BEKK

SEARCHING NEO4J USING NATURAL LANGUAGE

Oslo Graph Database Meetup
Ole-Martin Mørk
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What can Graph Search do?

Sushi restaurants in Oslo
liked by my friends

Sushi restaurants in **Oslo, Norway** liked by my friends

Ole-Martin | Home

Sushi | Open Now

1 **Alex Sushi** CLOSED
Sushi

2 **Nodee Asian Cooking** OPEN
Sushi

3 **Rå Sushi Majorstuen** OPEN
Sushi

4 **Jonoe**
Japanese

5 **Grand Sushi** OPEN
Restaurant

Oslo
Ring 3
Maridalsveien
Grefsenveien
Voldsløkka Idrettsanlegg
Bjerke Travbane
Ainsjøen
Stansevelen
Furuset
Leirdal
Kjelsrud
Frogner Park
Løren
Økern
Stubberud
Haslevangen
Persveien
Smalvollveien
Alna
Tøyen
Gladengvelen
Lodalen
Operatunnelen
Ryen
Helleruduveien
Lutvann
Filipstad
Palace Park

1 2 4 5 6 7 9 10 11 12 13

```
MATCH
(me {name:“Ole-Martin”})-[:IS_FRIEND_OF]->(friend),
(friend)-[:LIKES]->(restaurant),
(restaurant)-[:LOCATED_IN]->(location {name:“Oslo”}),
(restaurant)-[:SERVES]->(cuisine {name:“Sushi”})

RETURN restaurant
```

WE NEED TO DEFINE A GRAMMAR

Oppslagsord	Ordbokartikkel
neo-	**neo-** (fra gr av *neos* 'ny') ny-, i ord som *neofascisme, neoimpresjonisme, neorealisme*
neodym	**neodym** n1 (av *didym*) treverdig, gulaktig metallisk grunnstoff (kjem symbol *Nd*)
neoklassisisme	**neoklassisisme** m1 musikkretning på 1900-tallet som tar opp førromantiske stilidealer, jf **nyklassisisme*
neolittisk	**neolittisk** a2 (av gr *lithos* 'stein') i arkeologi: som hører til den yngre steinalder
neologi	**neologi** m1 nydannelse

GRAMMAR

A “language” can be formally defined as “any system of formalized symbols, signs, etc. used for communication”

A “grammar” can be defined as a “the set of structural rules that governs sentences, words, etc. in a natural language”

CFG PEG

Alfred, who loved fishing, bought fish at the store downtown

(Alfred, (who loved (fishing)), (bought (fish (at (the store (downtown))))))

```
additionExp
    :    multiplyExp
         ( '+' multiplyExp
         | '-' multiplyExp
         )*
    ;

multiplyExp
    :    atomExp
         ( '*' atomExp
         | '/' atomExp
         )*
    ;

atomExp
    :    Number
    |    '(' additionExp ')'
    ;

Number
    :    ('0'..'9')+
    ;
```

An additionExp is defined as a multiplyExp + or - a multiplyExp

A multiplyExp is defined as an atomExp * or / an atomExp

An atomExp is defined as a number or a parenthesized additionExp

Number is one or more character between 0-9

```
Rule expression() {
    return sequence(
            term(),
            zeroOrMore(anyOf("+-"), term())
    );
}

Rule term() {
    return sequence(
            factor(),
            zeroOrMore(anyOf("*/"), factor())
    );
}

Rule factor() {
    return firstOf(
            number(),
            sequence('(', expression(), ')')
    );
}

Rule number() {
    return oneOrMore(charRange('0', '9'));
}
```

An expression is a sequence of Term followed by zero or more “+” or “-” followed by a Term

Term is a Factor followed by zero or more sequences of “*” or “/” followed by a factor

Factor is a number or a parenthesized expression

Number is a one or more characters between 0-9

Name	CFG	*Parboiled*
Sequence	*a b*	Sequence (a, b)
Ordered Choice	*a / b*	FirstOf (a, b)
Zero-or-more	*a* *	ZeroOrMore (a)
One-or-more	*a* +	OneOrMore (a)
Optional	*a* ?	Optional (a)
And-predicate	& *a*	Test (a)
Not-predicate	! *a*	TestNot (a)

