TTR

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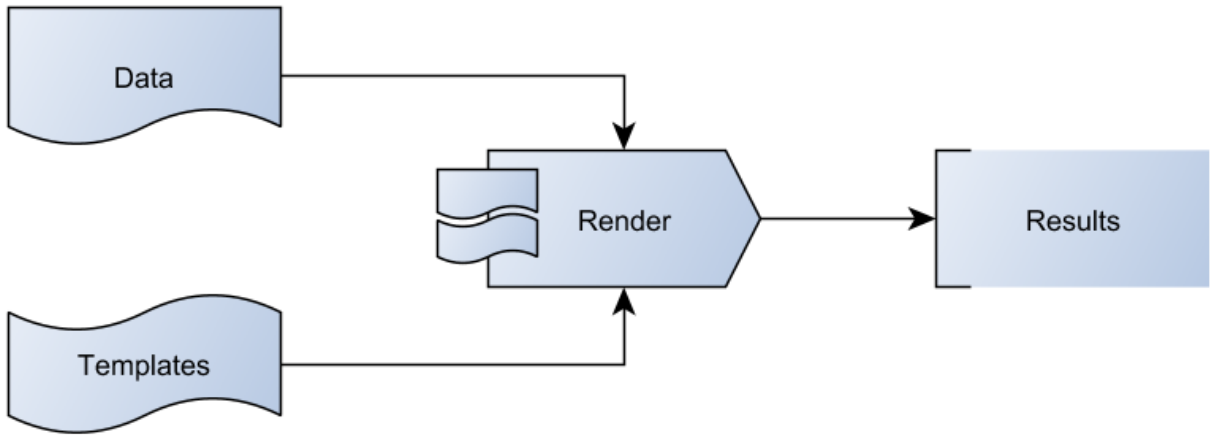
CONTENTS

CHAPTER

ONE

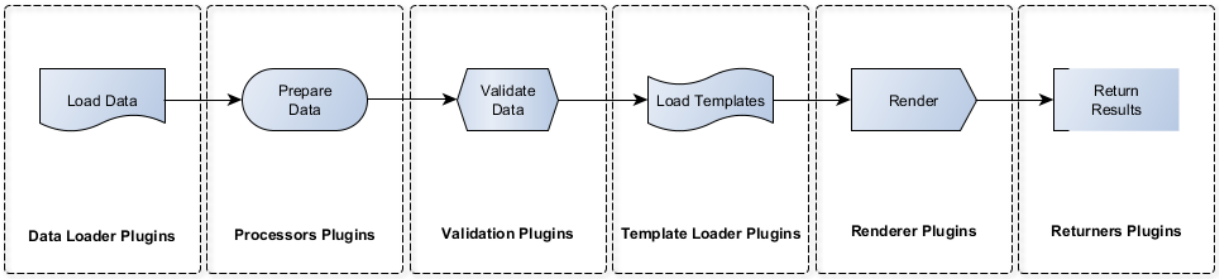
OVERVIEW

Module to produce text files using templates. TTR targets to implement common work flow:



Above approach is fairly simple but powerful enough to address various use cases where structured data need to be transformed in a textual form understandable by targeted system.

TTR uses plugins to load data and templates, render and return results.



Where:

- data plugins - load data from various format and transform it in a list of dictionaries
- processor plugins - optional step, but can be used to process data before rendering
- validation plugins - optional step, used to validate data before rendering it
- template loaders - retrieve template content from various sources (files, directories etc.)
- renderes - iterate over list of dictionaries data and render each item with template
- returners - return rendering results to various destinations, e.g. save to file system

In addition, TTR comes with a collection of Jinja2 templates to help with common use cases, such as generating configuration for network devices interfaces or BGP peers.

On the base level TTR takes list of dictionaries, renders each dictionary with template defined in `template_name_key` and saves rendered data in results dictionary keyed by `result_name_key`. Because of that each dictionary item must contain `template_name_key` and `result_name_key` keys.

