**Part 1**

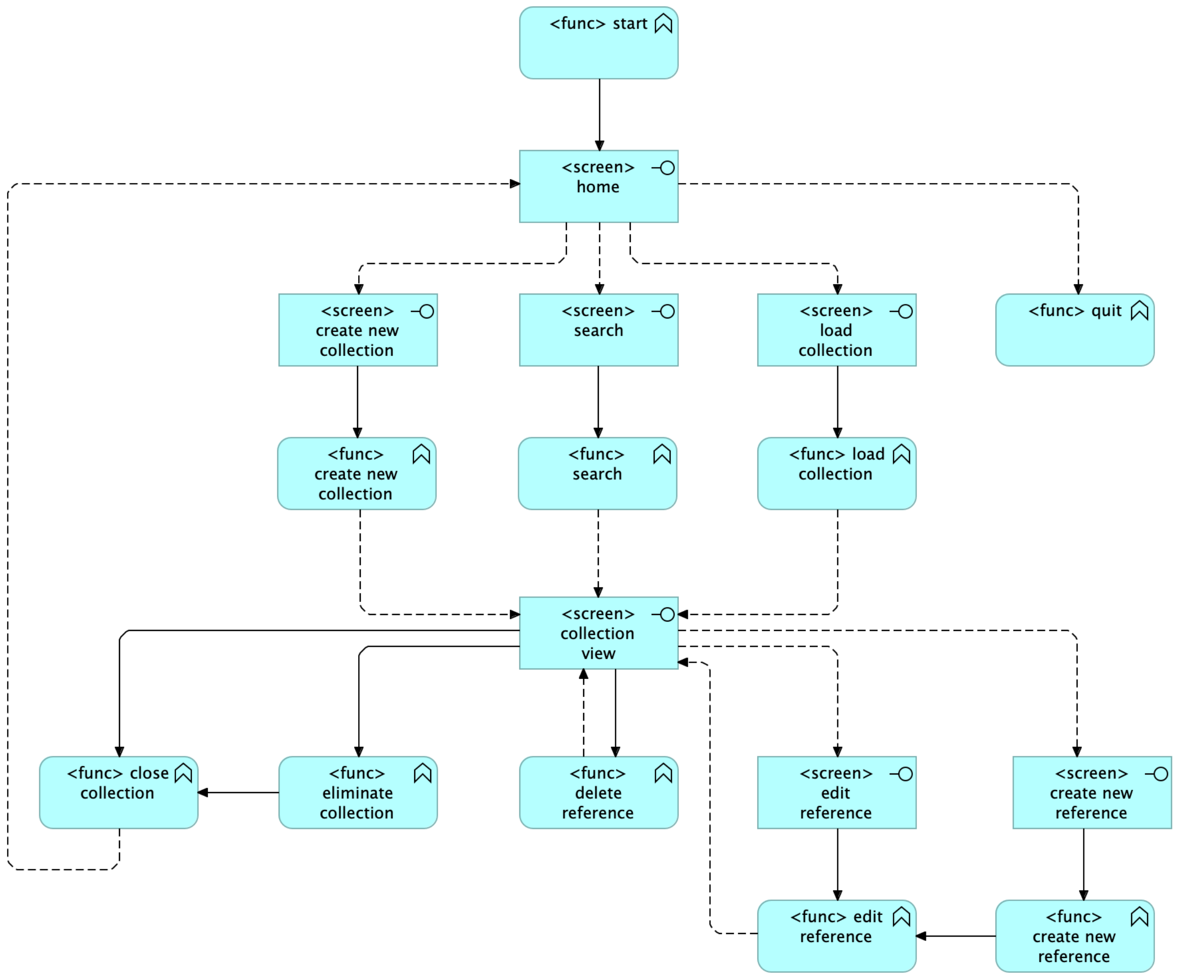
# Harvard References

## Overview

Harvard References is a console application that helps to collect and to format references according to the rules of the Harvard Referencing Guide (University of Essex, 2018). References are organized in collections to let the user work on multiple projects at the same time. References can be searched by authors or title.

## Functional description

- From the home screen, the user can choose between creating and loading a collection, performing a search, and quitting. Quitting is always possible with ctrl+c.
- The search screen lets the user search references by author or by title. The research allows for partial matching. Results show the matching reference and the collection containing it. The user can select a result and open the corresponding collection.
- The collection view shows the collection, its description, and all its references. References are displayed sorted and formatted. From this screen, the user can close or delete the active collection or add, edit, or delete a reference. A print&exit function closes the application printing a copy&paste-friendly list of references.
- The user must confirm the deletion before the application deletes content.
- The creation and edit screens of a reference show only the relevant fields for the selected type. While editing, the current value is the default.

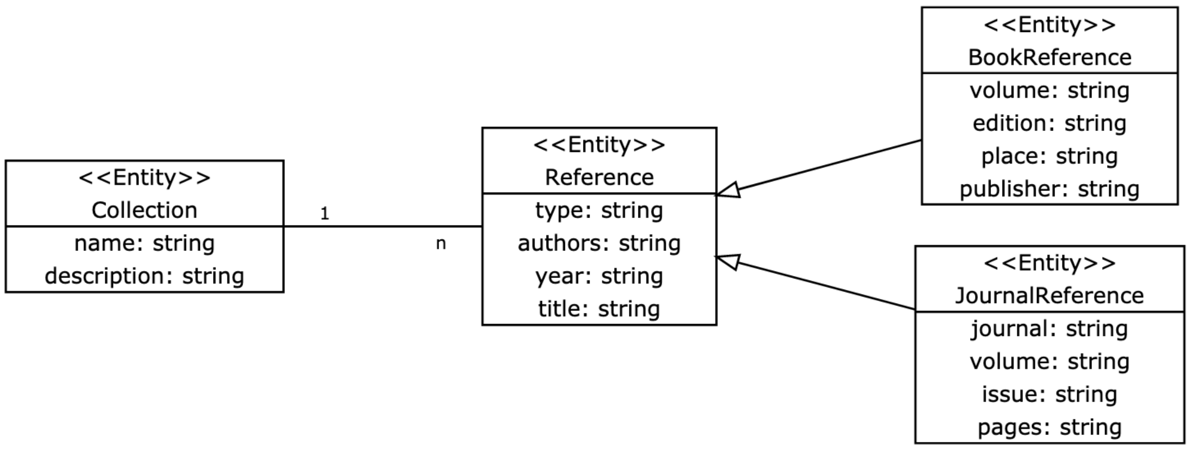


*Connections between functionalities and screens*

## Data structure

The basic structure is the collection that is characterized by a unique name, description, and a list of references.

A reference is an abstract type containing the common fields of all references like authors or title. It has multiple concrete implementations representing each different type, like Book, Ebook, or Vitalsource.



*Partial UML diagram*

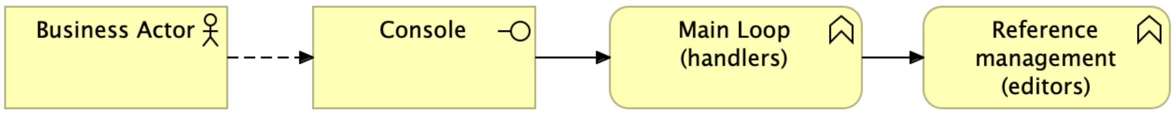
CRUD operations implemented by the Storage keep the collection persisted in the storage. The Storage is an abstraction layer that can be easily replaced with a database (e.g. SQLite) in future releases. It is implemented as a singleton as described by Gamma et al. (1995, as cited in Maclean, 1997)

**Rationale of the design**

The implementation follows the SOLID principles of Object Oriented design as described by Martin (2000). Additional design patterns are also followed to implements various components.

| **Responsibility** | **Class** |
|---|---|
| Main loop of the state machine | Console |
| Handling one state of the machine | Handler* |
| Editing a type of reference | Edit* |
| Formatting reference | *Reference |
| Sorting references | Collection |
| Persistence | Storage |

The interface implements a state machine combined with a command dispatcher pattern that allows for easy expansion as suggested by Dupire et al. (2001). Each iteration calls the handler corresponding to the state and the handler sets the next state and the context. Some handlers use Edit* classes to manipulate references.

