Estimation (theoretical and experimental) of the computational complexity of a query execution to a multilevel TN model relative to a one-level model.

Request #1 – Select node using the identifier

Request #2 – Select of related elements (obtaining elements taking into account the hierarchy)

Request #3 – Select of related items using a filter

Request #4 – Select of related items with filtering and grouping

Request #5 – Substring search

Number of KG nodes	Model type	Model parameters		Number of KG triples	Time of RDF/XML data loading	Request #1 Execution time (mean/mean-square deviation), ms.	Request #2 Execution time (mean/mean-square deviation), ms.	Request #3 Execution time (mean/mean-square deviation), ms.	Request #4 Execution time (mean/mean-square deviation), ms.	Request #5 Execution time (mean/mean-square deviation), ms.
		Number of levels	Source models linked levels							
100к	One-level model			302к	4,0sec	187 / 5	204 / 3	510 / 30	478 / 8	452 / 4
	Hierarchical model	3 levels	3-3	219k	3,48sec.	72 / 4	76 / 4	94 / 5	92 / 3	94 / 5
			2-2	219k	2,37sec.	75 / 2	83 / 3	121 / 11	106 / 3	110 / 6
		4 levels	2-2	219k	3,01sec	79 / 3	106 / 4	141 / 13	117 / 3	126 / 6
		5 levels	2-2	219k	2,92sec	103 /10	115 / 3	152 / 9	139 / 3	137 / 3
5M	One-level model			15,0M	184,8sec	209 / 2	1311 / 25	23 360 / 292	24 452 / 379	21 670 / 187
	Hierarchical model	3 levels	3-3	10,0M	125,5sec	80 / 3	724 / 39	627 / 33	154 / 13	1 075 / 74
			2-2	10,0M	128,1sec	81 / 2	730 / 60	636 / 27	165 / 6	1 138 / 45
		4 levels	2-2	10,0M	117,4sec	81 / 2	739 / 34	714 / 40	192 / 5	1 205 / 83
		5 levels	2-2	10,0M	132,2sec	131 / 1	745 / 27	730 / 65	202 / 5	1 360 / 120
15M	One-level model			45,0M	852,8sec	520 / 15	3 336 / 94	87 594 / 824	88 525 / 1251	88 525 / 1058
	Hierarchical model	3 levels	3-3	30,0M	455,5sec	84 / 4	2 936 / 143	2 573 / 323	158 / 5	5 215 / 266
			2-2	30,0M	514,4sec	84 / 3	3 090 / 44	2 532 / 128	158 / 8	5 669 / 211
		4 levels	2-2	30,0M	457,5sec	86 / 4	3 413 / 268	2 611 / 167	154 / 8	5 857 / 516
		5 levels	2-2	30,0M	395,9sec	133 / 3	3 574 / 233	2 700 / 78	218 / 8	5 920 / 1041

The parameters of the experiment

The two models are linked:

Model #1		Model #2	
Level 1	1 node	Level 1	1 node
Level 2	1000 nodes	Level 2	1000 nodes
Level 3	1000 nodes	Level 3	1000 nodes
Level 4	1000 nodes	Level 4	1000 nodes
Level 5	1000 nodes	Level 5	1000 nodes
Objects number	100к – 15M	Options number	1000

The graph structure from Level 1 to Level 5 is tree. The objects and options are linked to levels 2-3 according to the experiment conditions.

Every SPARQL request is executed 10 times and average time and deviation values are taken as result. To avoid SPARQL requests answers caching, the particular literals values were changed for per request.

Requests

One-level model

Request #1	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_id "Object_10000"
	}

Request #2	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_option_id "Option_10" .
	}

Request #3	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_option_id ?Option_id .
	FILTER (?Option_id = "Option_9" || ?Option_id = "Option_10")
	}

Request #4	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT (count(distinct ?Object) as ?count) WHERE

	{
	?Object my:has_option_id ?Option_id .
	FILTER (?Option_id = "Option_9" || ?Option_id = "Option_10")
	}
	GROUP BY ?Option_id

Request #5	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_option_id ?Option_id .
	FILTER contains(?Option_id, "_200")
	}

3-level model, the source connected levels: 3-3

Request #1	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_id "Object_10000"
	}

Request #2	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id "Option_10" . ?Option my:has_parent_id ?Core_2_Level_3 . ?Core_1_Level_3 my:linked_to ?Core_2_Level_3 .

