TOWARDS A SYSTEMATIC BENCHMARKING OF ONTOLOGY-BASED QUERY REWRITING SYSTEMS

José Mora and Óscar Corcho

{jmora, ocorcho}@fi.upm.es

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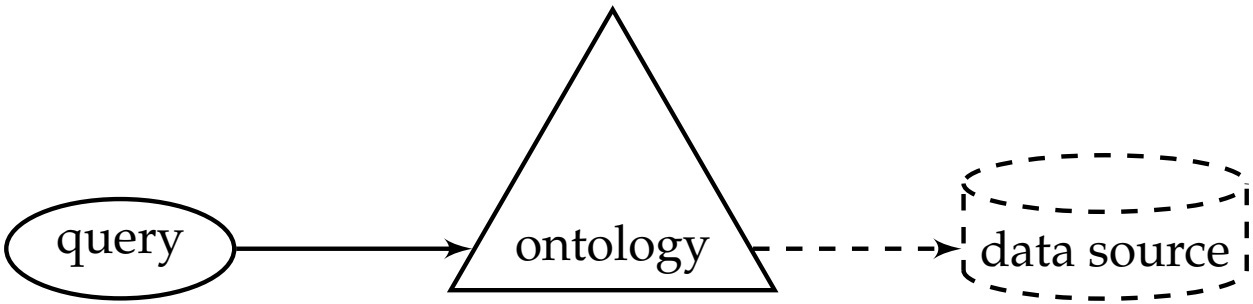
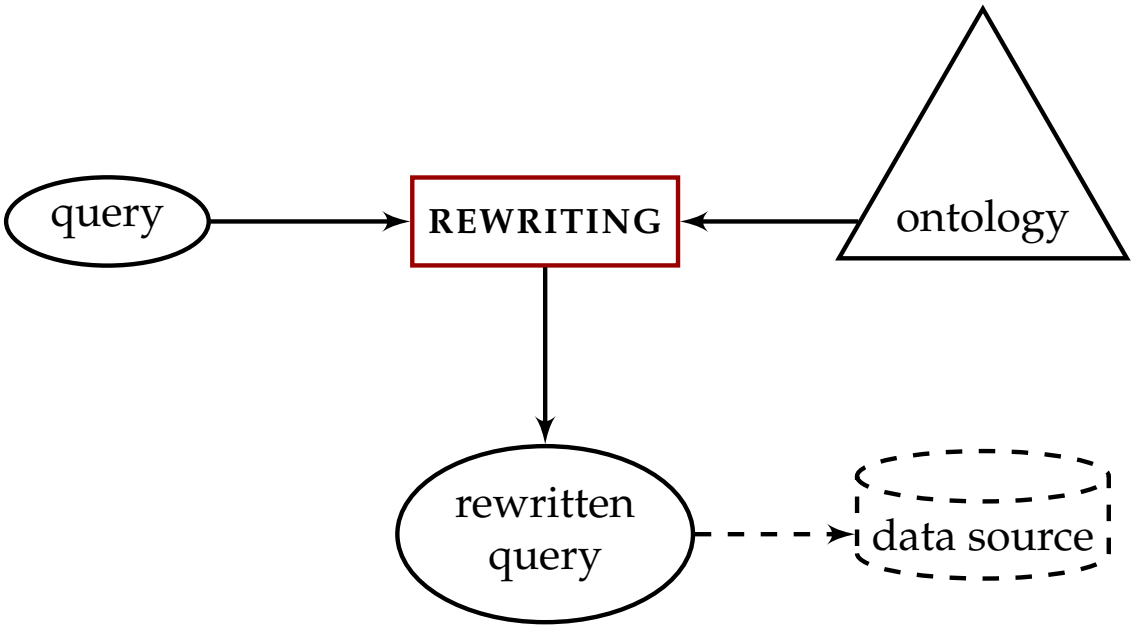
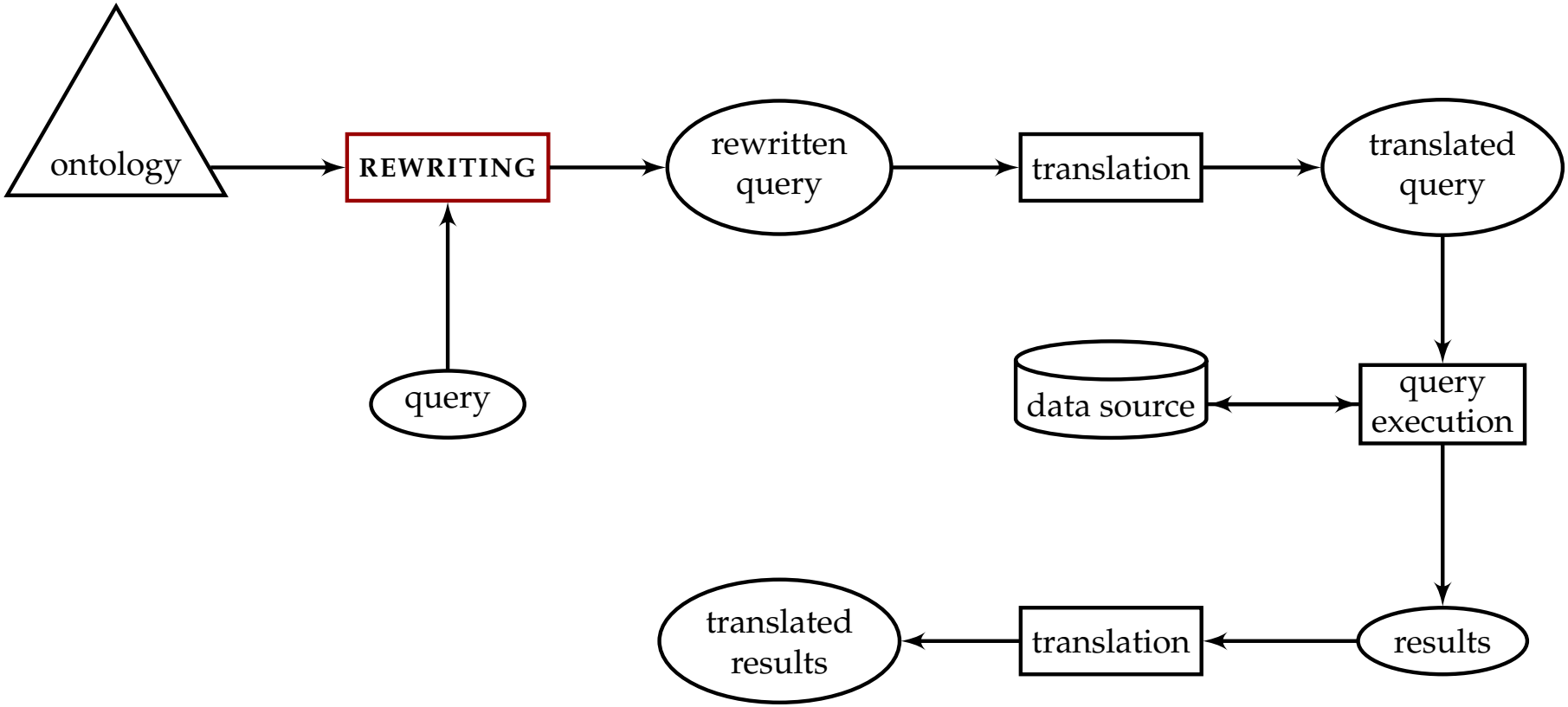
IDEA



