



JTMS - modelizado em Owl 2.0 e SWRL

Engenharia do Conhecimento

Grupo 018

João Rodrigues, nº 45582

Simão Neves, nº 45681

Índice

[Introdução](#)

[Regras SWRL utilizadas](#)

[Perguntas e respostas de queries](#)

[Pergunta 1: Quais os Nós?](#)

[Pergunta 2: Quais as Justificações?](#)

[Pergunta 3: Quais as justificações de N5?](#)

[Pergunta 4: Qual o Nó que possui a justificação de J1de8?](#)

[Pergunta 5: Quais os Nós sem justificação?](#)

[Pergunta 6: Quem não é uma justificação?](#)

[Pergunta 7: Quem não é o J1de2?](#)

[Pergunta 8: Quem não possui a justificação J1de2?](#)

[Pergunta 9: Quem é justificação válida?](#)

[Pergunta 10: Quem é justificação inválida?](#)

[Pergunta 11: Quais os nós que têm pelo menos duas justificações válidas?](#)

[Pergunta 12: Quais os nós que não têm 3 ou mais justificações?](#)

[Pergunta 13: Quais os nós com estatuto IN?](#)

[Pergunta 14: Quais os nós OUT?](#)

[Pergunta 15: Quais as premissas?](#)

[Pergunta 16: Quais as deduções?](#)

[Pergunta 17: Quais as presunções?](#)

[Pergunta 18: Dado o modelo apresentado foram efectuadas algumas queries para a sua validação. Para isso definimos propriedades inversas apenas por uma questão de lógica de query. Todas as queries efectuadas devolveram os valores esperados.](#)

[Pergunta 19: Quais os nós que não são suporte de N3?](#)

[Pergunta 20: Quais as justificações que não são de suporte de N1?](#)

[Pergunta 21: Quais as justificações que não são de suporte de N8?](#)

[Pergunta 22: Quem tem apenas uma justificação que não é de suporte?](#)

[Conclusão](#)

Introdução

O objectivo deste trabalho foi modelizar um sistema JTMS recorrendo ao Protegé para manipulação de uma ontologia em OWL e regras SWRL, podendo assim inferir através do motor de inferência, o que acreditamos ser verdade com base em conhecimento que é inserido no sistema e no modelo desenvolvido.

De modo a poder estabelecer relações binárias lógicas entre individuals de acordo com a definição de JTMS decidimos definir Classes base e suas classes de equivalência. As classes presentes neste projecto são a Node, NodeIN, NodeDedução, NodePremissa, NodeSuposicao, NodeOUT, Justification, JustificationVALID, JustificationINVALID, List, ListEMPTY, ListIN, ListIN_VALID, ListIN_INVALID, ListOUT, ListOUT_VALID, ListOUT_INVALID. De uma forma mais detalhada podemos dizer que as classes Node, Justification e List são disjuntas entre si, que as classes *VALID e *INVALID são igualmente disjuntas entre si e que uma ListEMPTY é sempre uma list VALID. As object properties (relações) definidas são hasAntecedente, hasAntepassado, hasConsequencia, hasConsequenciaAfectada, hasConsequenciaAcreditada, hasFundamento, hasJustification, hasList, hasListIN, hasListOUT, hasNode, hasRepercussao, hasRepercussaoAcreditada, hasSupportNode, isSupportedBy. Algumas propriedades inversas foram igualmente definidas para que algumas das queries efectuadas pudessem ser mais facilmente legíveis e intuitivas. Para uma manipulação mais “manual” foi utilizada a syntax de manchester.

A nossa ontologia conta com 311 axiomas, 18 classes, 19 object properties e 42 individuals.

São em seguida apresentadas as regras SWRL utilizadas e alguns exemplos de queries passíveis de serem realizadas e respectivos resultados.

Regras SWRL utilizadas

Regra 1: **Node(?x) ^ isSupportedBy(?x, ?ju) ^ hasList(?ju, ?li) ^ hasNode(?li, ?ant) -> hasAntecedente(?x, ?ant)**

Descrição: Se um nó X, que tem uma justificação de suporte JU que tenha o nó ANT numa das suas listas, então esse nó ANT é antecedente do nó X.

Regra 2: **Node(?x1) ^ Node(?x2) ^ differentFrom(?x1, ?x2) ^ hasJustification(?x2, ?ju) ^ hasList(?ju, ?l) ^ hasNode(?l, ?x1) -> hasConsequencia(?x1, ?x2)**

Descrição: Se houver um nó X1 diferente do nó X2, e X2 tiver uma justificação que tem X1 numa das suas listas, então X1 tem como consequência o nó X2.

