

COMP62324 FAMILY HISTORY IN OWL

EDITION 1.1

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Preamble

Licencing

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Reporting Errors

This set of exercises will almost certainly contain errors, defects and infelicities. Please do report them to sean.bechhofer@manchester.ac.uk. Supplying some actual context in the form of words will help in fixing any of these issues.

Acknowledgements

As well as the author list, many people have contributed to this work. Any contribution, such as reporting bugs etc., is rewarded by an acknowledgement of contribution (in alphabetical order) when the authors get around to adding them.

- Patrick Koopman;
- Matthew Horridge.
- Nicolas Matentzoglou.
- Margaret Stevens.

Conventions used in these exercises

- All OWL is written in Manchester Syntax;
- When we use FHKB entities within text, we use a **sans serif typeface**;
- We use CamelCase for classes and property names;
- Class names start with upper case;

- Individual names start with a lower case letter and internal underscores to break words;
- Property names usually start with 'is' or 'has' and are CamelCase with a lower case initial letter.
- When there is some scary OWL or the reasoner may find the FHKB hard work, you will see a 'here be dragons' image.¹



¹The image comes from <http://ancienthomeofdragon.homestead.com/> May 2012.

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Chapter 1

Introduction

These exercises in the Web Ontology Language (OWL) take participants through OWL from its basics to some rather advanced features of the OWL DL profile of OWL. The exercises use family history as a topic and much of the tutorial is based on the ‘Manchester Family History Advanced OWL Tutorial’ found at <http://owl.cs.manchester.ac.uk/publications/talks-and-tutorials/fhkbtutorial/>. Here, instead of an ‘advanced tutorial’, the exercises go from the start to quite a lot of what anyone using OWL to model needs to know about the language and the use of an automated reasoner; the exercises do not really explore much in the way of modelling issues.

These exercises don’t give any instruction in Protégé; for that use the Pizza tutorial at <http://owl.cs.manchester.ac.uk/tutorials/protegeowltutorial/>. These exercises don’t give any explanation behind the phenomena revealed during the exercises; these are explained by the human beings delivering the exercises. More explanation can be found in the Pizza tutorial and the written, original, long version of the Family History OWL tutorial is in Blackboard.

In these exercises we take an “objects (individuals) first” approach. Most tutorials concentrate on classes then individuals (if at all). By doing it this way our aim is to emphasise that OWL is all about modelling individuals—even if most axioms are restrictions upon classes that say ‘each and every individual in this class holds at least one of these properties to an individual of the filler class’. Similarly, object properties are relationships between two individuals, we just usually model at the class level and these sort of distinctions can sometimes get lost. So, these exercises start with asserting lots of properties between named individuals and only later do we start talking about classes of these individuals. It may be, and probably will be, that most modelling is with classes and properties, but this way really emphasises what the language is actually doing.

Subsequent material in the course unit will focus largely on classes and modelling with classes.

Once you have completed these exercises in the lab, you are recommended to work your way through the Protege Pizza tutorial and the Family History OWL Tutorial. These will help you gain experience of the mechanics of using Protégé and provide a further introduction to OWL 2.

- <http://owl.cs.manchester.ac.uk/tutorials/protg-owl-tutorial/>
- <http://owl.cs.manchester.ac.uk/publications/talks-and-tutorials/fhkbtutorial/> contains the ontologies, and the long version of the tutorial explanation is in Blackboard.

1.1 Learning outcomes

By the end of a successful completion of these exercises you should be able to:

1. Understand the core aspects of OWL 2 syntax and semantics;
2. Use Protégé to build an ontology, and use an automated reasoner to draw inferences from the axioms in your ontology;
3. Use classes and individuals;
4. Use OWL 2's property hierarchy;
5. Use OWL 2's property characteristics;
6. Know more than you need to about the family history of Robert David Bright;
7. Know some of the limitations of OWL 2.

These learning outcomes are very generic; each exercise encapsulates a significant learning outcome. For example, Exercise 10 has a learning outcome of: knowing how to use data properties; knowing about and using the `DifferentIndividuals` axiom; a reinforcement of the use of the functional property characteristic; and an introduction to qualified cardinality restrictions.