Various plugins can be used to load data in a list of dictionaries with other plugins helping to process and validate it, render and save results.

CHAPTER

TWO

INSTALLATION

From PyPi:

```
python3 -m pip install py-ttr
```

Make sure that TTR installed using Python version 3.6 or higher.

Or latest code from GitHub master branch:

```
python3 -m pip install git+https://github.com/dmulyalin/template-text-renderer
```

But for this to work need to have git installed on the system.

As part of installation TTR will automatically install these libraries:

```
PyYAML>=5.3.1
openpyxl>=3.0.4
Jinja2>=2.11.2
```

Alternatively, if you planning to use TTR as a CLI utility only, for Windows you can download `ttr.exe` file from GitHub repository *Executable* folder and use it as a CLI tool. **No Python required on the system in that case**, all dependencies packed within `ttr.exe` executable.

CHAPTER

THREE

QUICK START

After installing TTR, simplest way to start using it is via CLI utility. For instance, this file with data at `/path/to/data.yaml`:

```
- interface: Gi1/1
  description: Customer A
  vid: 100
  ip: 10.0.0.1
  mask: 255.255.255.0
  vrf: cust_a
  template: interfaces.cisco_ios.txt
  device: rt-1
- interface: Gi1/2
  description: Customer C
  vid: 300
  ip: 10.0.3.1
  mask: 255.255.255.0
  vrf: cust_c
  template: interfaces.cisco_ios.txt
  device: rt-1
- interface: Gi1/2
  description: Customer B
  vid: 200
  ip: 10.0.2.1
  mask: 255.255.255.0
  vrf: cust_b
  template: interfaces.cisco_ios.txt
  device: rt-2
```

And this file with template at `/path/to/templates_folder/interfaces.cisco_ios.txt`:

```
interface {{ interface }}
{% if description is defined %}
 description {{ description }}
{% endif %}
{% if vid is defined %}
 encapsulation dot1q {{ vid }}
{% endif %}
{% if vrf is defined %}
 vrf forwarding  {{ vrf }}
{% endif %}
{% if ip is defined and mask is defined %}
```

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```
 ip address {{ ip }} {{ mask }}
{% endif %}
{% if ipv6 is defined and maskv6 is defined %}
 ipv6 address {{ ipv6 }}/{{ maskv6 }}
{% endif %}
 exit
!
```

Could be combined using TTR by running this command:

```
ttr --data /path/to/data.yaml --template /path/to/templates_folder/ --print
```

Printing this output to terminal screen:

```
# ------------------------------------------------------------------------------
# rt-1 rendering results
# ------------------------------------------------------------------------------
interface Gi1/1
 description Customer A
 encapsulation dot1q 100
 vrf forwarding  cust_a
 ip address 10.0.0.1 255.255.255.0
 exit
!
interface Gi1/2
 description Customer C
 encapsulation dot1q 300
 vrf forwarding  cust_c
 ip address 10.0.3.1 255.255.255.0
 exit
!

# ------------------------------------------------------------------------------
# rt-2 rendering results
# ------------------------------------------------------------------------------
interface Gi1/2
 description Customer B
 encapsulation dot1q 200
 vrf forwarding  cust_b
 ip address 10.0.2.1 255.255.255.0
 exit
!
```

Note: `--templates` argument should be a path to folder with templates files within that folder/subfolders or path to `.xlsx` spreadsheet file with templates or path to `.txt` file with single template content.

TTR can be used as a module instantiating TTR object and supplying it with required attributes:

```
import pprint
from ttr import ttr

```

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```
templates = {
"interfaces.cisco_ios.txt": """
interface {{ interface }}
{% if description is defined %}
 description {{ description }}
{% endif %}
{% if vid is defined %}
 encapsulation dot1q {{ vid }}
{% endif %}
{% if vrf is defined %}
 vrf forwarding  {{ vrf }}
{% endif %}
{% if ip is defined and mask is defined %}
 ip address {{ ip }} {{ mask }}
{% endif %}
{% if ipv6 is defined and maskv6 is defined %}
 ipv6 address {{ ipv6 }}/{{ maskv6 }}
{% endif %}
 exit
!
"""
}

data = """
- interface: Gi1/1
  description: Customer A
  vid: 100
  ip: 10.0.0.1
  mask: 255.255.255.0
  vrf: cust_a
  template: interfaces.cisco_ios.txt
  device: rt-1
- interface: Gi1/2
  description: Customer C
  vid: 300
  ip: 10.0.3.1
  mask: 255.255.255.0
  vrf: cust_c
  template: interfaces.cisco_ios.txt
  device: rt-1
- interface: Gi1/2
  description: Customer B
  vid: 200
  ip: 10.0.2.1
  mask: 255.255.255.0
  vrf: cust_b
  template: interfaces.cisco_ios.txt
  device: rt-2
"""

gen = ttr(data=data, data_plugin="yaml", templates_dict=templates)
results = gen.run()
```

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```
pprint.pprint(results)

# prints:
#
# {'rt-1': '\n'
#          'interface Gi1/1\n'
#          ' description Customer A\n'
#          ' encapsulation dot1q 100\n'
#          ' vrf forwarding  cust_a\n'
#          ' ip address 10.0.0.1 255.255.255.0\n'
#          ' exit\n'
#          '!\n'
#          '\n'
#          'interface Gi1/2\n'
#          ' description Customer C\n'
#          ' encapsulation dot1q 300\n'
#          ' vrf forwarding  cust_c\n'
#          ' ip address 10.0.3.1 255.255.255.0\n'
#          ' exit\n'
#          '!',
#  'rt-2': '\n'
#          'interface Gi1/2\n'
#          ' description Customer B\n'
#          ' encapsulation dot1q 200\n'
#          ' vrf forwarding  cust_b\n'
#          ' ip address 10.0.2.1 255.255.255.0\n'
#          ' exit\n'
#          '!'}
```

It is also possible to source templates and data from text files:

```
import pprint
from ttr import ttr

gen = ttr(
    data="./data/data.yaml",
    templates="./Templates/"
)

gen.run()
pprint.pprint(gen.results)

# prints:
#
# {'rt-1': 'interface Gi1/1\n'
#          ' description Customer A\n'
#          ' encapsulation dot1q 100\n'
#          ' vrf forwarding  cust_a\n'
#          ' ip address 10.0.0.1 255.255.255.0\n'
#          ' exit\n'
#          '!\n'
```

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```
#          'interface Gi1/2\n'
#          ' description Customer C\n'
#          ' encapsulation dot1q 300\n'
#          ' vrf forwarding  cust_c\n'
#          ' ip address 10.0.3.1 255.255.255.0\n'
#          ' exit\n'
#          '!',
#  'rt-2': 'interface Gi1/2\n'
#          ' description Customer B\n'
#          ' encapsulation dot1q 200\n'
#          ' vrf forwarding  cust_b\n'
#          ' ip address 10.0.2.1 255.255.255.0\n'
#          ' exit\n'
#          '!'}
```

Data is the same as in previous example but stored in `./data/data.yaml` file, TTR picked up `YAML` loader based on data file extension. Directory `./Templates/` contains `interfaces.cisco_ios.txt` template file.

Notice that rendering results also accessible using TTR object `results` property.

TTR also can be invoked using context manager:

```
import pprint
from ttr import ttr

with ttr("./data/data.yaml") as gen:
    results = gen.run()

pprint.pprint(gen.results)
```

Above example produces same results as before, `templates_dir` used with default value which is `./Templates/`.

CHAPTER

FOUR

TUTORIALS

4.1 Using TTR with Excel Tables

TTR can source data and templates from Excel spreadsheets, this tutorial is going to show how.