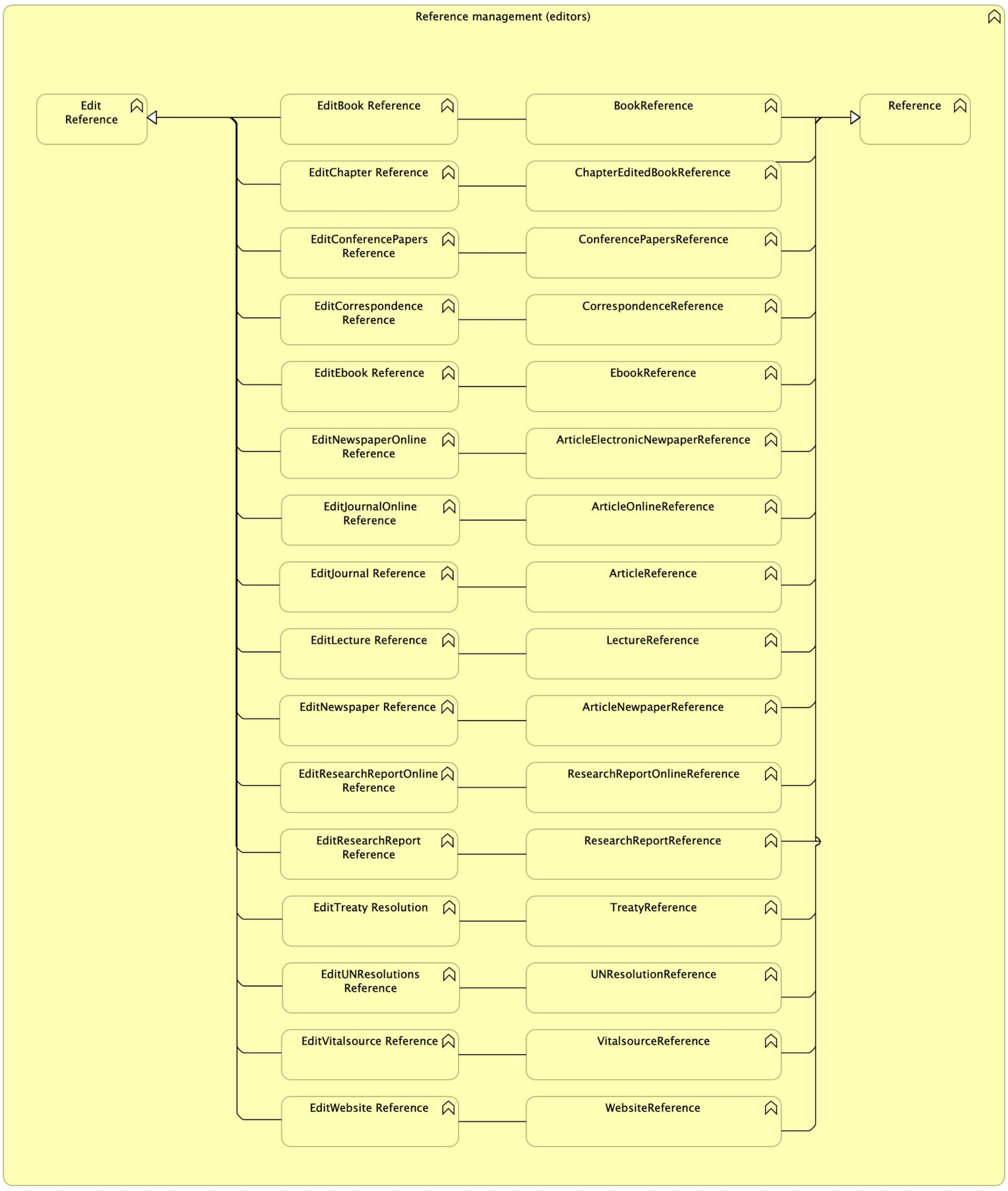


*Main logic components*

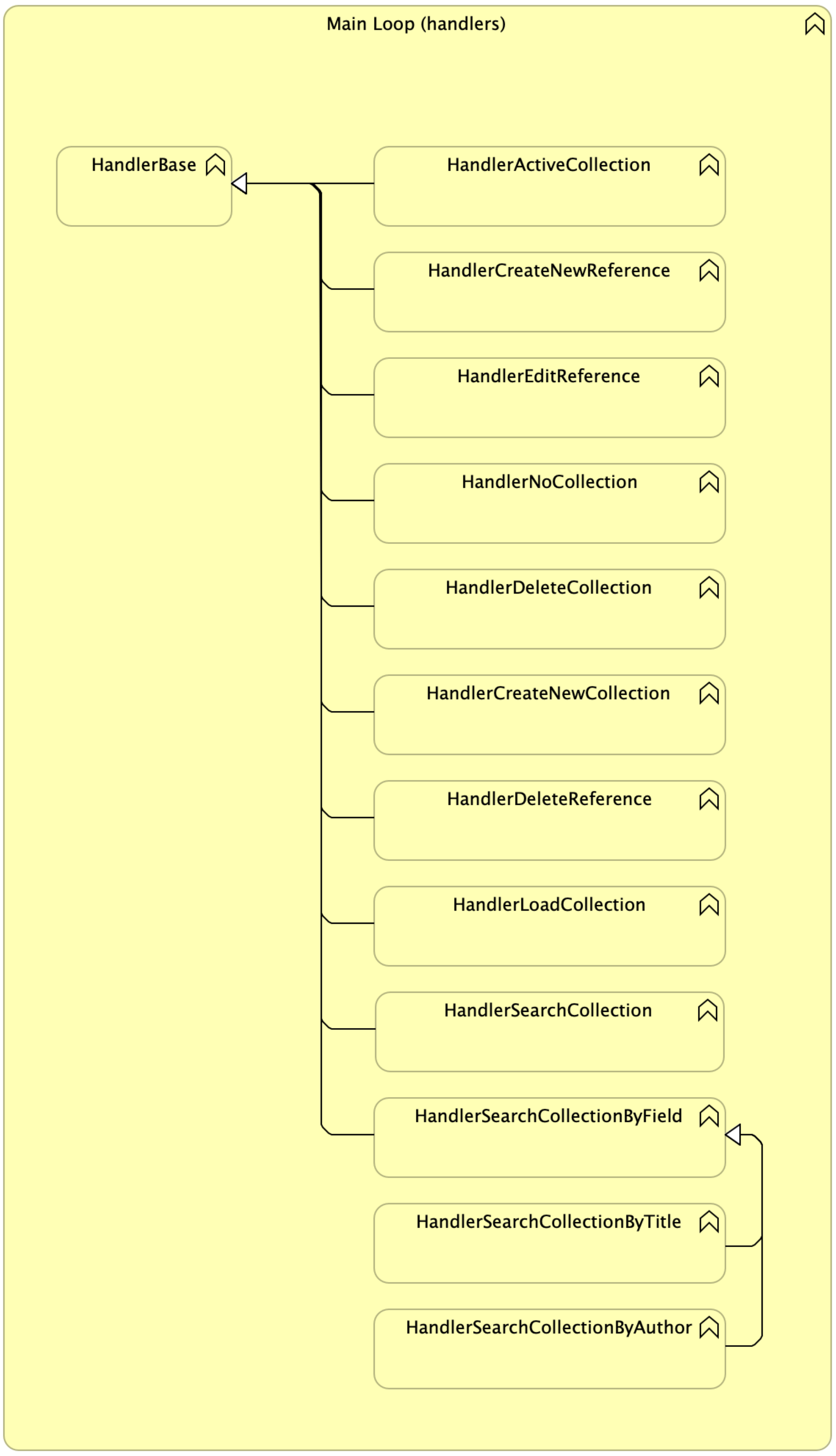
In pseudo-code:

```
while(current_state!=EXIT):
    handler = handlers [current_state]
    current_state, context = handler.handle(context)
```

Handlers and Editors are organized in two hierarchies of classes with a base class. Handlers implement a prototype design pattern extending a base interface. Editors implement a decorator pattern extending a base class as described by Mu (2011).