Approach



CONTEXT


ontology
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rewritten query
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translated query
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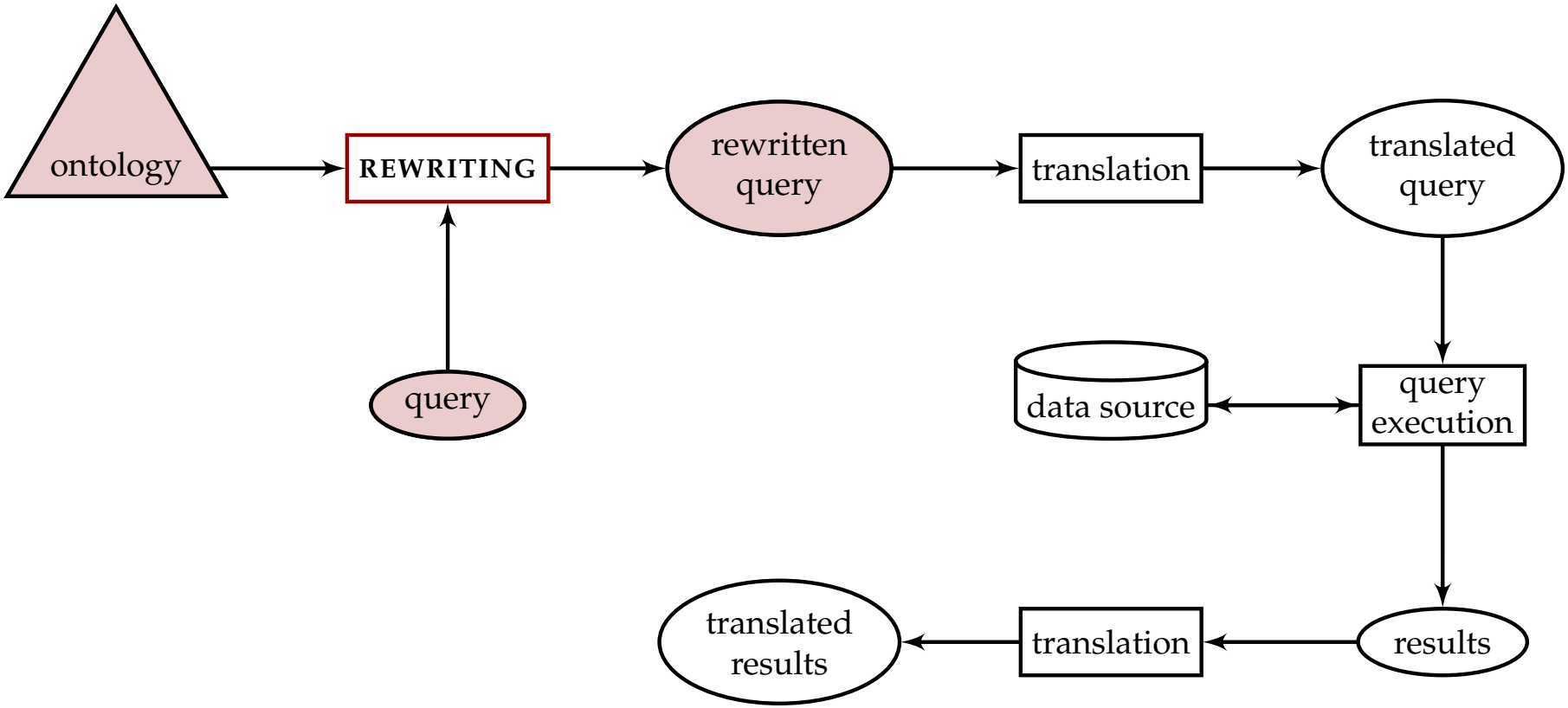
CONTEXT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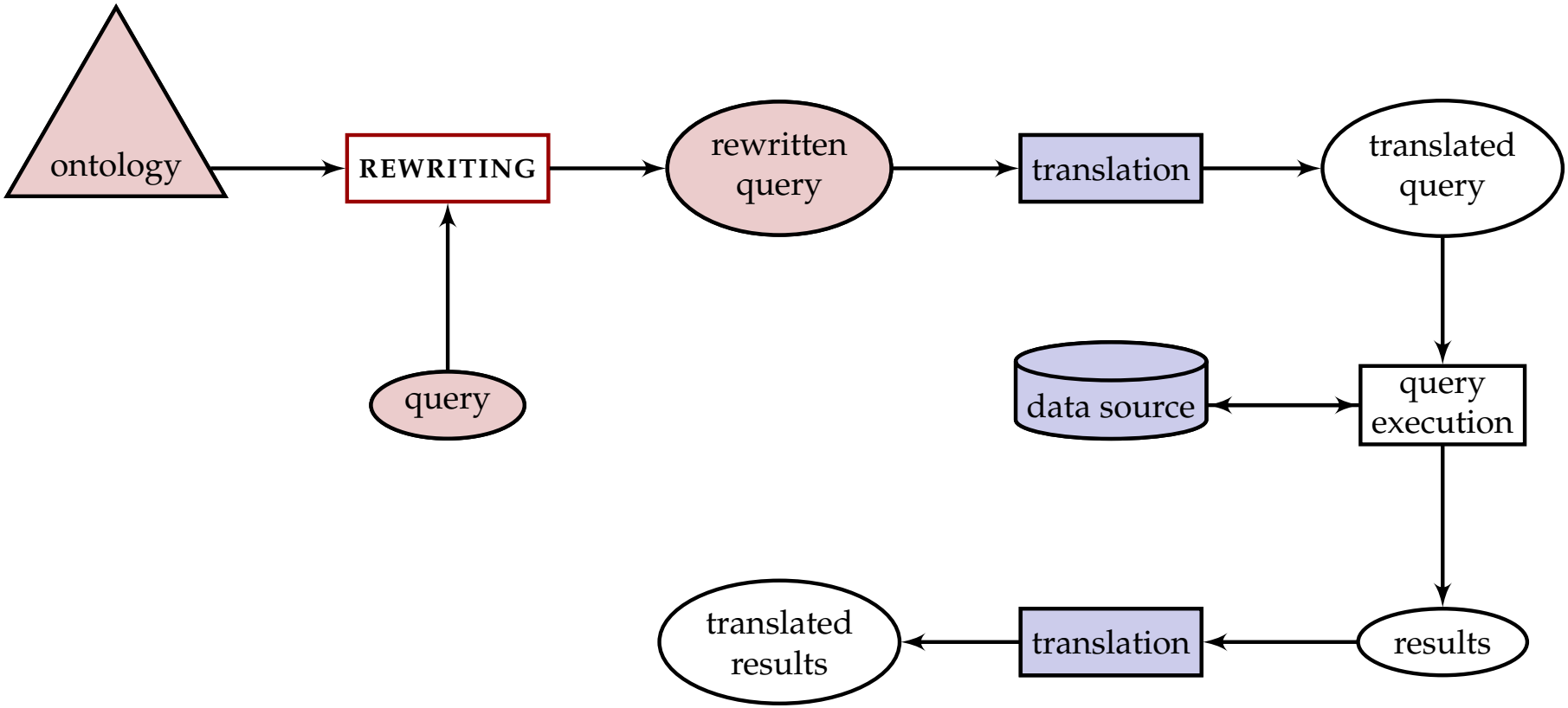