TBD

CHAPTER

FIVE

TTR CLI TOOL

TTR CLI is a tool built using TTR library.

This tool can be used to render data from various sources and either print results to screen or save them in output folder.

Supported arguments:

```
-d,  --data          OS path to folder with data files or to data file, default ./Data/
-t,  --templates     OS path to folder, .txt or .xlsx file with template(s), default ./
↪Templates/
-o,  --output        Output folder location, default ./Output/<current time><data file␣
↪name>/
-p,  --print         Print results to terminal instead of saving to folder
-l,  --logging       Set logging level - "DEBUG", "INFO", "WARNING", "ERROR", "CRITICAL";
↪ default ERROR
-f,  --filters       Comma separated list of glob patterns to use for filtering data to␣
↪render
```

Note: `--templates` argument should be a path to folder with templates files within that folder/subfolders or path to `.xlsx` spreadsheet file with templates or path to `.txt` file with single template content.

In general case TTR CLI utility takes data file and templates location references and saves produced results in a subfolder within `./Output/` directory, where subfolder name has this format `./Output/<current time><data file name>/`.

Sample invocation:

```
ttr -d ./data/data.yaml
ttr -d ./data/data.yaml -t ./templates_folder/
ttr -d ./data/data.yaml -t ./templates/templates_spreadsheet_file.xlsx
```

Alternatively a path to directory can be provided instead of data file, in that case TTR will scan that path and prompt user to select file to work with:

```
ttr -d ./data/
====================
Files found in './data/' directory
0: csv_data_1.csv
1: data.yaml
2: table_data_1.xlsx
Choose data file to work with (number): 1
```

CHAPTER

SIX

DATA LOADER PLUGINS

Data plugins responsible for loading data to render from various formats such as `YAML` structured text or `xlsx` spreadsheets.

By default TTR uses file extension to choose plugin for loading data, alternatively TTR object `data_plugin` attribute can be used to specify default plugin to use.

For instance, to load `data.csv` file TTR will use `csv` plugin, to load `data.yaml` file, `yaml` plugin will be used, etc.

Data plugins load data in a list of dictionaries, where each item rendered using template as per `template_name_key` attribute.

6.1 XLSX Spreadsheets loader plugin

Plugin reference name: `xlsx`

This plugin supports loading data from multiple sheets, combining them for rendering.

Prerequisites:

- Requires openpyxl >= 3.0.0 library

Restrictions and guidelines

Spreadsheets must contain a column or multiple columns with headers starting with `template_name_key` argument string, default is `template`. Values of template(s) columns either names of the template to use for rendering or OS path string to template file relative to `template_dir` argument supplied to TTR object on instantiation.

In addition, table must contain column with `result_name_key` values, default is `device`, they used to combine results, i.e. rendering results for identical `result_name_key` combined in a single string. `result_name_key` used further by returners to return results.

Spreadsheet tabs with names starting with # are skipped, useful to comment out tabs that no need to render.

First row in the spreadsheet must contain headers, otherwise spreadsheet not loaded.

Note: empty cells loaded with value of `None`

Sample spreadsheet table that contains details for interfaces configuration:

device	interface	vid	vrf	ip	mask	template
rt1	Gi1/1.100	100	MGMT	10.0.0.1	24	ttr://simple/interface.cisco_ios.txt
rt1	Gi2/3		CUST	10.3.0.1	30	ttr://simple/interface.cisco_ios.txt
sw23	Vlan21		MGMT	10.0.0.2	24	ttr://simple/interface.cisco_ios.txt

where:

- `device` column contains `result_name_key` values
- `template` column contains `template_name_key` values
- `ttr://simple/interface.cisco_ios.txt` - is a template included in TTR templates collection