*Relations between Edit* and model*



*Handler* classes*

Each Reference class implements the Reference prototype to correctly print the reference in the console.

Searching is a function implemented by a base class with a controlled extension pattern realizing a template-method design pattern as described by Gamma et al. (1995, as cited in Zafeiris et al., 2016: 22).

In pseudo-code:

```
foreach collection in collections:
    foreach reference in collection.references:
        if matches(reference, query):
            results.add(reference)
```

Where “matches” is an abstract method with different implementations for authors and titles.

To guarantee a homogeneous style across the application, user input/output is centralized in a Utility class that collects static methods. Utility supports formatting styles such as “title” or “option” and accepts a list of strings as well as a list of lists that is processed recursively.

In pseudo-code:

```
print_lines(list_to_print):
    for entry in list_to_print:
        if entry is-a list:
            print_lines(entry)
        else
            print_formatted(entry)
```

Dependency injection is used to automatically wire handlers and editors reducing coupling and improving maintainability as suggested by Razina et al. (2007).

In pseudo-code:

```
foreach mber in module.members.filter(m->m is-a module):
     foreach inner-member in mber.members      \
          .filter(i->i is-a typex and i is-not abstract):
          list_of_tipex.add(inner-member)
return list_of_typex
```

**Requirements and installation**

The application requires Python 3.6 or greater, and Colorama as an additional module.

The application has dependencies that can be installed with:

```
pip3 install -e .
```

from the root folder.

**How to use it**

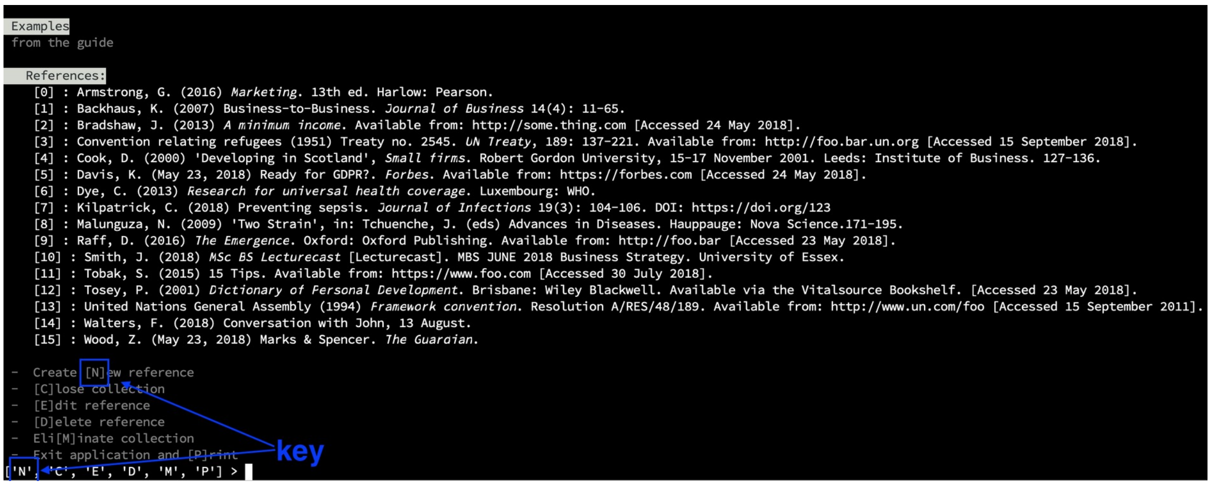
The code is available at https://github.com/ros101/harvard-referencing

To start the application it is sufficient to call

```
python3 main.py
```

from the root folder.

The user can navigate the application by inserting the key letter of an option and pressing return. Keys as listed in the command line and refer to the letters in brackets in the text.



```
 Examples
 from the guide

   References:
    [0] : Armstrong, G. (2016) Marketing. 13th ed. Harlow: Pearson.
    [1] : Backhaus, K. (2007) Business-to-Business. Journal of Business 14(4): 11-65.
    [2] : Bradshaw, J. (2013) A minimum income. Available from: http://some.thing.com [Accessed 24 May 2018].
    [3] : Convention relating refugees (1951) Treaty no. 2545. UN Treaty, 189: 137-221. Available from: http://foo.bar.un.org [Accessed 15 September 2018].
    [4] : Cook, D. (2000) 'Developing in Scotland', Small firms. Robert Gordon University, 15-17 November 2001. Leeds: Institute of Business. 127-136.
    [5] : Davis, K. (May 23, 2018) Ready for GDPR?. Forbes. Available from: https://forbes.com [Accessed 24 May 2018].
    [6] : Dye, C. (2013) Research for universal health coverage. Luxembourg: WHO.
    [7] : Kilpatrick, C. (2018) Preventing sepsis. Journal of Infections 19(3): 104-106. DOI: https://doi.org/123
    [8] : Malunguza, N. (2009) 'Two Strain', in: Tchuenche, J. (eds) Advances in Diseases. Hauppauge: Nova Science.171-195.
    [9] : Raff, D. (2016) The Emergence. Oxford: Oxford Publishing. Available from: http://foo.bar [Accessed 23 May 2018].
    [10] : Smith, J. (2018) MSc BS Lecturecast [Lecturecast]. MBS JUNE 2018 Business Strategy. University of Essex.
    [11] : Tobak, S. (2015) 15 Tips. Available from: https://www.foo.com [Accessed 30 July 2018].
    [12] : Tosey, P. (2001) Dictionary of Fersonal Development. Brisbane: Wiley Blackwell. Available via the Vitalsource Bookshelf. [Accessed 23 May 2018].
    [13] : United Nations General Assembly (1994) Framework convention. Resolution A/RES/48/189. Available from: http://www.un.com/foo [Accessed 15 September 2011].
    [14] : Walters, F. (2018) Conversation with John, 13 August.
    [15] : Wood, Z. (May 23, 2018) Marks & Spencer. The Guardian.

 -   Create [N]ew reference
 -   [C]lose collection
 -   [E]dit reference
 -   [D]elete reference
 -   Eli[M]inate collection
 -   Exit application and [P]rint
['N', 'C', 'E', 'D', 'M', 'P'] >
```

*Collection view*

The application automatically saves data in the `./harvard_collections_data` folder.

**Test plan**

- Verify the automated tests with

  `python3 setup.py test`

- Create a collection and insert the examples from the Harvard Reference Guide. Verify that the formatting is correct.
- Search for an author and a title with a partial match and verify that the collection is found.
- Print and exit and verify that output is sorted and formatted

## References

Dupire B., Fernandez E.B. (2001) ‘The Command Dispatcher Pattern’, *8th Conference on Pattern Languages of Programs*.

Gamma E., Helm E., Johnson R., Vlissides J. (1995) *Design Patterns Elements of Reusable Object Oriented Software.* Addison Wesley.