PEG VS CFG

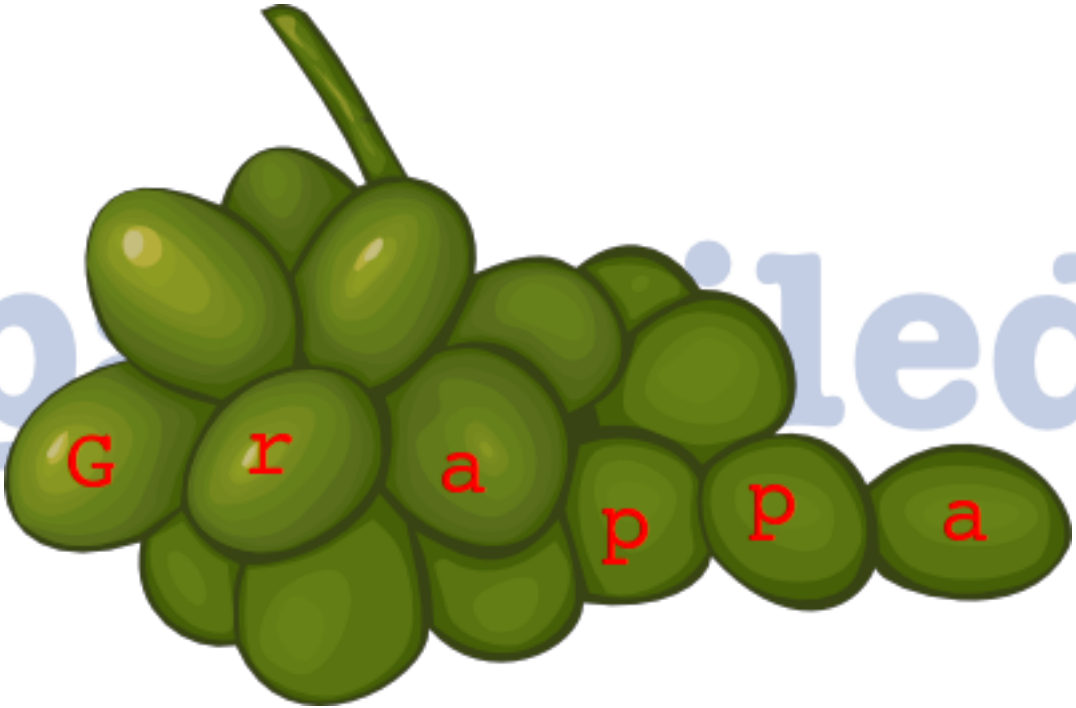
PEGs firstOf operator vs CFG's | operator

PEG does not have a separate tokenizing step

CFG might come across as more powerful, but also more difficult to master

PEG does not allow ambiguity in the grammar

PEG is easier to write, CFG is easier to analyze..?


G
r
a
p
p
a

GRAPPA

Parsing expression grammars parser

Fork of Parboiled

Lightweight

Easy to use

Implementation in Java

Rules are written in Java

Examples

I went for a walk downtown

sequence(“I”, “went”, “for”, “a”, “walk”, “downtown”)

I went / wend for a walk downtown / to the city

```
sequence(
    string(“I”),
    firstOf(“went”, “wend”),
    sequence(“for”, “a”, “walk”),
    firstOf(“downtown”, “to the city”));
```

I went / walked for a walk downtown / to the city *today*

```
sequence(
    …,
    optional(string(“today”)));
```

today I went / walked for a walk downtown / to the city *today*

```
sequence(
    today(),
    ...,
    today());
Rule today() { return optional(String("today")); }
```