Above table loaded into this list of dictionaries:

```
[{'device': 'rt1',
  'interface': 'Gi1/1.100',
  'ip': '10.0.0.1',
  'mask': 24,
  'template': 'ttr://simple/interface.cisco_ios.txt',
  'vid': 100,
  'vrf': 'MGMT'},
 {'device': 'rt1',
  'interface': 'Gi2/3',
  'ip': '10.3.0.1',
  'mask': 30,
  'template': 'ttr://simple/interface.cisco_ios.txt',
  'vid': None,
  'vrf': 'CUST'},
 {'device': 'sw23',
  'interface': 'Vlan21',
  'ip': '10.0.0.2',
  'mask': 24,
  'template': 'ttr://simple/interface.cisco_ios.txt',
  'vid': None,
  'vrf': 'MGMT'}]
```

Combined with `ttr://simple/interface.cisco_ios.txt` it will produce these results:

```
ttr -d /path_to_table.xlsx/ -p

# ------------------------------------------------------------------------------
# rt1 rendering results
# ------------------------------------------------------------------------------
interface Gi1/1.100
 encapsulation dot1q 100
 vrf forwarding  MGMT
 ip address 10.0.0.1 24
 exit
!
interface Gi2/3
 encapsulation dot1q None
 vrf forwarding  CUST
 ip address 10.3.0.1 30
 exit
!

# ------------------------------------------------------------------------------
# sw23 rendering results
# ------------------------------------------------------------------------------
interface Vlan21
```

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```
 encapsulation dot1q None
 vrf forwarding  MGMT
 ip address 10.0.0.2 24
 exit
!
```

6.1.1 Multiple Templates suffix separation

Using multitemplate processor it is possible to define multiple template columns within same spreadsheet tab using suffixes. Columns with headers with same suffixes considered part of same datum and combined together. Headers without suffixes shared across all datums.

For example, this table uses `:a` and `:b` suffixes to denote relationship with certain templates:

device:a	interface:a	ip:a	mask	device:b	interface:b	ip:b	template:a	template:b
rt1	Gi1/1	10.0.0.1	30	rt2	Gi1	10.0.0.2	ttr://simple/interface.cisco_ios.txt	ttr://simple/interface.cisco_nxos.txt
rt3	Gi2/3	10.3.0.1	30	rt4	Gi3	10.3.0.2	ttr://simple/interface.cisco_ios.txt	ttr://simple/interface.cisco_nxos.txt

where:

- `device` columns contains `result_name_key` values
- `template` columns contains `template_name_key` values
- `ttr://simple/interface.cisco_ios.txt` - is a template included in TTR templates collection
- `ttr://simple/interface.cisco_nxos.txt` - is a template included in TTR templates collection

Above table data, after passing through `multitemplate` processor loaded into this list of dictionaries:

```
import pprint
from ttr import ttr

gen = ttr("./path/to/table.xlsx", processors=["multitemplate"])

pprint.pprint(gen.data_loaded)

# prints:
# [{'device': 'rt1',
#   'interface': 'Gi1/1',
#   'ip': '10.0.0.1',
#   'mask': 30,
#   'template': 'ttr://simple/interface.cisco_ios.txt'},
#  {'device': 'rt2',
#   'interface': 'Gi1',
#   'ip': '10.0.0.2',
#   'mask': 30,
#   'template': 'ttr://simple/interface.cisco_nxos.txt'},
#  {'device': 'rt3',
#   'interface': 'Gi2/3',
#   'ip': '10.3.0.1',
#   'mask': 30,
```

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```
#   'template': 'ttr://simple/interface.cisco_ios.txt'},
#  {'device': 'rt4',
#   'interface': 'Gi3',
#   'ip': '10.3.0.2',
#   'mask': 30,
#   'template': 'ttr://simple/interface.cisco_nxos.txt'}]
```

That technique allows to simplify definition of "paired" configurations, e.g. device A and device B configurations or forward and rollback configurations etc.

ttr.plugins.data.xlsx_loader.**load**(*data*, *templates_dict*, *template_name_key*, ***kwargs*)

Function to load XLSX spreadsheet. Takes OS path to `.xlsx` file and returns list of dictionaries, where keys equal to headers of spreadsheets' tabs.