H. Mu and S. Jiang, (2011) ‘Design patterns in software development’, *IEEE 2nd International Conference on Software Engineering and Service Science.* Beijing, China, 15-17 July 2011. 2011 IEEE 2nd International Conference on Software Engineering and Service Science. 322-325, doi: 10.1109/ICSESS.2011.5982228.

Maclean, S. (1997) *On The Singleton Software Design Pattern*. Dept of Electronics and Computer Science, Higheld Southampton United Kingdom: University of Southampton.

Martin, R.C. (2000) Design principles and design patterns. *Object Mentor*. Available from: http://staff.cs.utu.fi/staff/jouni.smed/doos_06/material/DesignPrinciplesAndPatterns.pdf [Accessed on 26 September 2021]

Razina E., Janzen D. (2007) ‘Effects of dependency injection on maintainability’, *Proceedings of the 11th IASTED International Conference on Software Engineering and Applications.* Cambridge, MA, USA, 19-21 November 2007.

University of Essex (2018) *Harvard Referencing Guide*. Available from: https://www.my-course.co.uk/mod/resource/view.php?id=202690 [Accessed 11 Sep 2021]

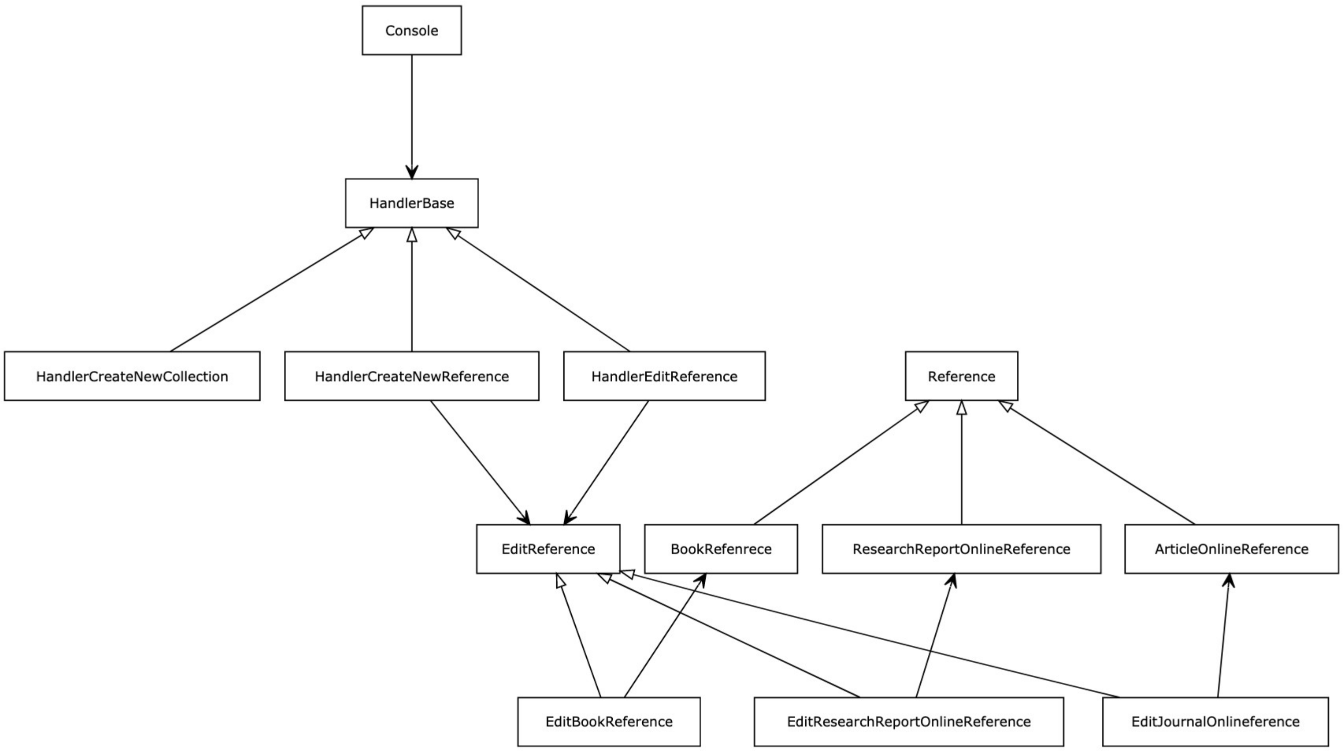
Zafeiris E.V., Poulias S.H., Diamantidis N.A., Giakoumakis E.A. (2016) Automated refactoring of super-class method invocations to the Template Method design pattern. *Information and Software Technology* 82: 19-35

## Part 2 - Readme

**Harvard References – Technical notes**

**Navigating the code**

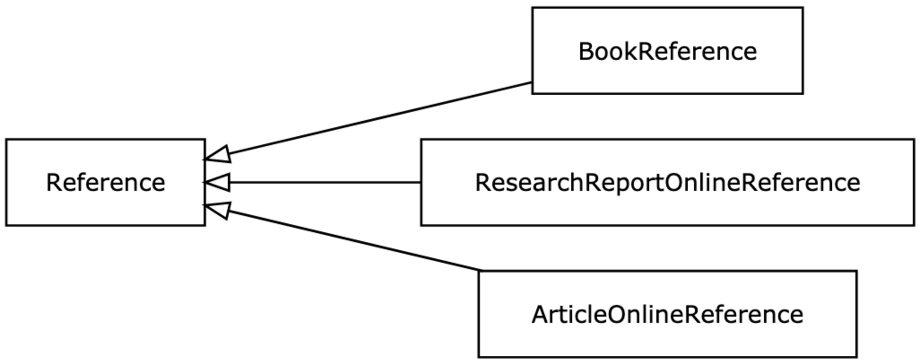
The entry point is `main.py` that contains the call to the real main class of the software, `Console`, in `harvard.py`. The `loop` calls `Handler` classes in `handler_*.py` depending on the state. Two special Handlers are `HandlerCreateNewReference` and `HandlerEditReference` that call `Edit` classes in `edit_*.py`. The model, `Reference` classes and `Collection`, is coded in the `reference_*.py` and `collection.py.` The remaining files contain the `Storage` (`storage.py`), the enumeration of possible `States` (`state.py`), and `Utility` methods (`utility.py`).



*Partial model*

**References**

There are multiple types of References. A few attributes are common to all types (e.g. having a title), but most of the attributes are specific to one or a few types. However, all References are semantically perfectly equivalent. One Reference is part of a collection, can be searched, and has a printed representation. For these reasons, it was natural to model References as multiple classes with `Reference` as a base class.



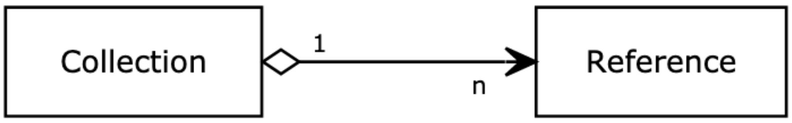
*Partial model*

The Object-Oriented approach is also preferred to maintain data encapsulation and avoid external formatters that may easily grow in size with the growth of Reference types, therefore, a Reference contains the `format_console` method to format itself.