Regra 3: **Node(?x) ^ Node(?y) ^ hasConsequenciaAfectada(?x, ?y) ^ NodeIN(?y) -> hasConsequenciaAcreditada(?x, ?y)**

Descrição: Se houver um nó X diferente do nó com estado IN Y, e X tem como consequência afectada Y, então o nó X tem como consequência acreditada Y.

Perguntas e respostas de queries

Pergunta 1: Quais os Nós?

Query: Node

The screenshot shows the Protege software interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The main window displays the 'untitled-ontology-14' with a search bar and a 'Search...' button. The left pane shows the 'Class hierarchy: owl:Thing' with a tree view containing 'owl:Thing'. The right pane shows the 'DL query' section with a text input field containing 'Node'. Below the input field are 'Execute' and 'Add to ontology' buttons. The 'Query results' section displays two lists: 'Subclasses (6)' and 'Instances (9)'. The 'Subclasses (6)' list includes 'NodeDeducao', 'NodeIN', 'NodeOUT', 'NodePremissa', 'NodeSuposicao', and 'owl:Nothing'. The 'Instances (9)' list includes 'N2', 'N3', 'N1', 'N8', 'N9', 'N6', 'N7', 'N4', and 'N5'. On the far right, there are checkboxes for 'Direct superclasses', 'Superclasses', 'Equivalent classes', 'Direct subclasses', 'Subclasses', and 'Instances'. The 'Subclasses' and 'Instances' checkboxes are checked. At the bottom right, it says 'Reasoner active' and 'Show Inferences'.

Subclasses (6)	Instances (9)
NodeDeducao	N2
NodeIN	N3
NodeOUT	N1
NodePremissa	N8
NodeSuposicao	N9
owl:Nothing	N6
	N7
	N4
	N5

Pergunta 2: Quais as Justificações?

Query: Justification

The screenshot shows the Protege DL Query interface. The query is set to "Justification" and the results are displayed under the "Query results" section. The results are categorized into "Subclasses (3)" and "Instances (11)".

Subclasses (3):

- JustificationINVALID
- JustificationVALID
- owl:Nothing

Instances (11):

- J2de8
- J1de6
- J1de9
- J1de8
- J1de1
- J2de1
- J2de4
- J1de3
- J1de2
- J1de5
- J1de4

The interface also shows a "Class hierarchy" on the left and a "Reasoner active" status at the bottom right.

Pergunta 3: Quais as justificações de N5?

Query: Justifies value N5

The screenshot shows the Protege DL Query interface. The query is set to "Justifies value N5" and the results are displayed under the "Query results" section. The results are categorized into "Subclasses (1)" and "Instances (1)".

Subclasses (1):

- owl:Nothing

Instances (1):

- J1de5

The interface also shows a "Class hierarchy" on the left and a "Reasoner active" status at the bottom right.

Pergunta 4: Qual o Nó que possui a justificação de J1de8?

Query: hasJustification value J1de8

The screenshot shows the Protege interface with a DL query window. The query is "hasJustification value J1de8". The results are displayed in a table with two columns: "Subclasses (1)" and "Instances (1)". The "Subclasses (1)" column shows "owl:Nothing". The "Instances (1)" column shows "N8". The "Reasoner active" checkbox is checked, and the "Show Inferences" checkbox is also checked.

Subclasses (1)	Instances (1)
owl:Nothing	N8

Pergunta 5: Quais os Nós sem justificação?

Query: Node and hasJustification max 0

The screenshot shows the Protege interface with a DL query window. The query is "Node and hasJustification max 0". The results are displayed in a table with two columns: "Subclasses (1)" and "Instances (1)". The "Subclasses (1)" column shows "owl:Nothing". The "Instances (1)" column shows "N7". The "Reasoner active" checkbox is checked, and the "Show Inferences" checkbox is also checked.

Subclasses (1)	Instances (1)
owl:Nothing	N7

Pergunta 6: Quem não é uma justificação?

Query: Not Justification and not List

The screenshot shows the Protege interface with a DL query: `not Justification and not List`. The query results are displayed in two sections: Subclasses (7) and Instances (9). The Subclasses section lists: Node, NodeDeducao, NodeIN, NodeOUT, NodePremissa, NodeSuposicao, and owl:Nothing. The Instances section lists: N2, N3, N1, N8, N9, N6, N7, N4, and N5. The right sidebar shows the query options: Direct superclasses, Superclasses, Equivalent classes, Direct subclasses, Subclasses (checked), and Instances (checked). The Reasoner is active, and Show Inferences is checked.