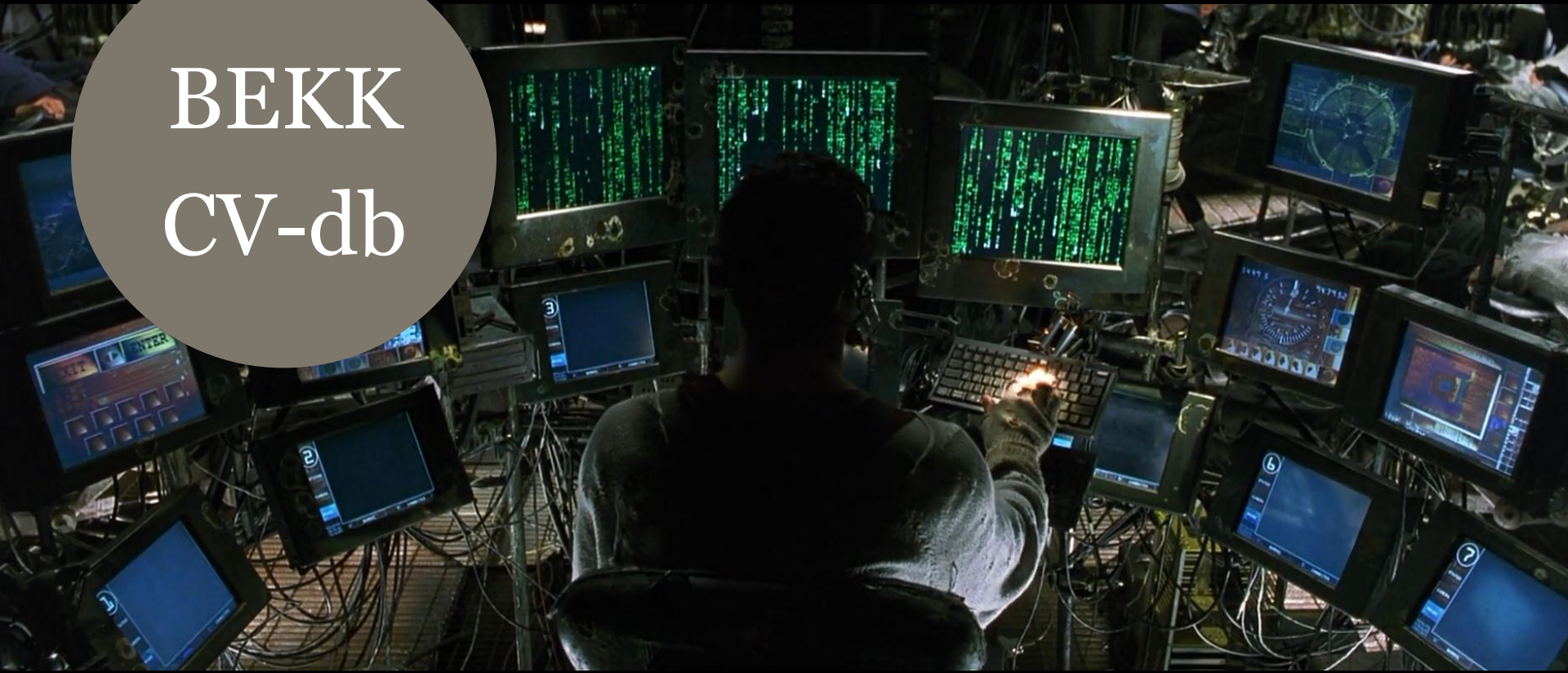
```
public Rule anyOf(String characters)
public Rule noneOf(String characters)
public Rule string(String string)
public Rule ignoreCase(String string)
public Rule firstOf(Object... rules)
public Rule oneOrMore(Object... rules)
public Rule optional(Object rule)
public Rule sequence(Object... rules)
public Rule zeroOrMore(Object rule)
public Rule nTimes(int repetitions, Object rule)

public boolean push(V value)
public V pop()
```

today I went / walked for a walk downtown / to the city *today*

```
sequence(
    …,
    firstOf(
        sequence(push(“downtown”), “downtown”,
        sequence(push(“city”), “to the city”)));
```