**Collection**

A Collection is a mere container of References. Its only function is to divide References into separate groups. The implementation is a simple class with functions to manipulate the list of references. Consistently with the modeling of

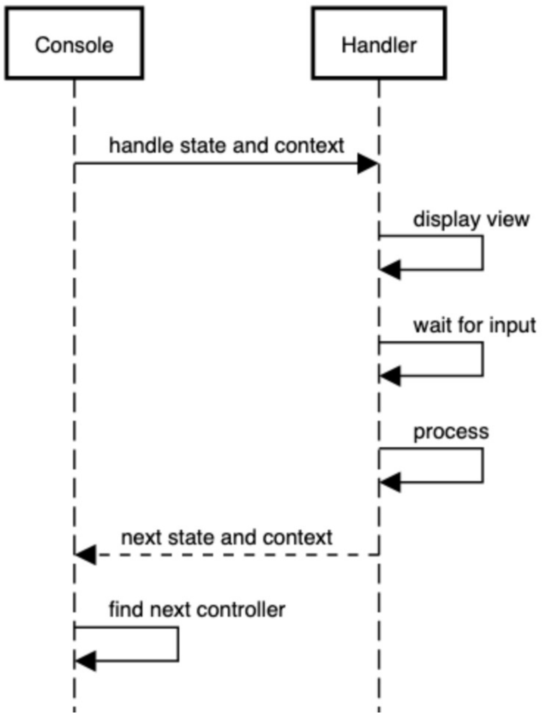
References, also Collection encapsulates its data and implement logic to manipulate itself.



**Console and Handlers**

The interaction with the user follows a loop in the Console and Handlers classes: display view, wait for input, process input, repeat. The processing function determines the next state and context, and the processing function is determined by the state of the application.

The logic is implemented in `Console.loop` and in all subclasses of `HandlerBase` implementing `handle`.



The `Console` class delegates the control to a Handler that is responsible for creating the view, getting the User’s input, processing it, and returning the context for the next iteration of the main loop.

All Handlers processing the state are semantically equivalent, they differ only in logic, and are bound 1:1 to a specific state.

The relation with state and context is

```
handler = f(state);

state, context = handler(context)
```

## Editors

Creating or editing a Reference is core functionality in the application. While it would be possible to assign the responsibility to `HandlerCreateNewReference` and `HandlerEditReference`, the complexity and the size of the task suggest the creation of a new type of specialized components. Editors are very similar among each other and are strongly related to the Reference they process. Having a specialized type of component results in clean and focused code that can be easily maintained.

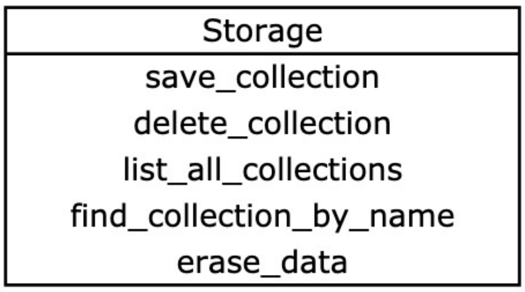
The relation with the Reference is:

```
editor = f(reference)

reference = editor(reference)
```

## Storage

`Storage` is a singleton that implements the input / output of the application. It is an abstraction layer hiding completely the implementation to the caller and it can be replaced by industry standards solutions. For example, Python offers a very simple API to use SQLite databases and that would be the easiest next step to easily integrate more advanced search functions.



Persistence is achieved using serialization / deserialization of the Python's objects to and from the filesystem with the `pickle` and `os` packages. The "artificial" limitations in the collections' names (alphanumerical with only a few special characters allowed) stem from this characteristic: the collection name is part of the filename that contains its serialized representation. This limitation could be lifted using standardized filenames (e.g. `collection_x.bin`) or serializing the data in a single collection of collections.

**Dependency injection**

As outlined in part 1, a mechanism of dependency injection is implemented in `Console.__find_handlers` and `HandlerEditReference.__find_editors` in order to minimize coupling and make extensions easier.

It was not used in `HandlerCreateNewReference` because there must be a relation between the menu key and the required Editor. This relation is a responsibility of the Handler and cannot be managed with dependency injection without introducing another layer of indirection that would have made the code less clear.

**The Utility class**

As outlined in part 1, the Utility class collects methods to print strings formatted with tags such as `@title` or `@subtitle`, and to interact with the user with a standardized menu.

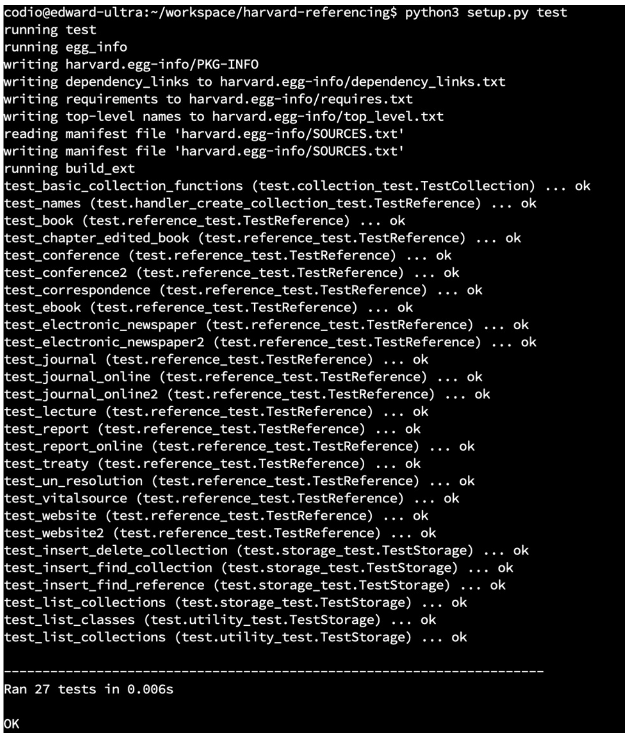
The style makes use of `colorama` to import ANSI escape character codes and format the text with colors, italic, and different backgrounds.
The methods interacting with the user accept only valid keys from the menu. Lines tagged with `@option` in the print functions are automatically inspected to find a key that will later be used in the interaction with the user. Where possible `Utility.interact` integrated printing the menu, extracting the keys, and returning the user's input in a single call.

In Utility, there is also `Utility.find_classes` that explores the codebase looking for implementations of the base class passed as a parameter. This method is the base of the dependency injection outlined earlier.

## Part 2 - Testing

**Harvard References – Testing**

Part of the development followed a test-driven approach coding a test and only in a second moment writing the implementation to satisfy it. This approach is a convenient way to avoid regressions during a refactoring and it is very useful to verify small details such as the presence of a full stop or the correct order of the many parts of a reference.



```
codio@edward-ultra:~/workspace/harvard-referencing$ python3 setup.py test
running test
running egg_info
writing harvard.egg-info/PKG-INFO
writing dependency_links to harvard.egg-info/dependency_links.txt
writing requirements to harvard.egg-info/requires.txt
writing top-level names to harvard.egg-info/top_level.txt
reading manifest file 'harvard.egg-info/SOURCES.txt'
writing manifest file 'harvard.egg-info/SOURCES.txt'
running build_ext
test_basic_collection_functions (test.collection_test.TestCollection) ... ok
test_names (test.handler_create_collection_test.TestReference) ... ok
test_book (test.reference_test.TestReference) ... ok
test_chapter_edited_book (test.reference_test.TestReference) ... ok
test_conference (test.reference_test.TestReference) ... ok
test_conference2 (test.reference_test.TestReference) ... ok
test_correspondence (test.reference_test.TestReference) ... ok
test_ebook (test.reference_test.TestReference) ... ok
test_electronic_newspaper (test.reference_test.TestReference) ... ok
test_electronic_newspaper2 (test.reference_test.TestReference) ... ok
test_journal (test.reference_test.TestReference) ... ok
test_journal_online (test.reference_test.TestReference) ... ok
test_journal_online2 (test.reference_test.TestReference) ... ok
test_lecture (test.reference_test.TestReference) ... ok
test_report (test.reference_test.TestReference) ... ok
test_report_online (test.reference_test.TestReference) ... ok
test_treaty (test.reference_test.TestReference) ... ok
test_un_resolution (test.reference_test.TestReference) ... ok
test_vitalsource (test.reference_test.TestReference) ... ok
test_website (test.reference_test.TestReference) ... ok
test_website2 (test.reference_test.TestReference) ... ok
test_insert_delete_collection (test.storage_test.TestStorage) ... ok
test_insert_find_collection (test.storage_test.TestStorage) ... ok
test_insert_find_reference (test.storage_test.TestStorage) ... ok
test_list_collections (test.storage_test.TestStorage) ... ok
test_list_classes (test.utility_test.TestStorage) ... ok
test_list_collections (test.utility_test.TestStorage) ... ok

----------------------------------------------------------------------
Ran 27 tests in 0.006s

OK
```

As outlined in part 1 automated tests can be launched with:

```
python3 setup.py test
```

Test automation is generally difficult and time-consuming on the presentation layer. In this particular case, the application does not make use of a standard GUI or a web interface, so it would be complex to verify the output on screen and mimic the user's input. This is the rationale behind choosing to manually test the interface, the flow between views, and the processes to manipulate collections and references.