	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Object my:has_parent_id ?Core_1_Level_3_id . } LIMIT 10000000

Request #3	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_3 .
	?Core_1_Level_3 my:linked_to ?Core_2_Level_3 .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Object my:has_parent_id ?Core_1_Level_3_id .
	FILTER (?Option_id = "Option_9" || ?Option_id = "Option_10")
	}
	LIMIT 10000000

Request #4	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT (count(distinct ?Object) as ?count)
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_3 .
	?Core_1_Level_3 my:linked_to ?Core_2_Level_3 .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Object my:has_parent_id ?Core_1_Level_3_id .
	FILTER (?Option_id = "Option_9" || ?Option_id = "Option_10")
	}
	GROUP BY ?Option_id

Request #5	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#>

	SELECT ?Object
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_3 .
	?Core_1_Level_3 my:linked_to ?Core_2_Level_3 .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Object my:has_parent_id ?Core_1_Level_3_id .
	FILTER contains(?Option_id, "_20")
	}
	LIMIT 10000000

3-level model, the source connected levels: 2-2

Request #1	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_id "Object_10000"
	}

Request #2	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id "Option_11" . ?Option my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id .

	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Object my:has_parent_id ?Core_1_Level_3_id . } LIMIT 10000000

Request #3	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id .
	?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id .
	?Core_1_Level_2 my:has_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Object my:has_parent_id ?Core_1_Level_3_id .
	FILTER (?Option_id = "Option_8" || ?Option_id = "Option_11")
	}
	LIMIT 10000000

Request #4	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT (count(distinct ?Object) as ?count) WHERE { ?Option my:has_id ?Option_id . ?Option my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .

	?Object my:has_parent_id ?Core_1_Level_3_id . FILTER (?Option_id = "Option_8" || ?Option_id = "Option_11") } GROUP BY ?Option_id

Request #5	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id .
	?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id .
	?Core_1_Level_2 my:has_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Object my:has_parent_id ?Core_1_Level_3_id .
	FILTER contains(?Option_id, "_20")
	}
	LIMIT 10000000

4-level model, the source connected levels: 2-2

Request #1	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_id "Object_10000"
	}

Request #2	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>

	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Option my:has_id "Option_913" .
	?Option my:has_parent_id ?Core_2_Level_4_id .
	?Core_2_Level_4 my:has_id ?Core_2_Level_4_id .
	?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id .
	?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id .
	?Core_1_Level_2 my:has_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id .
	?Core_1_Level_4 my:has_id ?Core_1_Level_4_id .
	?Object my:has_parent_id ?Core_1_Level_4_id .
	}
	LIMIT 10000000

Request #3	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id ?Option_id . ?Option my:has_parent_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id .

	?Core_1_Level_4 my:has_id ?Core_1_Level_4_id . ?Object my:has_parent_id ?Core_1_Level_4_id . FILTER (?Option_id = "Option_913" || ?Option_id = "Option_10") } LIMIT 10000000

Request #4	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT (count(distinct ?Object) as ?count)
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_4_id .
	?Core_2_Level_4 my:has_id ?Core_2_Level_4_id .
	?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id .
	?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id .
	?Core_1_Level_2 my:has_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id .
	?Core_1_Level_4 my:has_id ?Core_1_Level_4_id .
	?Object my:has_parent_id ?Core_1_Level_4_id .
	FILTER (?Option_id = "Option_913" || ?Option_id = "Option_10")
	}
	GROUP BY ?Option_id

Request #5	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id ?Option_id . ?Option my:has_parent_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_id ?Core_2_Level_4_id .

	?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_id ?Core_1_Level_4_id . ?Object my:has_parent_id ?Core_1_Level_4_id . FILTER contains(?Option_id, "_20") } LIMIT 10000000

5-level model, the source connected levels: 2-2

Request #1	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT ?Object
	WHERE
	{
	?Object my:has_id "Object_10000"
	}

Request #2	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id "Option_913" . ?Option my:has_parent_id ?Core_2_Level_5_id . ?Core_2_Level_5 my:has_id ?Core_2_Level_5_id . ?Core_2_Level_5 my:has_parent_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_id ?Core_2_Level_4_id .