Parameters

- **data** – string, OS path to `.xlsx` file
- **templates_dict** – dictionary to load templates from spreadsheet
- **template_name_key** – string, templates column header prefix

6.2 CSV Spreadsheets loader plugin

Plugin Name: `csv`

Support loading data from CSV text file.

Spreadsheet must contain a column or multiple columns with headers starting with `template_name_key` argument string. Values of template(s) columns either names of the template to use for rendering or OS path string to template file relative to `template_dir` argument supplied to TTR object on instantiation.

In addition, table must contain column with `result_name_key` values, they used to combine results, i.e. rendering results for identical `result_name_key` combined in a single string. `result_name_key` used further by returners to return results.

ttr.plugins.data.csv_loader.**load**(*data*, *templates_dict=None*, *template_name_key=None*, ***kwargs*)

Function to load CSV spreadsheet.

Parameters

- **data** – OS path to CSV text file
- **templates_dict** – (dict) dictionary to load templates from spreadsheet, not supported by csv loader
- **template_name_key** – (str) templates column header prefix, not supported by csv loader
- **kwargs** – (dict) any additional arguments to pass on to `csv.DictReader` object instantiation

6.3 YAML loader

Plugin Name: `yaml`

Prerequisites:

- Requires PyYAML library

Plugin to load data to render from YAML structured text.

`ttr.plugins.data.yaml_loader.`**`load`**(*data*, *templates_dict=None*, *template_name_key=None*, ***kwargs*)

Function to load YAML data from text file or from string. Text file should have `.yml` or `.yaml` extension to properly detect loader.

Parameters

- **`data`** – string, OS path to text file or YAML structured text
- **`templates_dict`** – (dict) dictionary to load templates from spreadsheet, not supported by yaml loader
- **`template_name_key`** – (str) templates column header prefix, not supported by yaml loader
- **`kwargs`** – (dict) any additional arguments are ignored

CHAPTER

SEVEN

PROCESSORS PLUGINS

Processors used to process loaded data before its rendered.

7.1 Multitemplate Processor

Plugin reference name: `multitemplate`

Processor to extract multiple template dictionaries from each data item based on suffix values.

Takes a list of dictionaries:

```
[{'device': 'r1',
  'hostname': 'r1',
  'lo0_ip': '1.1.1.1',
  'lo0_ip_rollback': '1.1.1.11',
  'template': 'test_path/device_base',
  'template_rollback': 'test_path/device_base_rollback'},
 {'device:a': 'r1',
  'device:b': 'r2',
  'interface:a': 'Eth1',
  'interface:b': 'Eth1',
  'ip:a': '10.0.0.1',
  'ip:b': '10.0.0.2',
  'mask': 24,
  'template:a': 'test_path/interf_cfg',
  'template:b': 'test_path/interf_cfg_b'}]
```

Returns:

```
[{'device': 'r1',
'hostname': 'r1',
'lo0_ip': '1.1.1.11',
'template': 'test_path/device_base_rollback'},
{'device': 'r1',
'hostname': 'r1',
'lo0_ip': '1.1.1.1',
'template': 'test_path/device_base'},
{'device': 'r1',
'interface': 'Eth1',
'ip': '10.0.0.1',
'mask': 24,
```