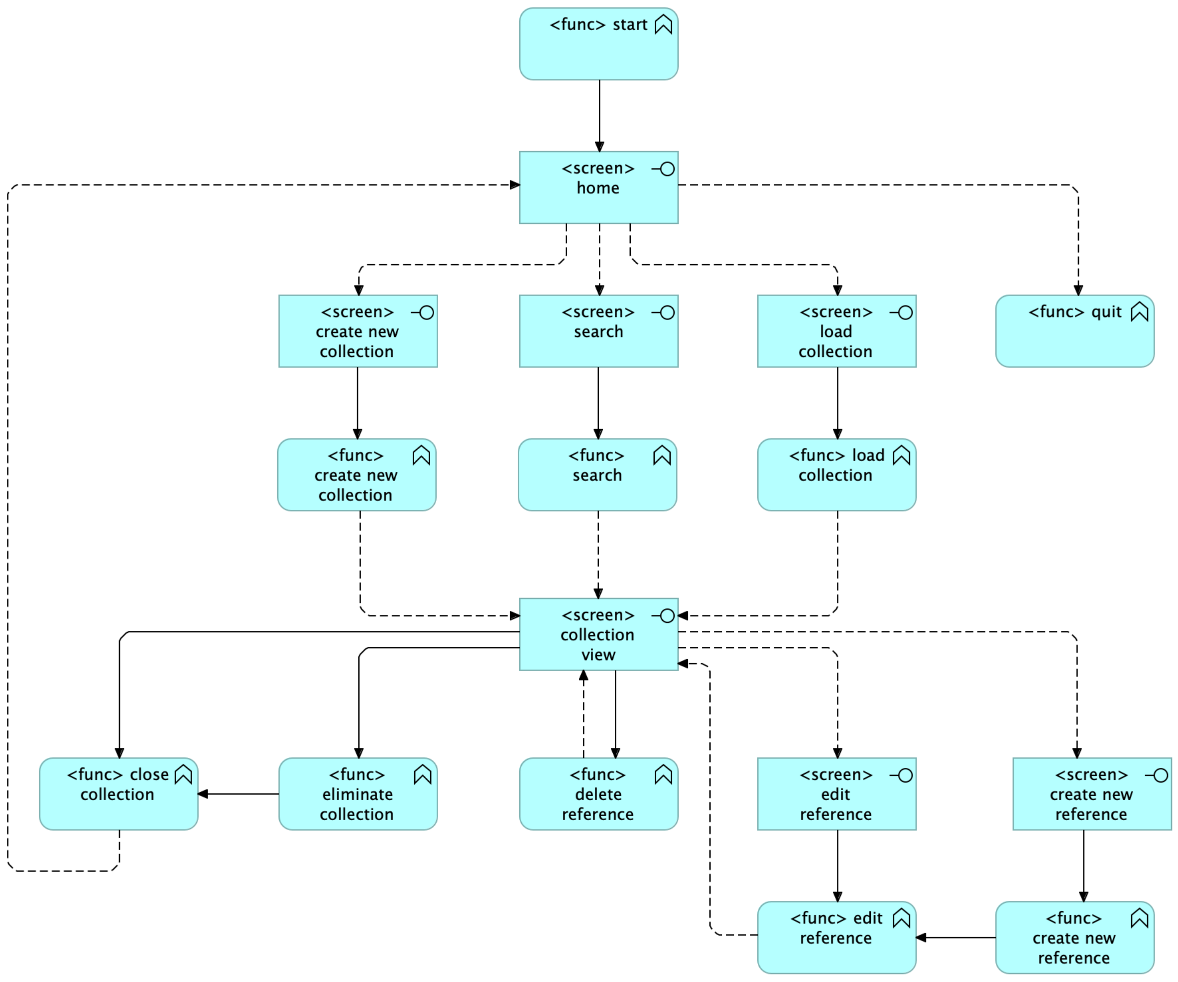
Manual testing covered:

- Navigating through menus.

- Creating and editing Collections and References as explained below.
- Deleting Collections and References selecting from the menu.
- Verify the order of the Reference, including in the exit&print function as outlined in part 1.
- Search by author or title as outlined in part 1.
- Verify the confirmation prompt when performing destructive action (deleting a Collection).

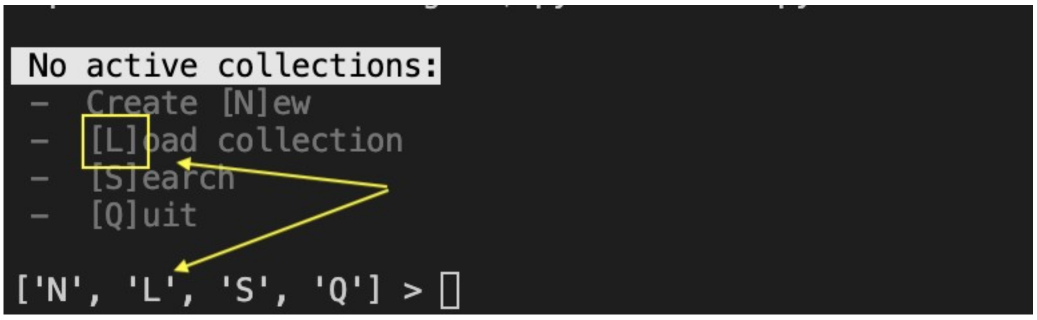
## Testing, in detail

The flow is modeled by this diagram (from part 1):



Testing the flow consists in entering the required key to move from a screen to another or to trigger a function.

The navigation keys are in brackets and are listed in the prompt.