1.2 Assumptions

We make some simplifying assumptions in this tutorial:

- We assume people doing the exercises know nothing about OWL.
- We assume that there are human beings present that are knowledgeable about OWL to conduct participants through the exercises and give explanations. You may need to ask these human beings (or consult some other sources) to understand some of the terms used in this tutorial (e.g., “inverse” or “transitive”).
- We take a conventional western view of family history. This appears to have most effects on naming of sibling and cousin relationships.
- We take a straight-forward view on the sex of people; this is explored further in Chapter 8;
- We make no special treatment of time or dates; we are only interested in years and we do not do anything fancy; this is explored more in Chapter 10.

At the end of the tutorial, you should be able to produce a property hierarchy and a TBox or class hierarchy; all supported by use of Protégé, the automated reasoner, and a lot of OWL 2's features.


1.3 How to use these exercises

Start at exercise one and work through to the last exercise. Don't just read the exercises and think you know what will happen; actually do it and you'll learn more.

Chapter 2

Exercise 1

Task 1: Getting things started

- 
1. Install Protégé.
 2. Install the matrix plugin.
 3. Open a new ontology called `fhkb-x.owl`, where `x` is your student user id.
 4. Remember to save your file often while working...
-

2.1 Notes

Your machines in the School have Protégé installed. The instructions below are for use ‘off-site’.