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```
'template': 'test_path/interf_cfg'},
{'device': 'r2',
'interface': 'Eth1',
'ip': '10.0.0.2',
'mask': 24,
'template': 'test_path/interf_cfg_b'}]
```

Where `template_name_key` is `template`.

Multitemplate processor detects suffixes/endings, `:a` and `:b` in this case, and uses them to split dictionaries apart, populating them with values corresponding to certain suffixes.

Key names without suffixes considered as common values and shared across all dictionaries.

`ttr.plugins.processors.multitemplate_processor.`**`process`**(*data*, *template_name_key*, ***kwargs*)

Function to process multitemplate data items.

Parameters

- **`data`** – (list), data to process - list of dictionaries
- **`template_name_key`** – string, name of the template key
- **`kwargs`** – (dict) any additional arguments ignored

7.2 Templates Split Processor

Plugin reference name: `templates_split`

Processor to support definition of several templates separated by delimiter (default - `;`) consequentially splitting data into several items with dedicated template.

Takes a list of dictionaries, for example:

```
[{'device': 'r1',
  'hostname': 'r1',
  'lo0_ip': '1.1.1.1',
  'lo0_ip_rollback': '1.1.1.11',
  'template': 'device_base; isis_base; bgp_base'},
 {'device': 'r2',
  'hostname': 'r2',
  'lo0_ip': '1.1.1.2',
  'lo0_ip_rollback': '1.1.1.22',
  'template': 'device_base; bgp_base'}]
```

After splitting templates `templates_split` processor returns:

```
[{'device': 'r1',
  'hostname': 'r1',
  'lo0_ip': '1.1.1.1',
  'lo0_ip_rollback': '1.1.1.11',
  'template': 'device_base'},
 {'device': 'r1',
  'hostname': 'r1',
  'lo0_ip': '1.1.1.1',
```

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```
  'lo0_ip_rollback': '1.1.1.11',
  'template': 'isis_base'},
 {'device': 'r1',
  'hostname': 'r1',
  'lo0_ip': '1.1.1.1',
  'lo0_ip_rollback': '1.1.1.11',
  'template': 'bgp_base'},
 {'device': 'r2',
  'hostname': 'r2',
  'lo0_ip': '1.1.1.2',
  'lo0_ip_rollback': '1.1.1.22',
  'template': 'device_base'},
 {'device': 'r2',
  'hostname': 'r2',
  'lo0_ip': '1.1.1.2',
  'lo0_ip_rollback': '1.1.1.22',
  'template': 'bgp_base'}]
```

ttr.plugins.processors.templates_split.**process**(*data*, *template_name_key*, *split_char=';'*, ***kwargs*)

Function to split templates. e.g. if `template_name_key` value contains several templates, this processor will split them using `split_char` and produce data item for each template coping data accordingly.

Parameters

- **data** – list of dictionaries to process
- **template_name_key** – string, name of the template key
- **split_char** – str, character to use to split template names
- **kwargs** – (dict) any additional arguments ignored

7.3 Filtering Processor

Plugin reference name: `filtering`

Processor to filter data using glob patterns. Filtering done against `result_name_key` values.

Takes a list of dictionaries, for example:

```
[{'device': 'rr21',
  'lo0_ip': '1.1.1.1',
  'lo0_ip_rollback': '1.1.1.11',
  'template': 'device_base},
 {'device': 'core-1',
  'lo0_ip': '1.1.1.2',
  'lo0_ip_rollback': '1.1.1.22',
  'template': 'device_base}]
```

If filter pattern is `core-*` and `result_name_key` is `device`, `filtering` processor will return:

```
[{'device': 'core-1',
  'lo0_ip': '1.1.1.2',
```