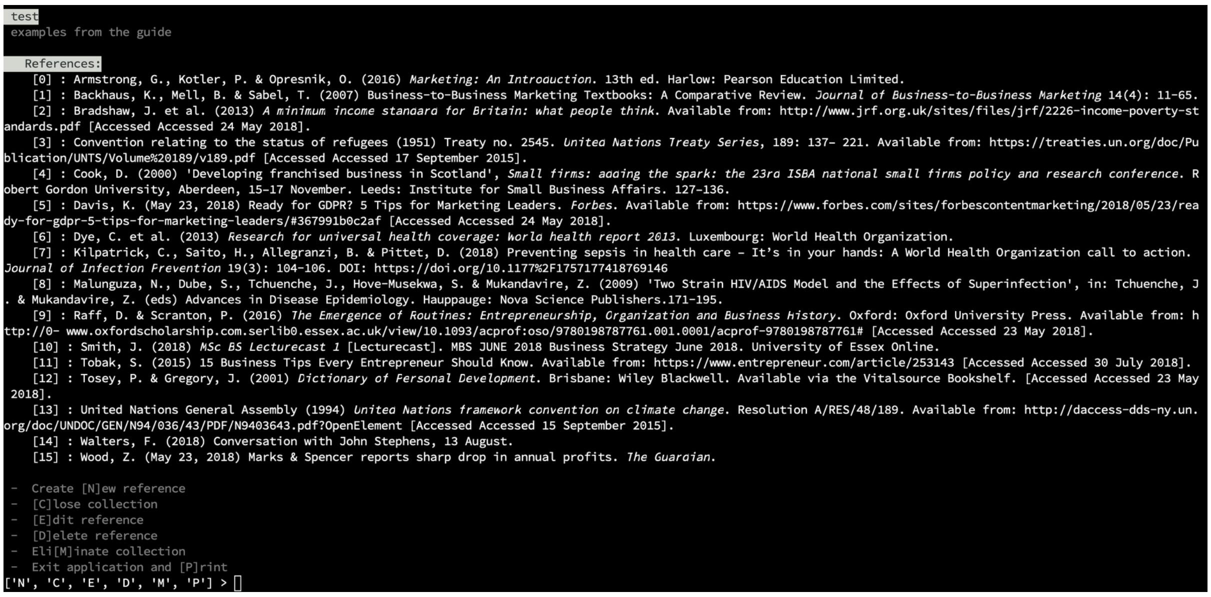


```
No active collections:
 -  Create [N]ew
 -  [L]oad collection
 -  [S]earch
 -  [Q]uit

['N', 'L', 'S', 'Q'] > 
```

Pressing L <enter>, for example, opens the Load screen.

The test plan requires the creation of all the examples from the Harvard Referencing Guide. The first step is the creation of a new collection (N, in the initial screen), followed by the definition of a custom name and description. Then, with the collection open, it is possible to create references (N, in the collection screen) choosing the type (e.g. B for books) and filling the values. The following image is the result.



```
 test
 examples from the guide

   References:
    [0] : Armstrong, G., Kotler, P. & Opresnik, O. (2016) Marketing: An Introduction. 13th ed. Harlow: Pearson Education Limited.
    [1] : Backhaus, K., Mell, B. & Sabel, T. (2007) Business-to-Business Marketing Textbooks: A Comparative Review. Journal of Business-to-Business Marketing 14(4): 11-65.
    [2] : Bradshaw, J. et al. (2013) A minimum income standard for Britain: what people think. Available from: http://www.jrf.org.uk/sites/files/jrf/2226-income-poverty-st
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    [3] : Convention relating to the status of refugees (1951) Treaty no. 2545. United Nations Treaty Series, 189: 137- 221. Available from: https://treaties.un.org/doc/Pu
blication/UNTS/Volume%20189/v189.pdf [Accessed Accessed 17 September 2015].
    [4] : Cook, D. (2000) 'Developing franchised business in Scotland', Small firms: adding the spark: the 23rd ISBA national small firms policy and research conference. R
obert Gordon University, Aberdeen, 15–17 November. Leeds: Institute for Small Business Affairs. 127–136.
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dy-for-gdpr-5-tips-for-marketing-leaders/#367991b0c2af [Accessed Accessed 24 May 2018].
    [6] : Dye, C. et al. (2013) Research for universal health coverage: World health report 2013. Luxembourg: World Health Organization.
    [7] : Kilpatrick, C., Saito, H., Allegranzi, B. & Pittet, D. (2018) Preventing sepsis in health care – It’s in your hands: A World Health Organization call to action.
Journal of Infection Prevention 19(3): 104-106. DOI: https://doi.org/10.1177%2F1757177418769146
    [8] : Malunguza, N., Dube, S., Tchuenche, J., Hove-Musekwa, S. & Mukandavire, Z. (2009) 'Two Strain HIV/AIDS Model and the Effects of Superinfection', in: Tchuenche, J
. & Mukandavire, Z. (eds) Advances in Disease Epidemiology. Hauppauge: Nova Science Publishers.171-195.
    [9] : Raff, D. & Scranton, P. (2016) The Emergence of Routines: Entrepreneurship, Organization and Business History. Oxford: Oxford University Press. Available from: h
ttp://0- www.oxfordscholarship.com.serlib0.essex.ac.uk/view/10.1093/acprof:oso/9780198787761.001.0001/acprof-9780198787761# [Accessed Accessed 23 May 2018].
    [10] : Smith, J. (2018) MSc BS Lecturecast 1 [Lecturecast]. MBS JUNE 2018 Business Strategy June 2018. University of Essex Online.
    [11] : Tobak, S. (2015) 15 Business Tips Every Entrepreneur Should Know. Available from: https://www.entrepreneur.com/article/253143 [Accessed Accessed 30 July 2018].
    [12] : Tosey, P. & Gregory, J. (2001) Dictionary of Personal Development. Brisbane: Wiley Blackwell. Available via the Vitalsource Bookshelf. [Accessed Accessed 23 May
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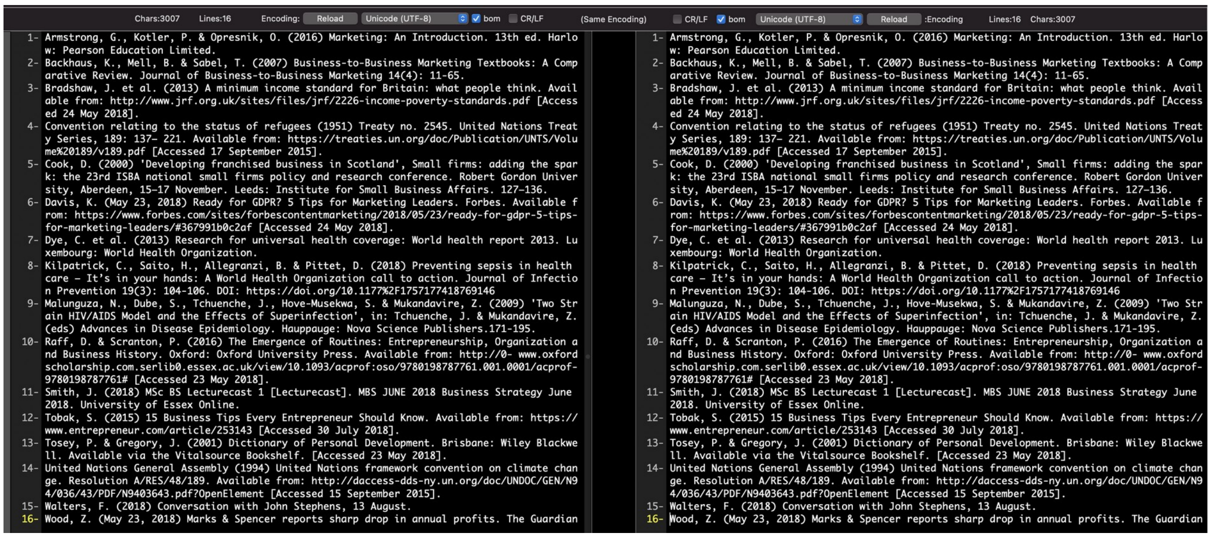
    [13] : United Nations General Assembly (1994) United Nations framework convention on climate change. Resolution A/RES/48/189. Available from: http://daccess-dds-ny.un.
org/doc/UNDOC/GEN/N94/036/43/PDF/N9403643.pdf?OpenElement [Accessed Accessed 15 September 2015].
    [14] : Walters, F. (2018) Conversation with John Stephens, 13 August.
    [15] : Wood, Z. (May 23, 2018) Marks & Spencer reports sharp drop in annual profits. The Guardian.

 -  Create [N]ew reference
 -  [C]lose collection
 -  [E]dit reference
 -  [D]elete reference
 -  Eli[M]inate collection
 -  Exit application and [P]rint
['N', 'C', 'E', 'D', 'M', 'P'] > 
```