	?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_id ?Core_1_Level_4_id . ?Core_1_Level_5 my:has_parent_id ?Core_1_Level_4_id . ?Core_1_Level_5 my:has_id ?Core_1_Level_5_id . ?Object my:has_parent_id ?Core_1_Level_5_id . } LIMIT 10000000
Request #3	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id ?Option_id . ?Option my:has_parent_id ?Core_2_Level_5_id . ?Core_2_Level_5 my:has_id ?Core_2_Level_5_id . ?Core_2_Level_5 my:has_parent_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_id ?Core_1_Level_4_id . ?Core_1_Level_5 my:has_parent_id ?Core_1_Level_4_id . ?Core_1_Level_5 my:has_id ?Core_1_Level_5_id . ?Object my:has_parent_id ?Core_1_Level_5_id .

	FILTER (?Option_id = "Option_913" || ?Option_id = "Option_10") } LIMIT 10000000

Request #4	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
	PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
	PREFIX xsd: <http://www.w3.org/2001/XMLSchema>
	PREFIX my: <http://127.0.0.1/bg/ont/test1#>
	SELECT (count(distinct ?Object) as ?count)
	WHERE
	{
	?Option my:has_id ?Option_id .
	?Option my:has_parent_id ?Core_2_Level_5_id .
	?Core_2_Level_5 my:has_id ?Core_2_Level_5_id .
	?Core_2_Level_5 my:has_parent_id ?Core_2_Level_4_id .
	?Core_2_Level_4 my:has_id ?Core_2_Level_4_id .
	?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_id ?Core_2_Level_3_id .
	?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id .
	?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id .
	?Core_1_Level_2 my:has_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id .
	?Core_1_Level_3 my:has_id ?Core_1_Level_3_id .
	?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id .
	?Core_1_Level_4 my:has_id ?Core_1_Level_4_id .
	?Core_1_Level_5 my:has_parent_id ?Core_1_Level_4_id .
	?Core_1_Level_5 my:has_id ?Core_1_Level_5_id .
	?Object my:has_parent_id ?Core_1_Level_5_id .
	FILTER (?Option_id = "Option_913" || ?Option_id = "Option_10")
	}
	GROUP BY ?Option_id

Request #5	PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema> PREFIX my: <http://127.0.0.1/bg/ont/test1#> SELECT ?Object WHERE { ?Option my:has_id ?Option_id .

	?Option my:has_parent_id ?Core_2_Level_5_id . ?Core_2_Level_5 my:has_id ?Core_2_Level_5_id . ?Core_2_Level_5 my:has_parent_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_id ?Core_2_Level_4_id . ?Core_2_Level_4 my:has_parent_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_id ?Core_2_Level_3_id . ?Core_2_Level_3 my:has_parent_id ?Core_2_Level_2_id . ?Core_1_Level_2 my:linked_to ?Core_2_Level_2_id . ?Core_1_Level_2 my:has_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_parent_id ?Core_1_Level_2_id . ?Core_1_Level_3 my:has_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_parent_id ?Core_1_Level_3_id . ?Core_1_Level_4 my:has_id ?Core_1_Level_4_id . ?Core_1_Level_5 my:has_parent_id ?Core_1_Level_4_id . ?Core_1_Level_5 my:has_id ?Core_1_Level_5_id . ?Object my:has_parent_id ?Core_1_Level_5_id . FILTER contains(?Option_id, "_20") } LIMIT 10000000

Detailed results

Number of KG nodes	Model type	Model parameters		Number of KG triples	Time of RDF/XML data loading	Request #1 Execution time,ms	Request #2 Execution time,ms	Request #3 Execution time,ms	Request #4 Execution time,ms	Request #5 Execution time,ms
		Number of levels	Source models linked levels							
100к	One-level model		RDF DB size 200Mb	302к	4,0sec	204 192 189 199 201 200 187 179 166 149 $\bar{X} = 187$ $\sigma = 5$	208 217 198 178 214 209 199 211 208 202 $\bar{X} = 204$ $\sigma = 3$	783 524 482 537 478 458 470 453 455 459 $\bar{X} = 510$ $\sigma = 30$	503 533 493 464 451 493 471 450 464 456 $\bar{X} = 478$ $\sigma = 8$	482 451 451 451 441 449 438 450 455 453 $\bar{X} = 452$ $\sigma = 4$
	Hierarchical model	3 levels	3-3 RDF DB size 200Mb	219k	3,48sec.	93 75 48 74 63 90 80 65 73 63 $\bar{X} = 72$ $\sigma = 4$	100 86 86 77 77 71 62 64 69 64 $\bar{X} = 76$ $\sigma = 4$	124 114 71 77 95 93 85 99 103 83 $\bar{X} = 94$ $\sigma = 5$	112 85 79 87 110 94 90 90 89 79 $\bar{X} = 92$ $\sigma = 3$	143 87 92 86 88 102 84 88 82 88 $\bar{X} = 94$ $\sigma = 5$
			2-2 RDF DB size 200Mb	219k	2,37sec.	81 76 79 74 66 78 68 83	98 97 73 89 69 94 72 77	202 170 123 98 115 106 108 86	128 98 106 105 100 106 100 95	127 110 100 104 103 100 158 101