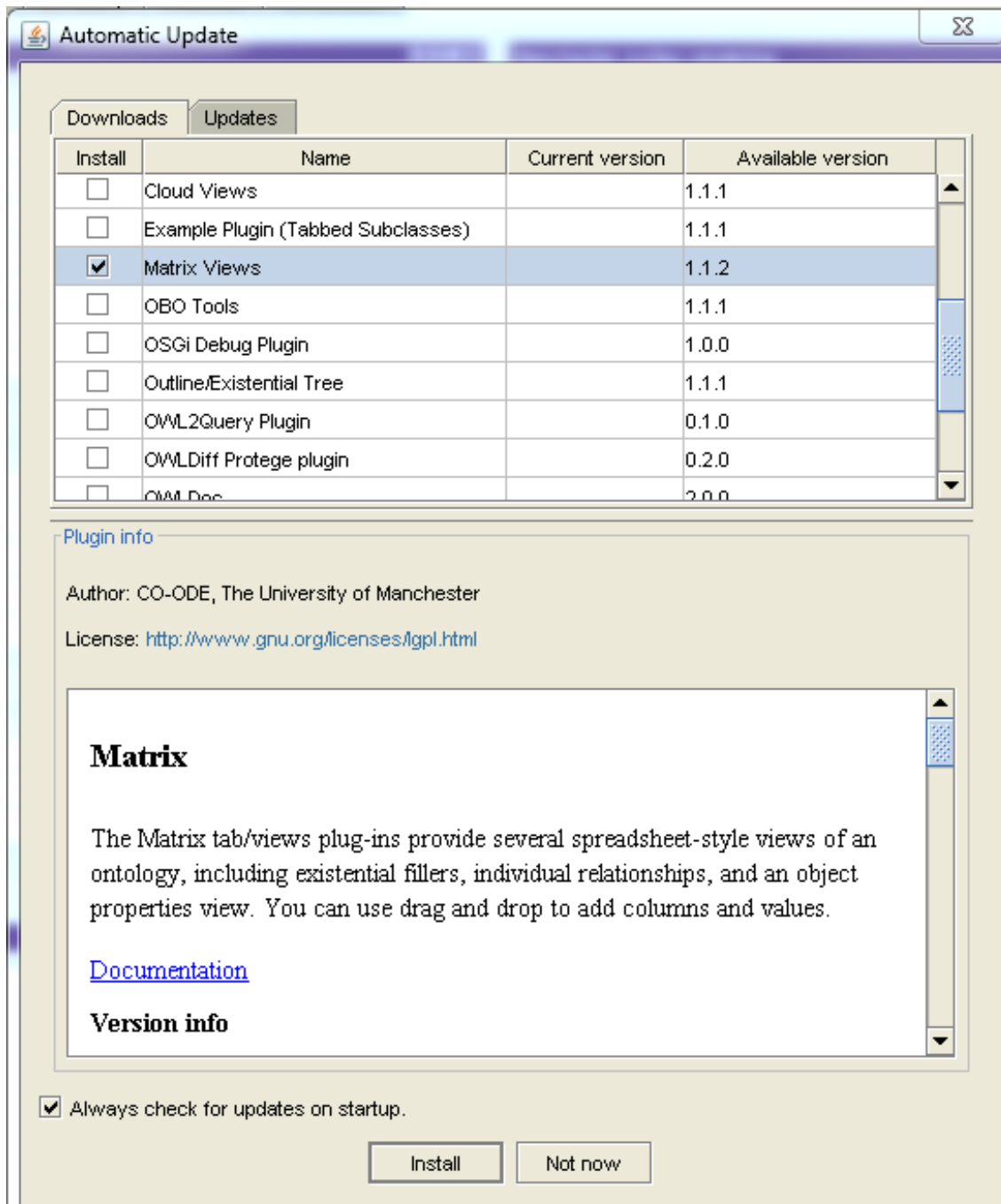
2.2 Installing Protégé

Go to <http://protege.stanford.edu/download/registered.html> and download the platform independent installer of Protégé Desktop 4.X (you do not have to register in order to download the software). Select the appropriate one for your operating system. We recommend downloading it bundled with the Java VM, to ensure compatibility. After the download is completed, run the installer and follow the instructions, selecting the appropriate VM (either the one bundled with it or your default one).

Once the installation is completed, open Protégé and go to File » Check for plugins. Select the Matrix views plugin, as shown on the screenshot towards the end of this chapter. Click install, wait until the software asks for a restart, close and re-open Protégé.

2.3 Create a first ontology

Select File » Save as, select either RDF/XML or OWL/XML, navigate to your preferred directory and save the file using the name fhkb-x, replacing the x with your student user id (e.g. mbax1234). The extension (*.owl) is put automatically. To be sure, go to File » Save, and do so frequently during your upcoming modelling efforts, as Protégé is known to crash in the unlikely situations.



Chapter 3

Exercise 2

Task 2: Create individuals

1. Load the initial ontology from the course unit home page (<http://studentnet.cs.manchester.ac.uk/pgt/COMP62342/>) into Protégé.
 2. Add about 6 more individuals to your FHKB—use the emboldened names from the table in Appendix A; you may add more names if you wish. For each individual, create an IRI fragment with the given names followed by family name, followed by birth year, each separated by underscores.
 3. Create two object properties: **hasFather** and **hasMother**. Add the appropriate assertions from the data table; run the reasoner.
 4. Ask the DL query **hasFather** value **David_Bright_1934** .
 5. Add inverses for the two properties: **isFatherOf** and **isMotherOf**; run the reasoner.
 6. Ask the DL query **isMotherOf** value **Robert_David_Bright_1965** and **isMotherOf** value **David_Bright_1934** .
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Chapter 4

Exercise 3


Task 3: Create hasParent

1. Add another object property `hasParent` and its obvious inverse. Make `hasParent` a super-property of `hasMother` and `hasFather`.
 2. Run the reasoner.
 3. Ask the DL queries: `hasParent value David_Bright_1934` and `hasParent value Margaret_Grace_Rever_1934` . Ask similar queries using the `isParentOf` property.
 4. Look at the object hierarchy and see the reasoner maintaining the ‘is’ side of the hierarchy.
 5. Write a DL query to find the grandparents of Robert David Bright. Specialise that query to find Robert David Bright’s grandfathers.
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Chapter 5

Exercise 4

Task 4: Finding ancestors and descendants

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1. Add the object property `hasAncestor` and make it a super-property of `hasParent`.
 2. Add its inverse `hasDescendant`.
 3. Make `hasAncestor` transitive.
 4. Run the reasoner.
 5. Ask the DL queries: `hasDescendant` value `Robert_David_Bright_1965` and `hasAncestor` value `william_george_bright_1901`. Check the answers against the table in Appendix A.
 6. Ask more queries and check your answers.
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Chapter 6