Using the print&exit (P, in the collection screen) quits the application and prints the references without the selection keys. Comparing the printed references with the expected result from the guide is better done using a *diff* tool to spot minimal differences as in the following picture.



```
Armstrong, G., Kotler, P. & Opresnik, O. (2016) Marketing: An Introduction. 13th ed. Harlow: Pearson Education Limited.
Backhaus, K., Mell, B. & Sabel, T. (2007) Business-to-Business Marketing Textbooks: A Comparative Review. Journal of Business-to-Business Marketing 14(4): 11-65.
Bradshaw, J. et al. (2013) A minimum income standard for Britain: what people think. Available from: http://www.jrf.org.uk/sites/files/jrf/2226-income-poverty-standards.pdf [Accessed 24 May 2018].
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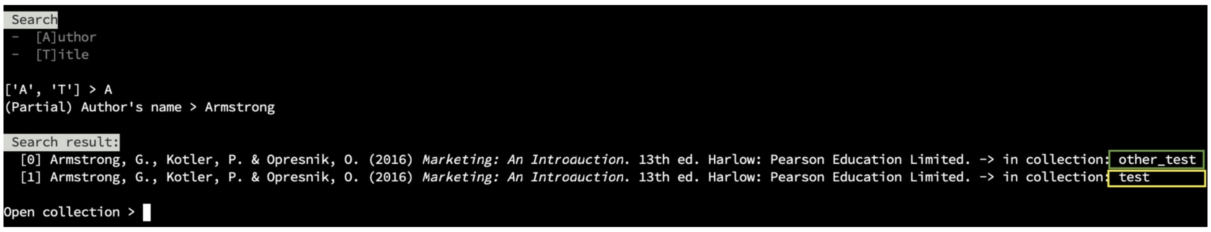
To test the search function it was necessary to duplicate one Reference in a new Collection in order to get multiple results. Searching for the duplicated reference results, indeed, in multiple findings in the two collections.



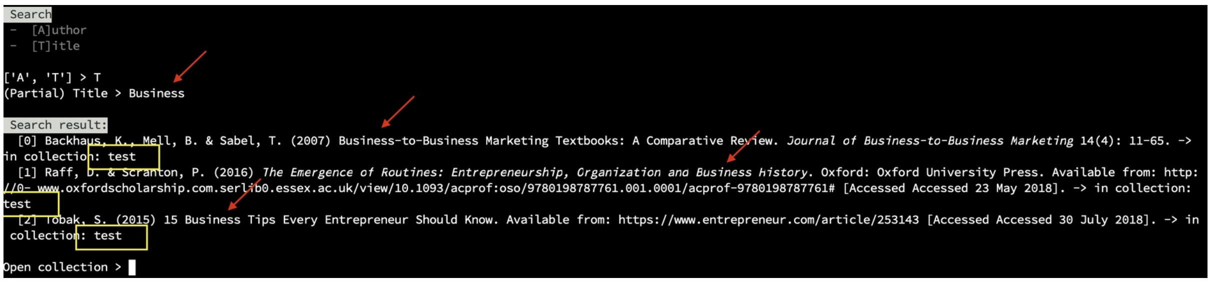
```
 Search
 -  [A]uthor
 -  [T]itle

['A', 'T'] > A
(Partial) Author's name > Armstrong

 Search result:
  [0] Armstrong, G., Kotler, P. & Opresnik, O. (2016) Marketing: An Introduction. 13th ed. Harlow: Pearson Education Limited. -> in collection: other_test
  [1] Armstrong, G., Kotler, P. & Opresnik, O. (2016) Marketing: An Introduction. 13th ed. Harlow: Pearson Education Limited. -> in collection: test

Open collection >
```

Searching for a substring present only in one collection results in multiple findings for the same collection.



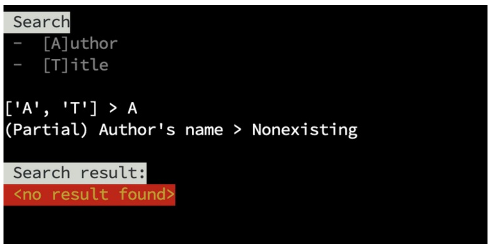
```
 Search
 -  [A]uthor
 -  [T]itle

['A', 'T'] > T
(Partial) Title > Business

 Search result:
  [0] Backhaus, K., Mell, B. & Sabel, T. (2007) Business-to-Business Marketing Textbooks: A Comparative Review. Journal of Business-to-Business Marketing 14(4): 11-65. ->
in collection: test
  [1] Raff, D. & Scranton, P. (2016) The Emergence of Routines: Entrepreneurship, Organization and Business History. Oxford: Oxford University Press. Available from: http:
//0- www.oxfordscholarship.com.serlib0.essex.ac.uk/view/10.1093/acprof:oso/9780198787761.001.0001/acprof-9780198787761# [Accessed Accessed 23 May 2018]. -> in collection:
test
  [2] Tobak, S. (2015) 15 Business Tips Every Entrepreneur Should Know. Available from: https://www.entrepreneur.com/article/253143 [Accessed Accessed 30 July 2018]. -> in
 collection: test

Open collection >
```

The final test for the search function is a negative test researching one author that doesn't exist in the collection to receive an empty result.

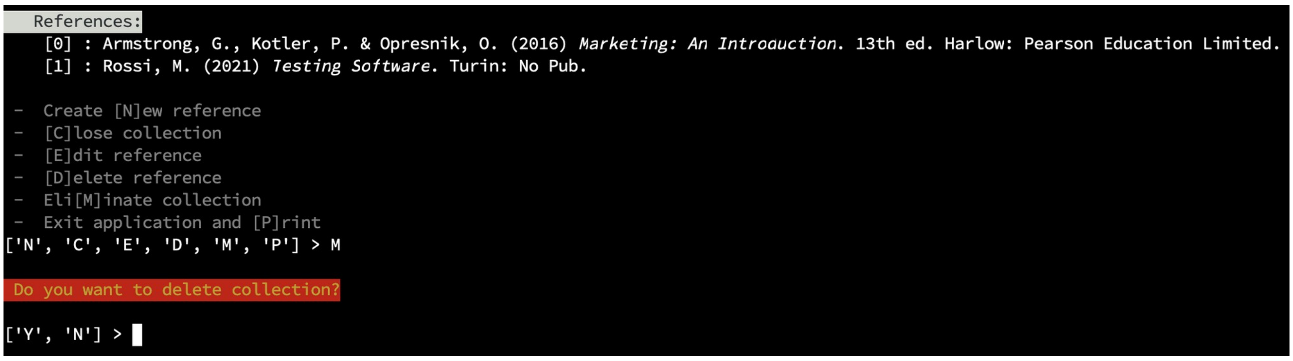


```
 Search
 -  [A]uthor
 -  [T]itle

['A', 'T'] > A
(Partial) Author's name > Nonexisting

 Search result:
 <no result found>
```

Deleting a collection results in a confirmation prompt from the application.



```
   References:
    [0] : Armstrong, G., Kotler, P. & Opresnik, O. (2016) Marketing: An Introduction. 13th ed. Harlow: Pearson Education Limited.
    [1] : Rossi, M. (2021) Testing Software. Turin: No Pub.

 -  Create [N]ew reference
 -  [C]lose collection
 -  [E]dit reference
 -  [D]elete reference
 -  Eli[M]inate collection
 -  Exit application and [P]rint
['N', 'C', 'E', 'D', 'M', 'P'] > M

 Do you want to delete collection?

['Y', 'N'] >
```