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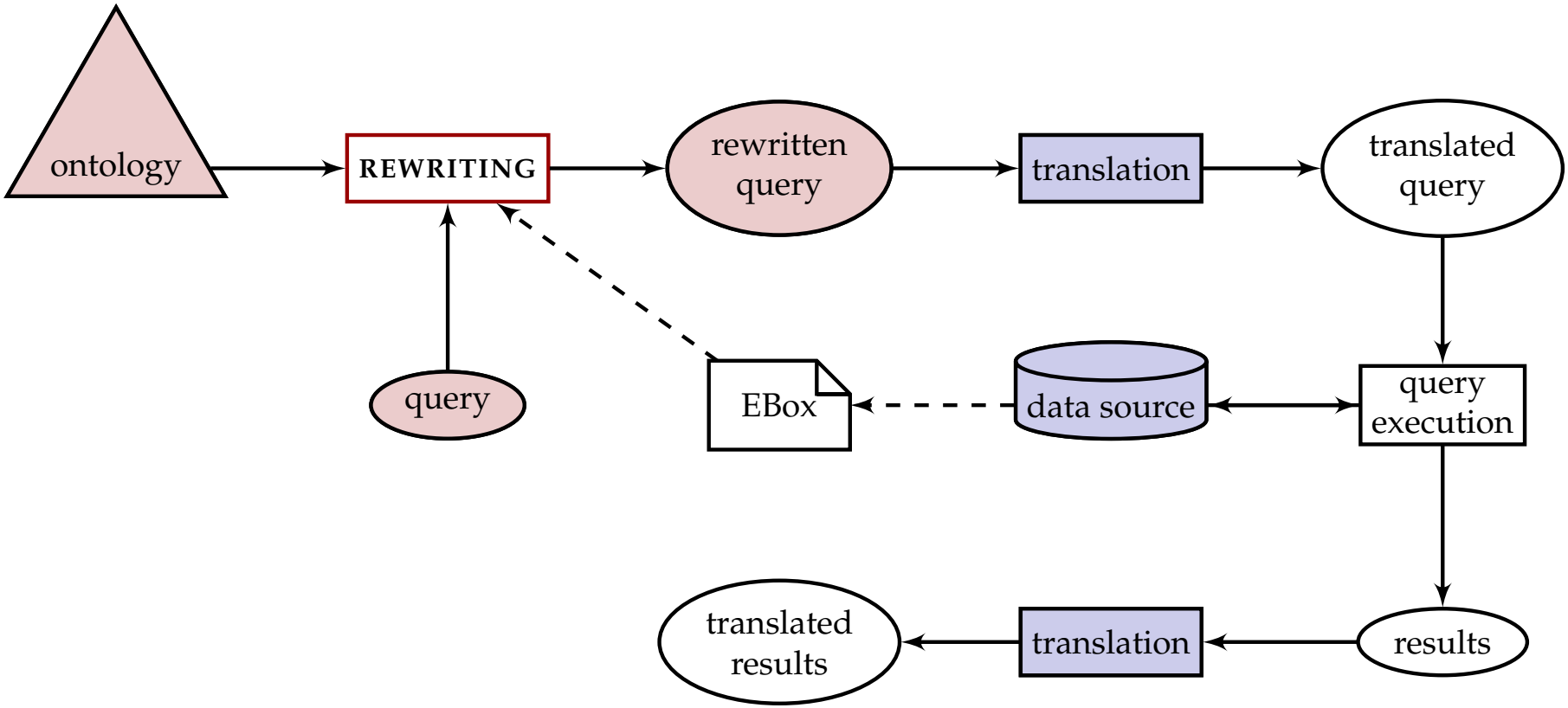
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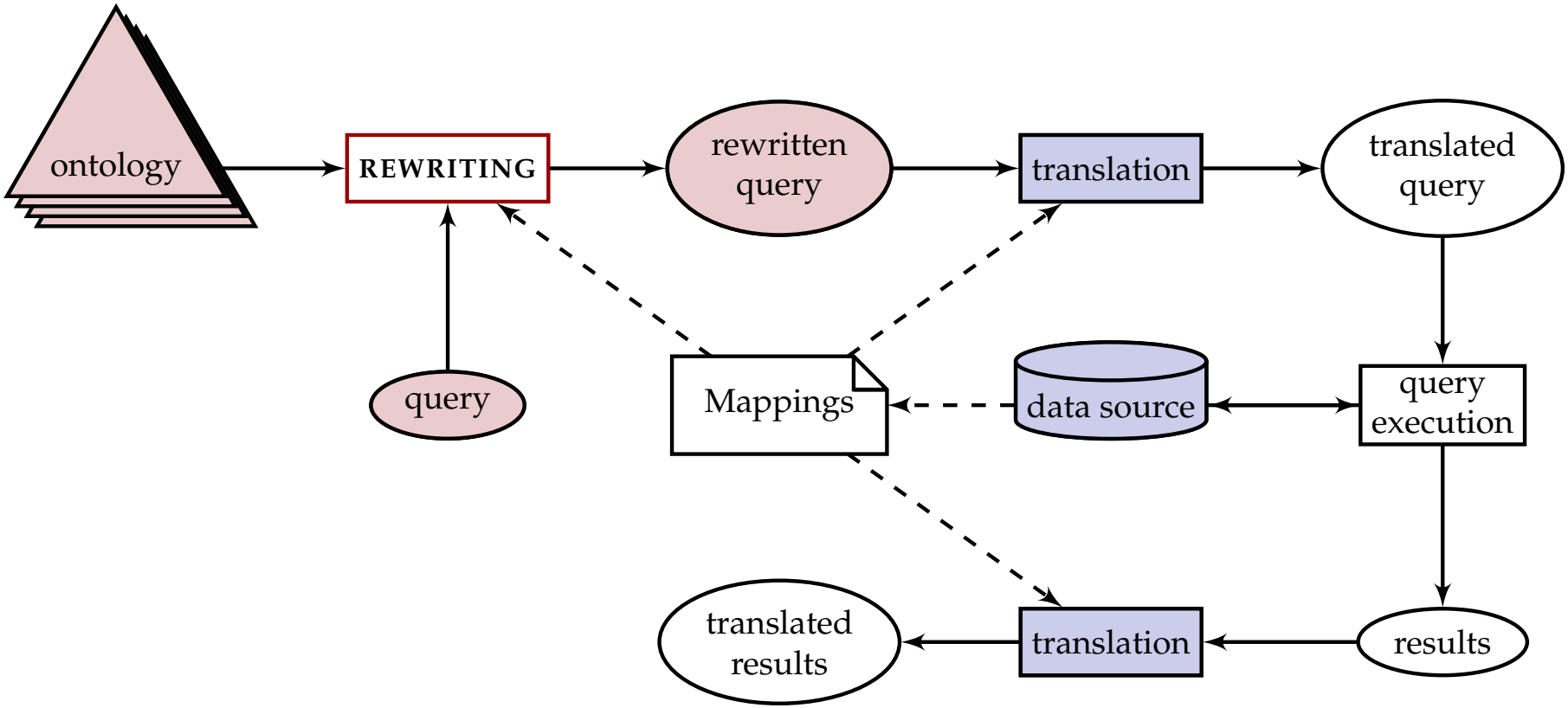