Exercise 5



Task 5: Finding grandparents

1. Add the object properties `hasGrandparent`, `hasGrandmother` and `hasGrandfather` arranged in the obvious hierarchy.
 2. Make `hasGrandparent` a sub-property of the appropriate property in the growing object hierarchy.
 3. Add the obvious ‘is’ inverses.
 4. Add a sub-property chain `hasParent o hasFather` to the `hasGrandfather` property; do the equivalent for `hasGrandmother`.
 5. Run the reasoner (and look at the object hierarchy).
 6. Ask DL queries about grandparents and grandchildren of various people.
 7. Add in properties and sub-property chains for finding great grandparents. (you may have to add some more individuals to test these properties.)
 8. Run the reasoner and test with DL queries.
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Chapter 7

Exercise 6

Task 6: Finding all blood relations

1. Add the object property `hasBloodRelation` to the object property hierarchy.
 2. Is this property transitive?
 3. What is this property's inverse? It is its own inverse, so make it symmetric.
 4. What is the sub-property chain that determines one's blood relations? Add this sub-property chain to `hasBloodRelation`.
 5. Run the reasoner and test your answer.
 6. One good test is to find the blood relations of the person furthest back in the hierarchy; do we get his or her blood relations? How do we fix it? Ask a human being—we don't yet know, in the ontology, that everyone has an ancestor; once we do know this, this sub-property chain will work. We know as humans that everyone has parents; the 'computer' doesn't know this yet—see Exercise ??.
 7. Look at the object property hierarchy.
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Chapter 8

Exercise 7



Task 7: Adding classes of individuals

1. Add the class `Person` to the FHKB.
 2. Add the classes `Sex`, `Male` and `Female`; make `Male` and `Female` subclasses of `Sex`.
 3. Add the object property `hasSex`; restrict the class `Person` to `hasSex some Sex`.
 4. Make two classes `Man` and `Woman`. Make `Man` `EquivalentTo: Person and hasSex some Male` and do the equivalent for `Woman`.
 5. Run the reasoner.
 6. Ask the DL query `Male and Female`; should this be possible? Make `Male` and `Female` disjoint, run the reasoner and ask the query again.
 7. Ask the DL query `Sex and not (Male or Female)`; the answer suggests that there are other ways of being a `Sex` than being either `Male` or `Female`. Stop this happening by adding the covering axiom `Sex EquivalentTo: Male or Female`; run the reasoner and ask the query again.
 8. Ask the DL query `Sex and not Female`; find an explanation for the results.
 9. Ask the DL query `Man and Woman`; is it possible for a person to be both a man and a woman (according to our ontology)? Find out why this is possible or not.
 10. Ask the DL query `Person and not (Man or Woman)`, that is, is it possible to be a person and neither a man nor a woman?
 11. Ask the DL query `Person and not Man`; what do you find out?
 12. Make the object property `hasSex` functional, run the reasoner and do all the queries again.
 13. Ask for an explanation of this inference.
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Chapter 9

Exercise 8

Task 8: Domains and ranges

1. Run the reasoner and ask DL queries about who is a **Man**, **Woman** and **Person**; note the answers.
2. Add the domain **Person** and range **Man** to **hasFather** and add the domain **Person** and range **Woman** to **hasMother**.
3. Run the reasoner and inspect the object hierarchy to see what the reasoner has done with the domains and ranges of the other properties; make any changes that are necessary.
4. Ask DL queries about who is a **Man**, **Woman** and **Person**; note for whom we don't have a specific sex.
5. Write the following defined classes (using the **equivalentTo**: construct):
 - (a) **Parent**—All the individuals that are parents.
 - (b) A **Grandparent** class that uses the **isGrandparentOf** property and **Grandparent2** that uses **EquivalentTo**: **Person** and (**isParentOf** some (**Person** and **isParentOf** some **Person**)).

Run the reasoner, look to see where the classes are placed in the hierarchy and work out why.

