Contents

1 Contents
  1.1 Installation ......................................................... 1
  1.2 Documentation ................................................... 1
  1.3 Development ...................................................... 1
  1.4 Installation ...................................................... 1
  1.5 Usage .............................................................. 2
  1.6 RRPAM-WDS Tutorial ............................................... 2
  1.7 Reference ........................................................... 15
  1.8 Contributing ....................................................... 15
  1.9 Authors ............................................................. 16
  1.10 Changelog .......................................................... 16
  1.11 About RRPAMWDS .................................................. 17
  1.12 Indices and tables ............................................... 17

Python Module Index ....................................................... 19
CHAPTER 1

Contents

Risk-based renewal planning for asset management of water distribution systems
  • Free software: The GNU General Public License version 3.0

Installation

```
pip install rrpam-wds
```

Documentation

https://RRPam-WDS.readthedocs.io/

Development

To run the all tests (after installing miniconda http://conda.pydata.org/miniconda.html in your system) run:

```
./service/test.bash
```

Installation

Install on windows

Download the latest self-extracting installation files from github release page of RRPAMWDS project. Double click on the downloaded file to install it.
Install as a python package

If you follow this path, make sure you have installed python and other required packages first. Then, 

At the command line:

```
pip install rrpam-wds
```

Usage

If you have installed windows self-installation file (can be downloaded from https://github.com/asselapathirana/RRPam-WDS/releases), simply double-click on the start-menu entry RRPAM-WDS.

If you have installed as a python package (e.g. using pip install RRPAM-WDS), then type:

```
python -mrrpam_wds
```

This should open the RRPAM-WDS desktop application. Then follow the tutorial

RRPAM-WDS Tutorial

RRPAM-WDS or Risk-based renewal planning for asset management of water distribution systems, is a educational software tool that demonstrates one of the many approaches for renewal planning in the domain of infrastructure asset management. It uses water distribution networks as basis for demonstrating the renewal planning approach. However, the principles demonstrated here are applicable for any other infrastructure asset system (e.g. roads, electrical grids, drainage/sewerage networks) equally well.

Requirements

Following information is required to do an analysis with RRPAM-WDS.

1. Water distribution Network in EPANET 2.0 network format (.inp)
2. Reasonable estimations for the parameters of exponential aging formula \( N(t) = N_0 e^{At} \) after Shamir and Howard (1979).

These requirements are explained below:

Water distribution network

RRPAM-WDS works with water distribution networks created with EPANET 2.0 modeling software\(^1\)

EPANET 2.0 model uses two model file formats, namely *.net format - which is a binary one and the text-based ‘network file’, *.inp format. RRPAM-WDS can read the latter format. If the hydraulic network file is in *.net format, it can be converted to a network (*.inp) file as follows:

1. Open the *.net with EPANET 2.0 desktop software.
2. Use File > Export > Network menu item to export the network as *.inp file.

---
\(^1\) EPANET 2.0 model is available for download (including comprehensive documentation) at https://www.epa.gov/water-research/epanet.
Fig. 1.1: How to export *.net file as .inp file.
Note: There are three example network files (in *.inp provided with the software, these can obviously be used with RRPAM-WDS directly without the above conversion. These are available at the subdirectory rrpam_wds\examples. For example on windows with default installation at C:\Program Files (x86)\rrpam-wds\rrpam_wds\examples)

**Warning:** Typical EPANET 2.0 network files has coordinates of all the junctions. However, while creating the network if coordinates are omitted for one or more junctions, that does not raise any errors in the hydraulic calculations (coordinates are not needed for the calculations). An example of this is the standard example file Net3.net provided with EPANET 2.0. In this network, the junction with ID 177 does **not** have X and Y coordinates! EPANET 2.0 simply does not display this junction (and its connecting links) on the network map. But the user can access the junction and related links using However, RRPAM-WDS expects to have coordinates for all the junctions in the network file. If you try to open a file with missing coordinates, RRPAM-WDS will complain and fail to open the network.

![EPANET 2.0 network files can have junctions with no coordinates. In this network (Net3.net), ID 177 does **not** have X and Y coordinates.](image)

Fig. 1.2: EPANET 2.0 network files can have junctions with no coordinates. In this network (Net3.net), ID 177 does **not** have X and Y coordinates.
Aging Parameters

In RRPAM-WDS we use the exponential background-aging model after Shamir and Howard (1979) which is:

\[ N(t) = N_0e^{At} \]

where \( N(t) \) - Number of failures per year per unit length (e.g. \#/km/year)
\( t \) - Age of the asset (pipe)
\( N_0 \) and \( A \) - Aging parameters

There are a number of techniques to estimate values of the aging parameters (e.g. empirical fit to pipe failure history if available) These techniques are beyond the scope of this tutorial.