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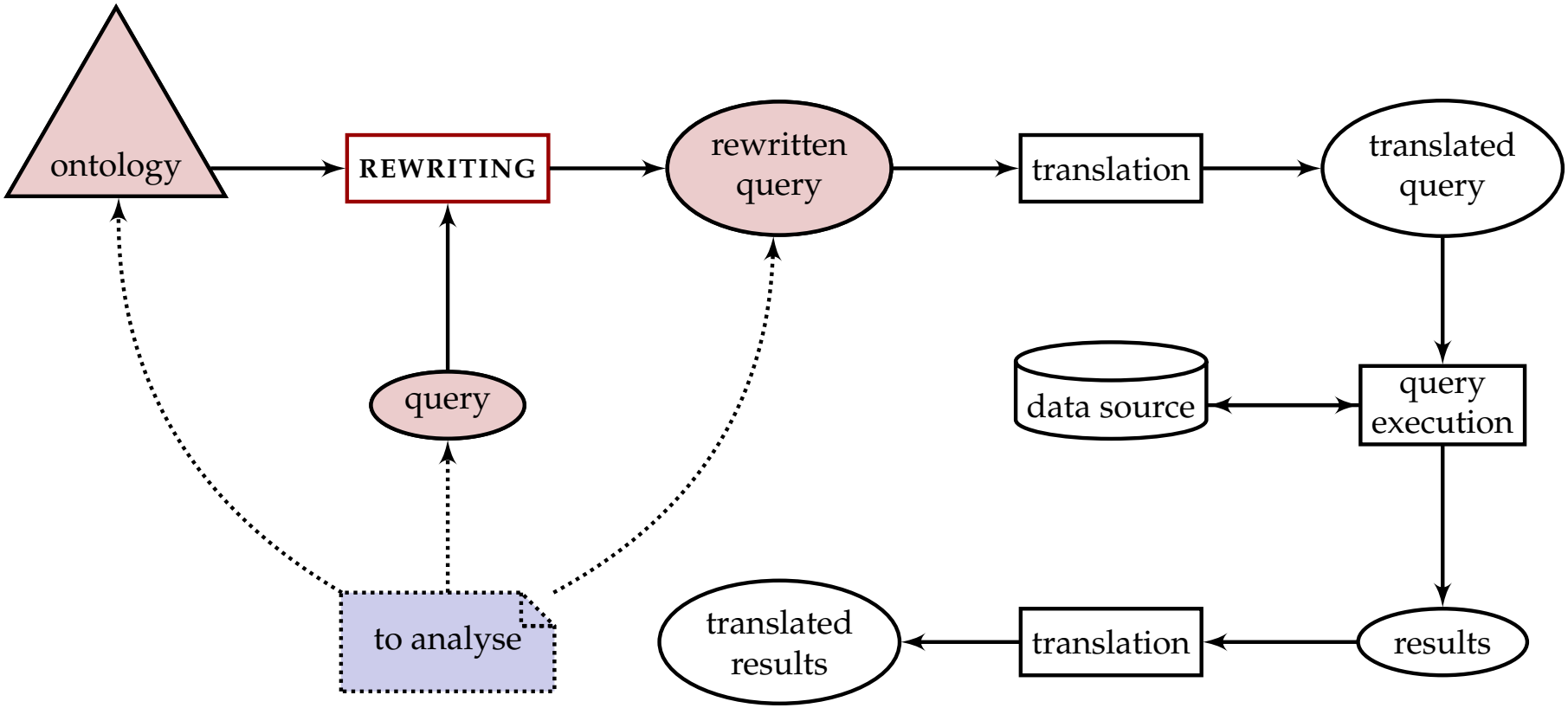
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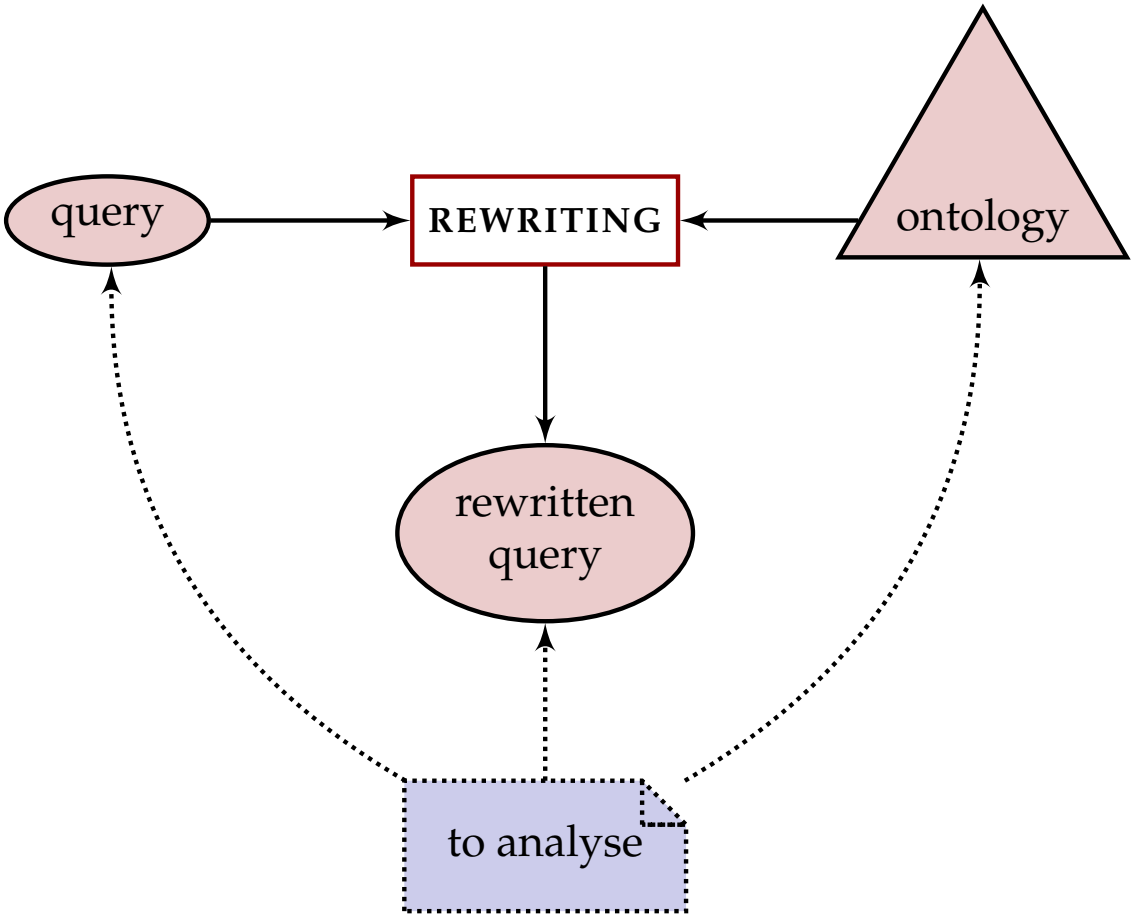
FOCUSING