						70 77 $\bar{X} = 75$ $\sigma = 2$	81 81 $\bar{X} = 83$ $\sigma = 3$	115 95 $\bar{X} = 121$ $\sigma = 11$	114 110 $\bar{X} = 106$ $\sigma = 3$	100 102 $\bar{X} = 110$ $\sigma = 6$
		4 levels	2-2 RDF DB size 200Mb	219k	3,01sec	89 82 78 83 80 87 83 80 62 66 $\bar{X} = 79$ $\sigma = 3$	132 111 113 97 85 91 110 102 106 110 $\bar{X} = 106$ $\sigma = 4$	248 180 139 134 113 142 114 105 119 116 $\bar{X} = 141$ $\sigma = 13$	132 114 116 98 109 113 124 120 116 131 $\bar{X} = 117$ $\sigma = 3$	178 134 135 125 123 112 119 109 114 111 $\bar{X} = 126$ $\sigma = 6$ 2266
		5 levels	2-2 RDF DB size 200Mb	219k	2,92sec	195 97 86 91 101 98 89 92 92 98 $\bar{X} = 103$ $\sigma = 10$	131 119 127 117 115 103 110 102 115 107 $\bar{X} = 115$ $\sigma = 3$	236 154 150 151 141 132 143 146 124 144 $\bar{X} = 152$ $\sigma = 9$	158 147 145 130 132 128 143 135 131 137 $\bar{X} = 139$ $\sigma = 3$	154 137 133 140 153 125 130 145 128 124 $\bar{X} = 137$ $\sigma = 3$
5M	One-level model		RDF DB size 3,14Gb	15,0M	227,8sec	212 219 209 207 205 202 202 213 211	1322 1287 1104 1348 1299 1321 1378 1287 1389	23301 23527 24432 23839 24036 23628 20968 23931 23653	22504 24990 25564 25840 24259 25983 22977 22927 24539	21495 21480 21189 21566 22640 20824 21490 22498 22498

						205 $\bar{X} = 209$ $\sigma = 2$	1377 $\bar{X} = 1311$ $\sigma = 25$	24281 $\bar{X} = 23560$ $\sigma = 292$	24940 $\bar{X} = 24452$ $\sigma = 379$	21316 $\bar{X} = 21670$ $\sigma = 187$
	Hierarchical model	3 levels	3-3 RDF DB size 3,14Gb	10,0M	125,5sec	91 79 81 89 87 75 80 61 68 84 $\bar{X} = 80$ $\sigma = 3$	867 999 571 692 662 776 745 672 661 597 $\bar{X} = 724$ $\sigma = 39$	861 517 633 731 557 513 637 579 558 689 $\bar{X} = 627$ $\sigma = 33$	273 136 145 151 140 128 131 142 144 150 $\bar{X} = 154$ $\sigma = 13$	1462 1149 1442 1263 1050 965 826 794 914 887 $\bar{X} = 1075$ $\sigma = 74$
			2-2 RDF DB size 3,14Gb	10,0M	128,1sec	88 68 82 89 79 71 82 78 88 83 $\bar{X} = 81$ $\sigma = 2$	1139 959 826 753 724 659 607 575 508 550 $\bar{X} = 730$ $\sigma = 60$	816 596 775 665 594 558 609 599 533 617 $\bar{X} = 636$ $\sigma = 27$	182 161 158 212 166 162 141 155 165 151 $\bar{X} = 165$ $\sigma = 6$	1089 1320 1412 1230 1174 979 1054 1162 1013 953 $\bar{X} = 1138$ $\sigma = 45$
		4 levels	2-2 RDF DB size 3,14Gb	10,0M	117,4sec	76 82 89 90 79 77 71 74 84 92 $\bar{X} = 81$	723 609 586 600 732 818 902 762 892 766 $\bar{X} = 739$	1003 869 713 623 572 676 616 709 598 766 $\bar{X} = 714$	206 196 174 164 215 209 196 182 190 187 $\bar{X} = 192$	1658 1685 1366 1137 1008 1090 996 908 1008 1199 $\bar{X} = 1205$