Pergunta 7: Quem não é o J1de2?

Query: Not {J1de2} and not List

The screenshot shows the Protege interface with a DL query: `not {J1de2} and not List`. The query results are displayed in two sections: Subclasses (8) and Instances (19). The Subclasses section lists: JustificationINVALID, Node, NodeDeducao, NodeIN, NodeOUT, NodePremissa, NodeSuposicao, and owl:Nothing. The Instances section lists: N8, N9, N6, N7, N4, N5, N2, J2de8, J1de6, and N3. The right sidebar shows the query options: Direct superclasses, Superclasses, Equivalent classes, Direct subclasses, Subclasses (checked), and Instances (checked). The Reasoner is active, and Show Inferences is checked.

Pergunta 8: Quem não possui a justificação J1de2?

Query: Not(hasJustification value J1de2) and not List

The screenshot shows the Protege interface with a DL query: `not (hasJustification value J1de2) and not List`. The query results are displayed in a table with 19 instances. The results are as follows:

Justification	Instances (19)
Justification	N8
JustificationINVALID	N9
JustificationVALID	N6
NodeOUT	N7
owl:Nothing	N4
	N5
	J2de8
	J1de6
	N3
	J1de9
	J1de8
	N1
	J1de1
	J2de1

The right sidebar shows the following options: ☐ Direct superclasses, ☐ Superclasses, ☐ Equivalent classes, ☐ Direct subclasses, ☒ Subclasses, and ☒ Instances. The bottom status bar indicates "Reasoner active" and "Show Inferences".

Pergunta 9: Quem é justificação válida?

Query: JustificationVALID

The screenshot shows the Protege interface with a DL query: `JustificationVALID`. The query results are displayed in a table with 7 instances. The results are as follows:

Subclasses (1)	Instances (7)
owl:Nothing	J1de6
	J1de1
	J2de1
	J1de3
	J1de2
	J1de5
	J1de4

The right sidebar shows the following options: ☐ Direct superclasses, ☐ Superclasses, ☐ Equivalent classes, ☐ Direct subclasses, ☒ Subclasses, and ☒ Instances. The bottom status bar indicates "Reasoner active" and "Show Inferences".

Pergunta 10: Quem é justificação inválida?

Query: JustificationINVALID

The screenshot shows the Protege interface with a DL query window. The query is 'JustificationINVALID'. The results are displayed in a table with two columns: 'Subclasses (1)' and 'Instances (4)'. The 'Subclasses' column contains 'owl:Nothing'. The 'Instances' column contains four instances: 'J2de8', 'J1de9', 'J1de8', and 'J2de4'. The 'Reasoner active' checkbox is checked, and the 'Show Inferences' checkbox is also checked.

Subclasses (1)	Instances (4)
owl:Nothing	J2de8
	J1de9
	J1de8
	J2de4

Pergunta 11: Quais os nós que têm pelo menos duas justificações válidas?

Query: Node and hasJustification min 2 JustificationVALID

The screenshot shows the Protege interface with a DL query window. The query is 'Node and hasJustification min 2 JustificationVALID'. The results are displayed in a table with two columns: 'Subclasses (1)' and 'Instances (1)'. The 'Subclasses' column contains 'owl:Nothing'. The 'Instances' column contains one instance: 'N1'. The 'Reasoner active' checkbox is checked, and the 'Show Inferences' checkbox is also checked.

Subclasses (1)	Instances (1)
owl:Nothing	N1

Pergunta 12: Quais os nós que não têm 3 ou mais justificações?

Query: Node and hasJustification max 2

The screenshot shows the Protege interface with a DL query window. The query is "Node and hasJustification max 2". The results are displayed in a table with two columns: "Subclasses (1)" and "Instances (9)". The subclasses list contains "owl:Nothing". The instances list contains "N2", "N3", "N1", "N8", "N9", "N6", "N7", "N4", and "N5". The "Reasoner active" checkbox is checked, and the "Show Inferences" checkbox is also checked.

Subclasses (1)	Instances (9)
owl:Nothing	N2
	N3
	N1
	N8
	N9
	N6
	N7
	N4
	N5

Pergunta 13: Quais os nós com estatuto IN?