Logics

axiom[1] \ logic	DL-Lite$_{core}$	DL-Lite$_F$	DL-Lite$_R$	Rapid's	$\mathcal{ELHIO}^{\neg}$	Datalog$^{\pm 2}$	Horn-$\mathcal{SHIQ}$
$B_1 \sqsubseteq B_2, B_1 \sqsubseteq \neg B_2$[3]	✓	✓	✓	✓	✓	✓	✓
$\geq 2R_1 \sqsubseteq \bot$	✗	✓	✗	✗	✗	✗	✓
$R_1 \sqsubseteq R_2, R_1 \sqsubseteq \neg R_2$	✗	✗	✓	✓	✓	✓	✓
$B_1 \sqsubseteq \exists R_1, \exists R_1 \sqsubseteq B_1$	✗	✗	✓	✓	✓	✓	✓
$B_1 \sqsubseteq \exists R_1.B_2$	✗	✗	✗	✓	✓	✓	✓
$\exists R_1.B_1 \sqsubseteq B_2$	✗	✗	✗	✗	✓	✗	✓
$B_1 \sqcap B_2 \sqsubseteq B_3$	✗	✗	✗	✗	✓	✗	✓
$\{a\} \sqsubseteq B, B \sqsubseteq \{a\}, B(a)$	✗	✗	✗	✗	✓	✗	✓
n-ary predicates	✗	✗	✗	✗	✗	✓	✗
$trans(R_1)$	✗	✗	✗	✗	✗	✗	✓
$B_1 \sqsubseteq \forall R_1.B_2, B_1 \sqsubseteq \leq 1R_1.B_2$	✗	✗	✗	✗	✗	✗	✓

[1] here B_i represents a basic concept and R_j a role that may be basic or inverted.
[2] as implemented in Nyaya
[3] note that some systems implementing negation assume a consistent ABox

SYSTEMS

System	Input	Output	Reference
Quonto	DL-Lite$_R$	UCQ	Calvanese et al. (2007)
REQUIEM	$\mathcal{ELHIO}^\neg$	Datalog or UCQ	Pérez-Urbina et al. (2009)
Presto	DL-Lite$_R$	Datalog	Rosati and Almatelli (2010)
Rapid	DL-Lite$_R$[4]	Datalog or UCQ	Chortaras et al. (2011)
Nyaya	*Datalog*$^\pm$	UCQ	Gottlob et al. (2011)
Venetis'	DL-Lite$_R$	UCQ	Venetis et al. (2011)
Prexto	DL-Lite$_R$ and EBox	Datalog or UCQ	Rosati (2012)
Clipper	Horn-$\mathcal{SHIQ}$	Datalog	Eiter et al. (2012)
kyrie	$\mathcal{ELHIO}^\neg$	Datalog or UCQ	Mora and Corcho (2013)

[4] Close to OWL2 QL, $B_1 \sqsubseteq \exists R.B_2$ axioms are supported

Previous efforts

- Imprialou et al. (2012) is the most notable previous effort
- Automatic and exhaustive coverage of the ontologies with queries
- Detected flaws in the implementations of most systems
- Still focused on qualitative results (soundness and completeness)

Dimensions

- Expressiveness in tests: traditionally DL-Lite$_R$
  - Most expressive logic in the intersection of all systems
  - Systems that handle more expressive logics cannot show their full potential
- Expressiveness lost in translation to Datalog
  - How expressive are the ontologies for OBDA?
  - Consequences of not covered expressiveness on precision and completeness
- Output complexity: apples, oranges and pears
  - How to compare UCQs and Datalog programs?
  - Characteristics of the system that is going to execute them
- Input complexity: treat with care
  - What kind of queries can be processed?
  - What kind of queries do we want to process?
- Additional inputs: to each one its own
  - EBox, cache of previous queries, etc.
  - Comparison among systems and comparison with Reality™

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ASSETS

- Several assets used for evaluation[5]
- Usual ontologies (A, AX, P1, P5, P5X, S, U, UX, V)
- Not so usual ontologies (core, galen-lite)
- New ontologies (AXE, AXEb, P5XE, UXE)
- Usually with 5 queries, but up to 9 in some cases

[5] available here: `http://j.mp/benchmarkqueryrewriting`

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RESULTS I

		REQUIEM(F)		Presto		Rapid		Clipper		kyrie	
$\mathcal{O}$	q	size	time	size	time	size	time	size	time	size	time
U	1	19	12	4	7	4	3	2	21	2	0
	2	47	16	2	9	2	9	49	19	47	3
	3	20	9	8	16	8	12	21	24	20	3
	4	64	15	3	12	3	3	63	18	64	3
	5	53	12	8	15	8	12	53	15	53	0
	6	20	12	19	6	21	15	16	18	16	9
	7	49	25	22	15	22	18	44	18	45	12
	8	10	9	13	6	13	9	10	20	10	3
	9	29	15	24	12	24	17	19	20	21	7
UX	1	22	6	7	10	7	3	5	27	5	6
	2	52	15	2	15	2	15	54	27	52	3
	3	24	15	10	28	10	9	25	28	24	3
	4	70	15	6	19	6	12	69	22	70	0
	5	56	15	11	15	11	15	56	21	56	12
	6	24	18	28	15	27	22	20	19	20	3
	7	55	28	29	21	27	21	50	28	51	12
	8	11	6	14	12	14	13	11	26	11	1
	9	32	15	30	21	30	15	22	46	24	4