6. Add the restrictions **hasFather** some **Man** and **hasMother** some **Woman** to **Person**. Run the reasoner and ask which individuals have a mother. Also ask the DL query for which individuals have a grandmother. Ask for explanations.
 7. Test the **hasBloodRelation** property again. This time you should see it working. this is because we've now said everyone has a mother and everyone has a father, therefore everyone has a parent and thus an ancestor. If everyone can have an ancestor, then everyone is someone's descendent.
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Chapter 10

Exercise 9



Task 9: Adding birth years

1. Add a data property `hasBirthYear` with a domain `Person` and range `integer`.
 2. Add the birth years from the data table.
 3. Run the reasoner.
 4. Ask DL queries for people born after 1930, before 1970 and during the 1960s.
 5. Ask the DL query `isParentOf min 3 Person`; note the answer.
 6. Make `hasBirthYear` functional; run the reasoner and ask the query again. Ask the DL query `hasFather value peter_william_bright_1940`—why doesn't he have three children?
 7. Make all individuals different, run the reasoner and ask the DL query `isParentOf min 3 Person` again; note the answer.
 8. You should also make `hasFather` and `hasMother` functional; we want individuals of type `Person` to have only one mother and father. Try giving a person more than one father, run the reasoner and ask for an explanation of what happens.
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Chapter 11

Exercise 10




Task 10: Finding siblings

1. Add an object property `hasSibling` at the appropriate place to the object property hierarchy.
 2. Decide whether it is symmetric and/or transitive.
 3. Add the property chain that will find siblings.
 4. Run the reasoner.
 5. Ask the DL query `hasSibling` value `Robert_David_Bright_1965` ; what's the problem?
 6. Make `hasSibling` irreflexive, this should make it impossible for Robert David Bright to be his own brother. What happens? ask for an explanation (from a human being).
 7. Add two sub-properties for `hasSibling`: `hasBrother` and `hasSister`. Decide on the transitivity, symmetry etc. for these properties and add an inverse property if you think it appropriate.
 8. What sub-property chains do we need to make `hasBrother` work? Remember that we do not, as yet, know the sex of Robert David Bright and several other individuals.
 9. The `isFatherOf` property has a range of `Person`; this will not determine the sex of a father's child. To fix this, make a property hierarchy of `hasChild`, `hasSon` and `hasDaughter`; add the appropriate domains and ranges.
 10. Use an `EquivalentProperty` axiom to tie `hasChild` to an appropriate existing object property.
 11. Add `hasSon` and `hasDaughter` assertions to the individuals.
 12. Add sub-property chains to `hasBrother` and `hasSister` using these new properties; run the reasoner and test the answers with DL queries.
 13. Inspect the object hierarchy.
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Chapter 12

Exercise 11

Task 11: Finding aunts and uncles

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1. Add the object properties **hasUncle** and **hasAunt**, their domains, ranges and inverses at the appropriate place in the object hierarchy.
 2. An uncle is a parent's brother (that is, a blood relation, not an 'uncle-in-law'); add a sub-property chain to find uncles and a similar one to find aunts.
 3. Run the reasoner and test with DL queries. Robert David Bright's uncles are John Bright and Peter William Bright; his aunt is Eileen Reeve.
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Chapter 13

Exercise 12



Task 12: Finding first cousins

1. Add the object property `hasFirstCousin` to the object property hierarchy at the appropriate place.
 2. Decide whether it is transitive, symmetric (and add an inverse if necessary), then add the appropriate domain and range.
 3. A first cousin is one of a parent's siblings children—or a person with a shared grandparent. Devise a sub-property chain to find first cousins. Robert David Bright's first cousins are Mark Bright, Ian Bright, Janet Bright, Willian Bright, James Bright, Clare Bright, Julie Bright, Mark Heath and Nicholas heath.
 4. Write a DL query to find the right answer.
 5. Inspect the object hierarchy.
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Chapter 14

Exercise 13

Task 13: In-laws: Modelling partnerships

1. Add the class **Partnership** to the FHKB as a sibling of **Person** and make it disjoint with its primitive siblings.
 2. Create the object properties **hasParticipant**, **hasMaleParticipant** and **hasFemaleParticipant** in the obvious object hierarchy, along with their inverses. **Partnership** is their common domain and add the obvious ranges to these properties.
 3. Add a restriction of **hasParticipant** min 2 **Person** to the **Marriage** class.
 4. Create the object properties **hasSpouse**, **hasWife** and **hasHusband** and inverses where appropriate (or use property characteristics when they are not). Use sub-property chains to infer when two individuals are husband and wife. David Bright and Margaret Grace Rever were married in 1958; create an individual for this marriage (you can add a **hasMarriageYear** data property if you wish). John Bright and Joyce Gosport were married in 1954. Add another individual for this marriage.
 5. Run the reasoner and ask DL queries to test what you have done.
 6. Create new object properties for in-laws-brother-in-law, sister-in-law (hint: these last two have possible sub-property chains) and sibling-in-law. You can also now add properties to find uncles- and aunts-in-law.
 7. Run the reasoner, and ask DL queries to confirm that it all works.
 8. Add these two property hierarchies to the main object property hierarchy, reason and look at it.
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Chapter 15