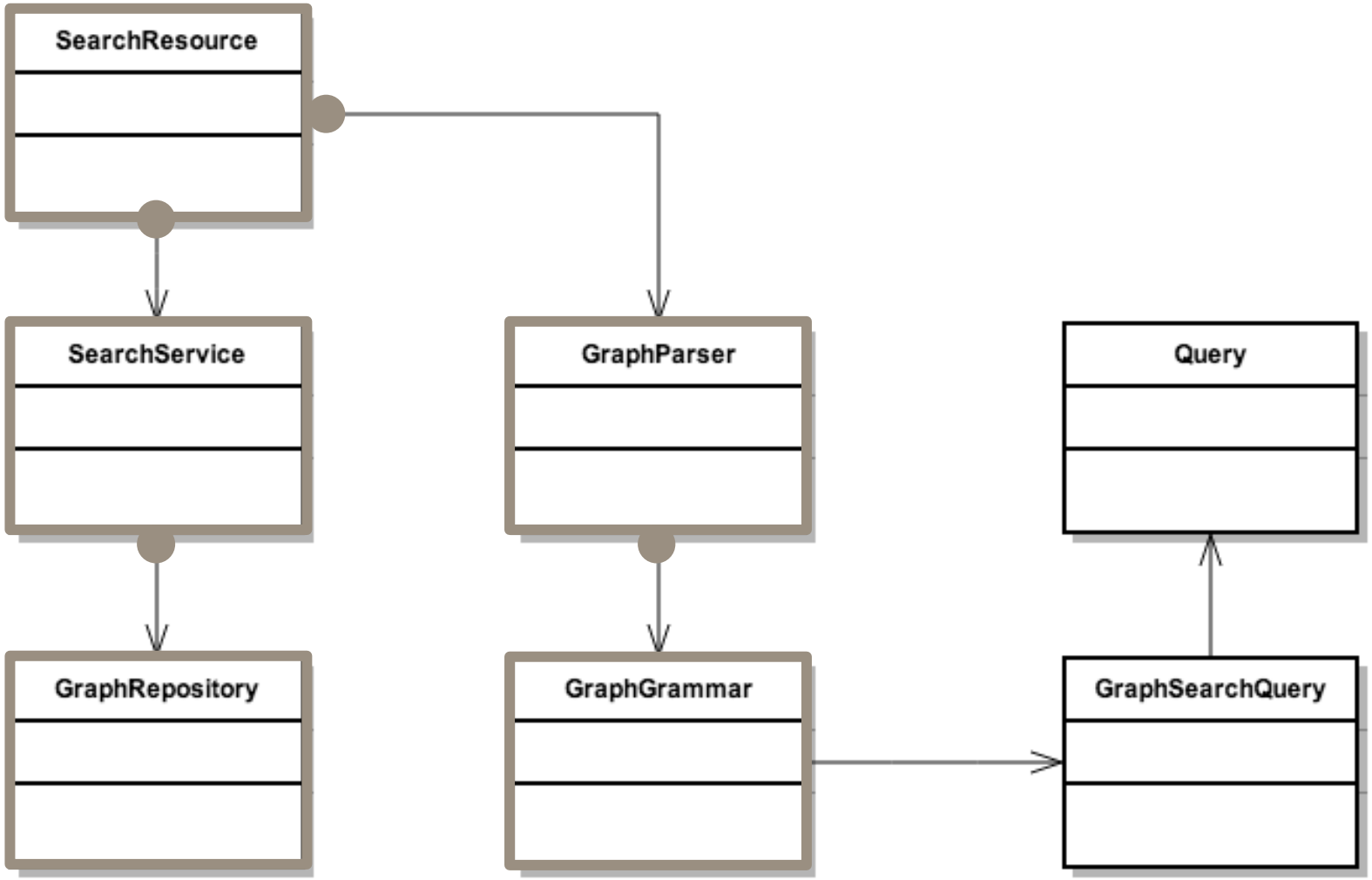
Implementation

BEKK CV-db



```
public Rule expression() {
  return sequence(
      start(),
      firstOf(
          people(), projects(), technologies(ROOT)
      ),
      oneOrMore(
          firstOf(
              and(),
              sequence(know(SEARCH), subjects()),
              sequence(workedAt(SEARCH), customers()),
              sequence(know(SEARCH), customers()),
              sequence(know(SEARCH), technologies(MIDDLE)),
              sequence(workedWith(), consultants()),
              know(PARAM),
              workedAt(PARAM))));
}
```

```
[expression] 'Finn prosjekter med Ole-Martin Mørk'
  [firstOf] 'prosjekter '
    [projects] 'prosjekter '
      [projectSequence] 'prosjekter '
        [“prosjekter”] 'prosjekter'
        [whiteSpace] ' '
  [oneOrMore] 'med Ole-Martin Mørk'
    [firstOf] 'med Ole-Martin Mørk'
      [sequence] 'med Ole-Martin Mørk'
        [“med”] 'med'
        [whiteSpace] ' '
        [consultants] 'Ole-Martin Mørk'
          ["Ole-Martin Mørk”] 'Ole-Martin Mørk'
          [whiteSpace]
```


SearchResource
SearchService
GraphParser
Query
GraphRepository
GraphGrammar
GraphSearchQuery

Demo

THANK YOU!

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Ole-Martin Mørk