TABLE : Results of the execution to obtain Datalog (time in ms)

RESULTS I

		REQUIEM(F)		Presto		Rapid		Clipper		kyrie	
$\mathcal{O}$	q	size	time	size	time	size	time	size	time	size	time
U	1	19	12	4	7	4	3	2	21	2	0
	2	47	16	2	9	2	9	49	19	47	3
	3	20	9	8	16	8	12	21	24	20	3
	4	64	15	3	12	3	3	63	18	64	3
	5	53	12	8	15	8	12	53	15	53	0
	6	20	12	19	6	21	15	16	18	16	9
	7	49	25	22	15	22	18	44	18	45	12
	8	10	9	13	6	13	9	10	20	10	3
	9	29	15	24	12	24	17	19	20	21	7
UX	1	22	6	7	10	7	3	5	27	5	6
	2	52	15	2	15	2	15	54	27	52	3
	3	24	15	10	28	10	9	25	28	24	3
	4	70	15	6	19	6	12	69	22	70	0
	5	56	15	11	15	11	15	56	21	56	12
	6	24	18	28	15	27	22	20	19	20	3
	7	55	28	29	21	27	21	50	28	51	12
	8	11	6	14	12	14	13	11	26	11	1
	9	32	15	30	21	30	15	22	46	24	4

TABLE : Results of the execution to obtain Datalog (time in ms)

RESULTS II

		REQUIEM(F)		Rapid		Prexto		Nyaya		kyrie	
$\mathcal{O}$	q	size	time	size	time	size	time	size	time	size	time
U	1	2	15	2	3	2	9	2	5	2	0
	2	1	103	1	15	1	15	1	1	1	34
	3	4	212	4	9	4	18	4	34	4	18
	4	2	3762	2	12	2	15	2	4	2	50
	5	10	13034	10	18	10	15	10	33	10	37
	6	29	47	29	28	28	12	40	1595	29	28
	7	42	797	42	37	70	18	54	670	42	43
	8	10	15	10	18	10	6	10	63	10	3
	9	960	1893	960	209	960	928	960	75135	960	1107
UX	1	5	15	5	12	5	12	5	22	5	9
	2	1	172	1	12	1	16	1	3	1	37
	3	12	2062	12	15	12	28	12	55	12	21
	4	5	31422	5	15	5	23	5	6	5	47
	5	25	91878	25	27	25	23	25	39	25	46
	6	323	468	323	106	448	178	348	2685	323	187
	7	1456	37212	224	81	280	75	264	852	224	121
	8	20	21	20	23	20	15	20	61	20	9
	9	4200	30506	4200	739	4200	21181	4200	366673	4200	16875

TABLE : Results of the execution to obtain UCQ (time in ms)

RESULTS II

		REQUIEM(F)		Rapid		Prexto		Nyaya		kyrie	
$\mathcal{O}$	q	size	time	size	time	size	time	size	time	size	time
U	1	2	15	2	3	2	9	2	5	2	0
	2	1	103	1	15	1	15	1	1	1	34
	3	4	212	4	9	4	18	4	34	4	18
	4	2	3762	2	12	2	15	2	4	2	50
	5	10	13034	10	18	10	15	10	33	10	37
	6	29	47	29	28	28	12	40	1595	29	28
	7	42	797	42	37	70	18	54	670	42	43
	8	10	15	10	18	10	6	10	63	10	3
	9	960	1893	960	209	960	928	960	75135	960	1107
UX	1	5	15	5	12	5	12	5	22	5	9
	2	1	172	1	12	1	16	1	3	1	37
	3	12	2062	12	15	12	28	12	55	12	21
	4	5	31422	5	15	5	23	5	6	5	47
	5	25	91878	25	27	25	23	25	39	25	46
	6	323	468	323	106	448	178	348	2685	323	187
	7	1456	37212	224	81	280	75	264	852	224	121
	8	20	21	20	23	20	15	20	61	20	9
	9	4200	30506	4200	739	4200	21181	4200	366673	4200	16875

TABLE : Results of the execution to obtain UCQ (time in ms)

Conclusions I

A benchmark should consider how the input represents reality wrt:

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TOWARDS A SYSTEMATIC BENCHMARKING OF ONTOLOGY-BASED QUERY REWRITING SYSTEMS

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{jmora, ocorcho}@fi.upm.es

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