Getting Started

**Attention:** Make sure that you have the required data ready before starting on this section. Refer to section Requirements.

There are a number of example EPANET 2.0 network files provided with RRPAM-WDS. They are available at \( \text{rrpam\_wds\examples} \) directory relative to your RRPAM-WDS installation. (e.g. In windows this is usually \( C:\Program\Files\x86\rrpam\wds\rrpam\wds\examples \)) For this walk-through we use the example \( \text{Adjumani\_network\_simplified2.inp} \). This network is a hypothetical case loosely based on a actual case study from Sub-Saharan Africa.

**Step 1**

First create a new project, which will ask you to locate the EPANET 2.0 file that you want to use in your project.

Navigate to the location of \( \text{Adjumani\_network\_simplified2.inp} \) and select that file. Then you will be asked to select a location to save your project. While it is possible to save a new project in any location in your computer, it is advised to create a new directory and save your project inside that. As shown about, for this example I created a directory \( \text{my\_project} \) on the Desktop and saved the project as \( \text{project1} \) inside it.

At this stage RRPAM-WDS will take a few seconds to perform hydraulic analysis on the network and show the following things:

1. A diagram representing the hydraulic network;
2. A list of ‘links’ of the network with their basic properties.
3. A representation of the risk-matrix (We have not provided any information of the failure probabilities, so for the moment just ignore this window.)

---

3 There are plans to create an add-on module to RRPAM-WDS that allows user to do regression analysis using failure history data. However, as this can be done with any spreadsheet software (like OpenOffice or Excel), this plan is not a priority at the moment.
1.6. RRPAM-WDS Tutorial
Step 2

At this stage we need to input the failure rate data. We need to provide aging parameters ($N_0$ and $A$) and the Age of each pipe (link) at the time of analysis.

RRPAM-WDS facilitates input of aging parameters based on asset groups. Let’s assume two groups of pipes. Following are the aging parameters estimated for each group. The last column gives the cost of replacement for a km of pipe in terms of millions of financial units.

<table>
<thead>
<tr>
<th>Diameter Range</th>
<th>$N_0$</th>
<th>$A$</th>
<th>Cost (mil/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d \leq 80$ mm</td>
<td>0.0291</td>
<td>0.0185</td>
<td>0.7</td>
</tr>
<tr>
<td>$80$ mm $d$</td>
<td>0.0222</td>
<td>0.0136</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Go to the Asset Data window and select Property Groups tab, Change the number of groups to 2 and enter the above values.

Now the next step is to assign each pipe to one of these two groups. Go to the Assign Assets tab on the Asset Data (same) window. Use the table below to read the Age values.

**Note** For those pipes with IDs not explicitly given in the table, use the default value (listed in the last row of the table with ID='OTHERS').

<table>
<thead>
<tr>
<th>Pipe ID</th>
<th>Age (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>35</td>
</tr>
<tr>
<td>P1</td>
<td>20</td>
</tr>
<tr>
<td>P2</td>
<td>20</td>
</tr>
<tr>
<td>P9</td>
<td>30</td>
</tr>
<tr>
<td>P10</td>
<td>32</td>
</tr>
<tr>
<td>P3</td>
<td>20</td>
</tr>
<tr>
<td>P11</td>
<td>35</td>
</tr>
<tr>
<td>P4</td>
<td>20</td>
</tr>
<tr>
<td>P5</td>
<td>20</td>
</tr>
<tr>
<td>P13</td>
<td>35</td>
</tr>
<tr>
<td>P17</td>
<td>35</td>
</tr>
<tr>
<td>P24</td>
<td>35</td>
</tr>
<tr>
<td>P27</td>
<td>35</td>
</tr>
<tr>
<td>P28</td>
<td>35</td>
</tr>
<tr>
<td>P50</td>
<td>35</td>
</tr>
<tr>
<td>OTHERS</td>
<td>20</td>
</tr>
</tbody>
</table>
Getting Started-II

At this point, you can examine the risk matrix window. Adjust the value of relative size in risk-matrix value, so that the circles representing assets have diameters of your liking (0.02 worked well at the time of writing).

![Risk Matrix Window](image)

**Note:** It is possible to explore the Network Map, Asset Data and Risk Matrix windows together by selecting assets (by right-clicking with the mouse in case of graphs or by ticking the check-box next to each asset in the case of Assign Assets tab in the Asset Data window). When an asset is selected in one window, it will be selected in all views. Use Ctrl + Mouse Click key to select more than one asset.

All the graph windows in the software allow the user to examine data by creating ‘cross-hairs’ with coordinates on the graphs.