Query: NodeIN

The screenshot shows the Protege interface with a DL query window. The query is "NodeIN". The results are displayed in a table with two columns: "Subclasses (4)" and "Instances (6)". The subclasses list contains "NodeDeducao", "NodePremissa", "NodeSuposicao", and "owl:Nothing". The instances list contains "N2", "N3", "N1", "N6", "N4", and "N5". The "Reasoner active" checkbox is checked, and the "Show Inferences" checkbox is also checked.

Subclasses (4)	Instances (6)
NodeDeducao	N2
NodePremissa	N3
NodeSuposicao	N1
owl:Nothing	N6
	N4
	N5

Pergunta 14: Quais os nós OUT?

Query: NodeOUT

The screenshot shows the Protege interface with a DL query named "NodeOUT" executed. The query results are displayed in the "Query results" panel. The results are categorized into "Subclasses (1)" and "Instances (3)".

Category	Item
Subclasses (1)	owl:Nothing
Instances (3)	N8
Instances (3)	N9
Instances (3)	N7

On the right side of the "Query results" panel, there are checkboxes for "Direct superclasses", "Superclasses", "Equivalent classes", "Direct subclasses", "Subclasses", and "Instances". The "Subclasses" and "Instances" checkboxes are checked.

Pergunta 15: Quais as premissas?

Query: NodePremissa

The screenshot shows the Protege interface with a DL query named "NodePremissa" executed. The query results are displayed in the "Query results" panel. The results are categorized into "Subclasses (1)" and "Instances (3)".

Category	Item
Subclasses (1)	owl:Nothing
Instances (3)	N2
Instances (3)	N3
Instances (3)	N1

On the right side of the "Query results" panel, there are checkboxes for "Direct superclasses", "Superclasses", "Equivalent classes", "Direct subclasses", "Subclasses", and "Instances". The "Subclasses" and "Instances" checkboxes are checked.

Pergunta 16: Quais as deduções?

Query: NodeDeducacao

The screenshot shows the Protege interface with a DL query window open. The query is "NodeDeducacao". The results are displayed in the "Query results" section, showing "Subclasses (1)" as "owl:Nothing" and "Instances (2)" as "N4" and "N5". The "Reasoner active" checkbox is checked, and the "Show Inferences" checkbox is also checked.

Class hierarchy: owl:Thing

DL query:

Query (class expression)

NodeDeducacao

Execute Add to ontology

Query results

Subclasses (1)

- owl:Nothing

Instances (2)

- N4
- N5

Direct superclasses
Superclasses
Equivalent classes
Direct subclasses
☒ Subclasses
☒ Instances

Reasoner active ☒ Show Inferences

Pergunta 17: Quais as presuposições?

Query: NodeSuposicao

The screenshot shows the Protege interface with a DL query window open. The query is "NodeSuposicao". The results are displayed in the "Query results" section, showing "Subclasses (1)" as "owl:Nothing" and "Instances (1)" as "N6". The "Reasoner active" checkbox is checked, and the "Show Inferences" checkbox is also checked.

Class hierarchy: owl:Thing

DL query:

Query (class expression)

NodeSuposicao

Execute Add to ontology

Query results

Subclasses (1)

- owl:Nothing

Instances (1)

- N6

Direct superclasses
Superclasses
Equivalent classes
Direct subclasses
☒ Subclasses
☒ Instances

Reasoner active ☒ Show Inferences

Pergunta 18: Dado o modelo apresentado foram efectuadas algumas queries para a sua validação. Para isso definimos propriedades inversas apenas por uma questão de lógica de query. Todas as queries efectuadas devolveram os valores esperados.

Pergunta 19: Quais os nós que não são suporte de N3?

Query: `Node and (not (justifies value N3 that hasList some List that hasNode some Node))`

The screenshot shows the Protege OWL editor interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The browser address bar shows the URL for 'untitled-ontology-14'. The left pane displays the 'Class hierarchy: owl:Thing' with a tree view showing 'owl:Thing' as the root. The right pane is titled 'DL query:' and contains the query: `Node and (not (justifies value N3 that hasList some List that hasNode some Node))`. Below the query, there are buttons for 'Execute' and 'Add to ontology'. The 'Query results' section shows two categories: 'Subclasses (6)' and 'Instances (9)'. The subclasses listed are 'NodeDeducao', 'NodeIN', 'NodeOUT', 'NodePremissa', 'NodeSuposicao', and 'owl:Nothing'. The instances listed are 'N2', 'N3', 'N1', 'N8', 'N9', 'N6', 'N7', 'N4', and 'N5'. On the far right, there are checkboxes for 'Direct superclasses', 'Superclasses', 'Equivalent classes', 'Direct subclasses', 'Subclasses', and 'Instances'. The 'Subclasses' and 'Instances' checkboxes are checked. At the bottom right, it says 'Reasoner active' and 'Show Inferences'.

