQL

After 10 years SPARQL is still an active area of research!

ISWC + ESWC SPARQL papers:

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- ▶ 24 papers from 2006 to 2010

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Our paper helped to bring SPARQL research
to a bigger audience of researchers

Practice can be benefited by a *formal approach*

A clean formalization can:

- clarify corner cases
- help in the implementation process
- *simplify* things

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W3C standardization processes can be enriched by good theory

- we shouldn't wait until having a final W3C specification
- formalizations can be very useful in the design process

The one who loves practice without theory is like the sailor who boards ship without a rudder and compass and never knows where he may cast.

Theory without practice cannot survive and dies as quickly as it lives.

Leonardo da Vinci

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