There are number of other facilities provided with these graphs like rectangular-zoom/reset, change axes scales/styles, Save graphs in variety of formats, etc. Go explore!

**Step 3**

Now it is the time to explore the Whole life cost window.

Select an asset in the system (e.g. click the asset’s representation in one of the graphs or tick the correct box in the Assign Assets tab in Asset Data window). The selected asset (P1 in this case) will be highlighted in all active windows.
Make sure that the `Discount Rate` value is set to 3 % and the `Time Horizon (years)` to 60. Now go to a `Whole Life Cost` windows and click on the curve icon on the top toolbar.

This will create the `Whole life cost` curve for the asset P1

**Note:** It is possible to create variety of combination of `Whole life cost` curves in the software.

1. It is possible to plot multiple curves in the same graph (simply select them and click on the curve icon.)
2. It is possible to create more than one `Whole Life Cost` graphs. ([File]>[New WLC window])

**Tip:** It is possible to change variety of parameters related to your project and see how those changes will impact your results. For example, you can change `Discount rate (%)` value (and press Apply Button) or `Age` of one of the asset parameters. These will update the `Whole life cost` curves and the `Risk Matrix` values.
Reference

rrpam_wds

Contributing

Contributions are welcome, and they are greatly appreciated! Every little bit helps, and credit will always be given.

Bug reports

When reporting a bug please include:

- Your operating system name and version.
- Any details about your local setup that might be helpful in troubleshooting.
- Detailed steps to reproduce the bug.

Documentation improvements

RRPam-WDS could always use more documentation, whether as part of the official RRPam-WDS docs, in docstrings, or even on the web in blog posts, articles, and such.

Feature requests and feedback

The best way to send feedback is to file an issue at https://github.com/asselapathirana/RRPam-WDS/issues.

If you are proposing a feature:

- Explain in detail how it would work.
- Keep the scope as narrow as possible, to make it easier to implement.
- Remember that this is a volunteer-driven project, and that code contributions are welcome :)

Development

To set up RRPam-WDS for local development:

1. Fork RRPam-WDS (look for the “Fork” button).
2. Clone your fork locally:
   
   ```bash
   git clone git@github.com:your_name_here/RRPam-WDS.git
   ```
3. Create a branch for local development:
   
   ```bash
   git checkout -b name-of-your-bugfix-or-feature
   ```

   Now you can make your changes locally.
4. When you’re done making changes, run all the checks, doc builder and spell checker.
(a) First make sure that miniconda http://conda.pydata.org/miniconda.html is installed (following command should work)

```bash
conda
```

(b) Then, from the top directory (where setup.py is) run the command:

```bash
./service/test.bash
```

5. Commit your changes and push your branch to GitHub:

```bash
git add .
git commit -m "Your detailed description of your changes."
git push origin name-of-your-bugfix-or-feature
```

6. Submit a pull request through the GitHub website.

**Pull Request Guidelines**

If you need some code review or feedback while you’re developing the code just make the pull request.

For merging, you should:

1. Include passing tests (run tox).
2. Update documentation when there’s new API, functionality etc.
3. Add a note to CHANGELOG.rst about the changes.
4. Add yourself to AUTHORS.rst.

**Tips**

To run a subset of tests:

```bash
tox -e envname -- py.test -k test_myfeature
```

To run all the test environments in parallel (you need to pip install detox):

```bash
detox
```

**Authors**


**Changelog**

**0.4.0 (2017-02-12)**

- Bug related to python 2.7 fixed

---

1 If you don’t have all the necessary python versions available locally you can rely on Travis - it will run the tests for each change you add in the pull request.

It will be slower though ...
0.3.0 (2017-02-12)

- Documentation mostly complete
- WLC test added

0.2.0 (2017-02-09)

- A major error calculating NPV fixed.
- Documentation updated
- First usable version
- Essential features are complete
- Added all essential sub-windows

0.1.0 (2016-09-27)

- First release on PyPI.
- Developed network plot

About RRPAMWDS

RRPAMWDS is a software tool that demonstrates the concepts of Risk Based Decision Making and Whole Life Cost Analysis concepts using water distribution networks as examples.

The intended use of the tool is for Asset Management Classes.

The software was developed by Assela Pathirana

Development was supported with a grant under the Global Partnership for Water and Development facility of UNESCO-IHE and Ministry of Foreign Affairs of the Kingdom of Netherlands.

Copyright: Assela Pathirana, 2016, 2017 (All rights reserved).

This program is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program. If not, see http://www.gnu.org/licenses/

Indices and tables

- genindex
- modindex
- search
Python Module Index

r

rrpam_wds, 15
Index

R
rrpam_wds (module), 15