Category	Item	Count
Subclasses (6)	NodeDeducao	7
	NodeIN	7
	NodeOUT	7
	NodePremissa	7
	NodeSuposicao	7
	owl:Nothing	7
Instances (9)	N2	7
	N3	7
	N1	7
	N8	7
	N9	7
	N6	7
	N7	7
	N4	7
	N5	7

Pergunta 20: Quais as justificações que não são de suporte de N1?

Query: Justification and (not (inverse isSupportedBy value N1) that justifies value N1)

The screenshot shows the Protege DL Query interface. The query is: Justification and (not (inverse isSupportedBy value N1) that justifies value N1). The query results are displayed in two sections: Subclasses (1) and Instances (1). The Subclasses section shows owl:Nothing. The Instances section shows J2de1. The right sidebar shows the following options: Direct superclasses (unchecked), Superclasses (unchecked), Equivalent classes (unchecked), Direct subclasses (unchecked), Subclasses (checked), and Instances (checked). The bottom status bar indicates Reasoner active and Show Inferences checked.

Pergunta 21: Quais as justificações que não são de suporte de N8?

Query: Justification and (not (inverse isSupportedBy value N8) that justifies value N8)

The screenshot shows the Protege DL Query interface. The query is: Justification and (not (inverse isSupportedBy value N8) that justifies value N8). The query results are displayed in two sections: Subclasses (1) and Instances (2). The Subclasses section shows owl:Nothing. The Instances section shows J2de8 and J1de8. The right sidebar shows the following options: Direct superclasses (unchecked), Superclasses (unchecked), Equivalent classes (unchecked), Direct subclasses (unchecked), Subclasses (checked), and Instances (checked). The bottom status bar indicates Reasoner active and Show Inferences checked.

Pergunta 22: Quem tem apenas uma justificação que não é de suporte?

Query: Node that (hasJustification exactly 1 (not (supports some)))

The screenshot shows the Protege OWL editor interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, Ontop, and Help. The browser address bar shows the URL for 'untitled-ontology-14'. The main workspace is divided into several panes. On the left, the 'Class hierarchy: owl:Thing' pane shows a tree view with 'owl:Thing' selected. The central pane displays a 'DL query' with the expression: 'Node that (hasJustification exactly 1 (not (supports some)))'. Below the query, there are buttons for 'Execute' and 'Add to ontology'. The 'Query results' pane on the right shows the results of the query. It lists 'Subclasses (1)' as 'owl:Nothing' and 'Instances (3)' as 'N1', 'N9', and 'N4'. On the far right, there are checkboxes for 'Direct superclasses', 'Superclasses', 'Equivalent classes', 'Direct subclasses', 'Subclasses', and 'Instances'. The 'Subclasses' and 'Instances' checkboxes are checked. At the bottom right, the status bar indicates 'Reasoner active' and 'Show Inferences' is checked.

Protege File Edit View Reasoner Tools Refactor Window Ontop Help

untitled-ontology-14 (http://www.semanticweb.org/joaor/ontologies/2016/4/untitled-ontology-14) : [/Users/simon/Dev/ec/Owl_JTMS_Project/versao4.owl]

untitled-ontology-14 (http://www.semanticweb.org/joaor/ontologies/2016/4/untitled-ontology-14) Search...

Active Ontology x Entities x Classes x Object Properties x Data Properties x Individuals by class x DL Query x SWRLTab x

Class hierarchy: owl:Thing

Asserted

Query (class expression)

Node that (hasJustification exactly 1 (not (supports some)))

Execute Add to ontology

Query results

Subclasses (1)

- owl:Nothing

Instances (3)

- N1
- N9
- N4

Direct superclasses
Superclasses
Equivalent classes
Direct subclasses
☒ Subclasses
☒ Instances

Reasoner active ☒ Show Inferences

Conclusão

A ontologia definida aceita qualquer tipo de JTMS desde que os inputs fornecidos sejam os necessários para que todas as inferências esperadas possam ser realizadas pelo motor de inferências. Optámos por recorrer a regras SWRL porque dado o modelo por nós desenvolvido, e dado o nosso conhecimento de OWL / Protegé foi a única forma de obter os resultados esperados. Fica apenas definir uma forma automática de inserir as justificações de suporte e respectivos nós de suporte.