Exercise 14



Task 14: Finding parents with only sons

1. Ask the DL query `isParentOf some Man`; note the answer.
 2. The query finds someone that has at least one son; we want a query that asks for people that are parents of only sons.
 3. Ask the DL query `isParentOf only Man`; note the answer. Are there any unusual answers?
 4. We need to ‘close off’ what people individuals are parents of. For David Bright we do this with an axiom such as `isParentOf only {Richard_John_Bright_1962 , Robert_David_Bright_1965 }`. Add such axioms to your FHKb’s individuals (David Bright, for instance, should have such an axiom.) and ask the questions again, noting the answers. (note how fast the reasoner runs.)
 5. Now write a defined class `ParentOfOnlySons`. this will be something like:
EquivalentTo: Person and `isParentOf some Man` and `isParentOf only Man`.
 6. Run the reasoner; where is the class placed in the TBox; which individuals are members of this class?
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Chapter 16

Exercise 15



Task 15: Are sibling's grandparents the same?

1. Make two defined classes `GrandparentOfRobert` and `GrandparentOfRichard`. Use the pattern `Person` and `EquivalentTo: isParentOf some (Person and isParentOf value x)` where `x` is either `Robert_David_Bright_1965` or `Richard_John_Bright_1962`.
 2. Run the reasoner and find out if the two classes are found to be equivalent; they won't be, despite the fact Robert David Bright and Richard John Bright share parents and therefore share the same grandparents.
 3. It doesn't work. If you add `hasParent max 2 Person` as a restriction to the class `Person` (only as a necessary condition), re-run the reasoner, then everything will work. You'll see that the two classes have been inferred to be equivalent.
 4. It's all to do with openness; ask a human being or read the full FHKB manual.
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Chapter 17

Exercise 16



Task 16: Grandparent as a defined class

1. Make the class `Parent` as `EquivalentTo: Person` and `isParentOf some Person`.
 2. Make two defined classes, `Grandparent1` and `Grandparent2`; in one use the `isGrandparentOf` property and in the other use `isParentOf some (Person and isParentOf some Person)`.
 3. Run the reasoner and look at the class hierarchy. Do both classes appear as subclasses of `Parent` as they should (all grandparents are, by definition, parents) and are they equivalent? think about it.
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Chapter 18

Exercise 17



Task 17: Making a big class hierarchy

1. Add defined classes for the following (some may already exist):
 - Son and Daughter;
 - Brother and Sister;
 - Cousin, FirstCousin, SecondCousin, FirstCousinOnceRemoved (and so on until you get bored);
 - InLaw, MotherInLaw, FatherInLaw and so on;
 - Aunt, Uncle, UncleInLaw, and so on;
 - GrandParent, Grandfather, GreatGrandparent, and so on;
 2. Look at how the class hierarchy grows; its shape and any ‘unusual’ placements; use explanation widely to check on your growing hierarchy.
 3. Note what happens to the classes `Son` and `Daughter` in the hierarchy—why?
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Appendix A