						$\sigma = 2$	$\sigma = 34$	$\sigma = 40$	$\sigma = 5$	$\sigma = 83$
		5 levels	2-2 RDF DB size 3,14Gb	10,0M	132,2sec	133 124 128 129 137 125 134 126 134 136 $\bar{X} = 131$ $\sigma = 1$	963 796 713 763 735 761 635 712 684 689 $\bar{X} = 745$ $\sigma = 27$	961 654 647 1177 925 618 567 666 567 516 $\bar{X} = 730$ $\sigma = 65$	226 195 199 212 230 191 185 195 199 192 $\bar{X} = 202$ $\sigma = 5$	2015 1510 1363 1138 2049 1393 1042 1182 1007 903 $\bar{X} = 1360$ $\sigma = 120$
15M	One-level model		RDF DB size 9,31Gb	45,0M	852,8sec	570 467 543 512 467 456 569 572 546 577 $\bar{X} = 528$ $\sigma = 15$	3788 3486 3289 3068 3164 2873 2955 3586 3475 3672 $\bar{X} = 3336$ $\sigma = 94$	88657 86728 88129 87712 89002 90964 84992 88830 81278 89645 $\bar{X} = 87594$ $\sigma = 824$	88163 89227 99010 87993 88672 92628 86702 89723 83459 86714 $\bar{X} = 89229$ $\sigma = 1251$	84483 89734 91639 92087 92561 90539 87677 85495 82102 88934 $\bar{X} = 88525$ $\sigma = 1058$
	Hierarchical model	3 levels	3-3 RDF DB size 9,31Gb	30,0M	455,5sec	100 86 85 74 84 62 94 81 77 99 $\bar{X} = 84$ $\sigma = 4$	3347 3784 3198 3030 2666 2512 3025 2765 2047 2987 $\bar{X} = 2936$ $\sigma = 143$	2151 1855 1853 1626 1643 1983 2500 3977 4650 3496 $\bar{X} = 2573$ $\sigma = 323$	192 156 150 142 170 137 153 166 172 144 $\bar{X} = 158$ $\sigma = 5$	4560 3792 5095 6686 5620 5212 4228 5272 6339 5348 $\bar{X} = 5215$ $\sigma = 266$
			2-2	30,0M	514,4sec	92	3083	2046	144	6700

			RDF DB size 9,31Gb			96 79 87 88 73 61 89 90 86 $\bar{X} = 84$ $\sigma = 3$	2999 3192 3285 3097 2984 2898 2891 3186 3287 $\bar{X} = 3090$ $\sigma = 44$	2352 2654 2899 2597 2981 1981 1930 2874 3008 $\bar{X} = 2532$ $\sigma = 128$	169 116 178 187 159 161 124 199 144 $\bar{X} = 158$ $\sigma = 8$	5917 5920 5465 5418 6792 5145 5171 4496 5669 $\bar{X} = 5669$ $\sigma = 211$
		4 levels	2-2 RDF DB size 9,31Gb	30,0M	457,5sec	112 77 88 92 61 82 99 86 78 87 $\bar{X} = 86$ $\sigma = 4$	4396 4762 4361 3856 3522 3031 2827 2683 2396 2301 $\bar{X} = 3413$ $\sigma = 268$	2726 2174 3818 2212 3179 2803 2599 2108 2021 2479 $\bar{X} = 2611$ $\sigma = 167$	193 129 127 169 140 127 192 182 129 152 $\bar{X} = 154$ $\sigma = 8$	9770 7845 5937 5412 5763 5281 5046 4109 5173 4230 $\bar{X} = 5857$ $\sigma = 516$
		5 levels	2-2 RDF DB size 9,31Gb	30,0M	395,9sec	134 131 134 127 154 128 135 123 130 138 $\bar{X} = 133$ $\sigma = 3$	4668 4593 4010 3784 2732 2541 3419 4131 2893 2970 $\bar{X} = 3574$ $\sigma = 233$	3357 2745 2505 2690 2650 2790 2661 2536 2386 2679 $\bar{X} = 2700$ $\sigma = 78$	273 223 242 208 203 202 223 178 231 195 $\bar{X} = 218$ $\sigma = 8$	14677 8389 6630 5204 3849 3172 3133 4538 5350 4259 $\bar{X} = 5920$ $\sigma = 1041$