FHKB Family Data

Table A.1: The list of individuals in the FHKB

Person	First given name	Second given name	Family name	Birth year	Mother	Father
Alec John Archer 1927	Alec	John	Archer	1927	Violet Heath 1887	James Alexander Archer 1882
Charles Herbert Rever 1895	Charles	Herbert	Rever	1895	Elizabeth Frances Jessop 1869	William Rever 1870
Charlotte Caroline Jane Bright 1894	Charlotte	Caroline Jane	Bright	1894	Charlotte Hewett 1863	Henry Edmund Bright 1862
Charlotte Hewett 1863	Charlotte	none	Hewett	1863	not specified	not specified
Clare Bright 1966	Clare	none	Bright	1966	Diana Pool	Peter William Bright 1941
Diana Pool	Diana	none	Pool	none	not specified	not specified
David Bright 1934	David	none	Bright	1934	Iris Ellen Archer 1906	William George Bright 1901
Dereck Heath	Dereck	none	Heath	1927	not specified	not specified
Eileen Mary Rever 1929	Eileen	Mary	Rever	1929	Violet Sylvia Steward 1894	Charles Herbert Rever 1895
Elizabeth Frances Jessop 1869	Elizabeth	Frances	Jessop	1869	not specified	not specified
Ethel Archer 1912	Ethel	none	Archer	1912	Violet Heath 1887	James Alexander Archer 1882
Frederick Herbert Bright 1889	Frederick	Herbert	Bright	1889	Charlotte Hewett 1863	Henry Edmund Bright 1862
Henry Edmund Bright 1862	Henry	Edmund	Bright	1862	not specified	not specified
Henry Edmund Bright 1887	Henry	Edmund	Bright	1887	Charlotte Hewett 1863	Henry Edmund Bright 1862
Ian Bright 1959	Ian	none	Bright	1959	Joyce Gosport	John Bright 1930
Iris Ellen Archer 1906	Iris	Ellen	Archer	1906	Violet Heath 1887	James Alexander Archer 1882
James Alexander Archer 1882	James	Alexander	Archer	1882	not specified	not specified
James Bright 1964	James	none	Bright	1964	Diana Pool	Peter William Bright 1941
James Frank Hayden Bright 1891	James	Frank	Bright	1891	Charlotte Hewett 1863	Henry Edmund Bright 1862
Janet Bright 1964	Janet	none	Bright	1964	Joyce Gosport	John Bright 1930
John Bright 1930	John	none	Bright	1930	Iris Ellen Archer 1906	William George Bright 1901
John Tacey Steward 1873	John	Tacey	Steward	1873	not specified	not specified
Joyce Archer 1921	Joyce	none	Archer	1921	Violet Heath 1887	James Alexander Archer 1882
Joyce Gosport	Joyce	none	Gosport	not specified	not specified	not specified
Julie Bright 1966	Julie	none	Bright	1966	Diana Pool	Peter William Bright 1941
Kathleen Minnie Bright 1904	Kathleen	Minnie	Bright	1904	Charlotte Hewett 1863	Henry Edmund Bright 1862
Leonard John Bright 1890	Leonard	John	Bright	1890	Charlotte Hewett 1863	Henry Edmund Bright 1862
Lois Green 1871	Lois	none	Green	1871	not specified	not specified
Margaret Grace Rever 1934	Margaret	Grace	Rever	1934	Violet Sylvia Steward 1894	Charles Herbert Rever 1895
Mark Anthony Heath 1960	Mark	Anthony	Heath	1960	Eileen Mary Rever 1929	Dereck Heath
Mark Bright 1956	Mark	none	Bright	1956	Joyce Gosport	John Bright 1930
Nicholas Charles Heath 1964	Nicholas	Charles	Heath	1964	Eileen Mary Rever 1929	Dereck Heath
Nora Ada Bright 1899	Nora	Ada	Bright	1899	Charlotte Hewett 1863	Henry Edmund Bright 1862
Norman James Archer 1909	Norman	James	Archer	1909	Violet Heath 1887	James Alexander Archer 1882
Peter William Bright 1941	Peter	William	Bright	1941	Iris Ellen Archer 1906	William George Bright 1901

continued..

Table A.1: The list of individuals in the FHKB

Richard John Bright 1962	Richard	John	Bright	1962	Margaret Grace Rever 1934	David Bright 1934
Robert David Bright 1965	Robert	David	Bright	1965	Margaret Grace Rever 1934	David Bright 1934
Violet Heath 1887	Violet	none	Heath	1887	not specified	not specified
Violet Sylvia Steward 1894	Violet	Sylvia	Steward	1894	Lois Green 1871	John Tacey Steward 1873
William Bright 1970	William	none	Bright	1970	Joyce Gosport	John Bright 1930
William George Bright 1901	William	George	Bright	1901	Charlotte Hewett 1863	Henry Edmund Bright 1862
William Rever 1870	William	none	Rever	1870	not specified	not specified