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```
  'lo0_ip_rollback': '1.1.1.22',
  'template': 'device_base}]
```

ttr.plugins.processors.filtering.**process**(*data*, *result_name_key*, *filters=None*, ***kwargs*)
Function to filter data using glob patterns.

Parameters

- **data** – list of dictionaries to process
- **filters** – list, list of glob patterns to use for filtering. Filtering successful if at list one pattern matches
- **result_name_key** – (str) name of the key in data items value of which should be used as a key in results dictionary, default `device`. Filtering done against values defined under `result_name_key`
- **kwargs** – (dict) any additional arguments ignored

CHAPTER

EIGHT

DATA VALIDATION PLUGINS

Data validation plugins responsible for validating loaded data to make sure it adheres to model or schema requirements.

By default TTR uses `yangson` plugin for data validation, alternatively TTR object `validator` attribute can be used to specify plugin to use.

Validation step is optional, if no models provided, data not validated. However, if required data models can be used to make sure that correct data provided prior to performing rendering step.

There are two types of validation plugins:

1. Plugins to load models
2. Plugins to validate the actual data

8.1 Yangson Models Loader

Reference name `yangson`

This plugin loads YANG models into yangson DataModel objects.

YANG models must sit within their own directories, each such a directory used to create JSON library for Yangson to load models from.

Directory name, main YANG model file name and module name must be the same, directory name used as a reference name for the model.

For example, this is directory tree with YANG models inside:

```
|-- Models
    |-- interface
        |-- ietf-inet-types@2013-07-15.yang
        |-- interface.yang
    |-- vrf
        |-- vrf.yang
```

Above directory structure translated to two models named `interface` and `vrf`, these names can be used to reference models in data for validation, e.g.:

```
- interface: Gi1/1
  description: Customer A
  vid: 100
  ip: 10.0.0.1
  mask: 255.255.255.0
```

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```
  vrf: cust_a
  device: R1
  template: interfaces.cisco_ios
  model: interface # YANG model name to validate this data item
```

For reference, YANG model `Models/interface/interface.yang` file content is:

```
module interface {
    yang-version "1.1";

    namespace "http://ttr/test-1";

    import ietf-inet-types {
    prefix inet;
    }

    typedef ipmask {
    type string {
        pattern '([0-9]{1,3}.){3}[0-9]{1,3}';
    }
    description
        "Pattern to match strings like 255.255.255.0 or 255.0.0.0";
    }

    prefix "ttr";

    leaf interface {
        mandatory true;
        type string;
    }
    leaf template {
        mandatory true;
        type string;
    }
    leaf device {
        mandatory true;
        type string;
    }
    leaf description{
        type string;
    }
    leaf vid {
        type int32;
    }
    leaf ip {
        type inet:ipv4-address;
    }
    leaf mask {
        type ipmask;
    }
    leaf vrf {
        type string;
```

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```
    }
}
```

ttr.plugins.models.yangson_model_loader.**load**(*models_dict*, *models_dir*, ***kwargs*)

Creates JSON-encoded YANG library data [RFC7895] and instantiates data model object out of it.

Parameters

- **models_dir** – (str) OS path to directory with YANG models modules subdirectories, each subdirectory models loaded to form single DataModel and added to models_dict under directory name key.
- **models_dict** – (dict) dictionary to store loaded model object at
- **kwargs** – (dict) any additional arguments ignored
- **return** – None

8.2 Yangson Data Validation

Reference name `yangson`

This plugin relies on Yangson library for data instance validation using YANG models.

ttr.plugins.validate.validate_yangson.**validate**(*data*, *model_content*, *model_name*, *validation_scope='all'*, *content_type='all'*, *on_fail='raise'*)

Validate data for compliance with YANG modules.

Parameters

- **data** – (dict) dictionary data to validate
- **model_content** – (obj) Fully instantiated Yangson DataModel object
- **model_name** – (str) name of the model
- **content_type** – (str) optional, content type as per https://yangson.labs.nic.cz/enumerations.html supported - all, config, nonconfig
- **validation_scope** – (str) optional, validation scope as per https://yangson.labs.nic.cz/enumerations.html supported - all, semantics, syntax
- **on_fail** – (str) action to do if validation fails - `raise` (default) or `log`

Returns:

- True if validation succeeded
- False if validation failed and `on_fail` is "log"
- Raises `RuntimeError` exception if validation failed and `on_fail` is "raise"

CHAPTER

NINE

TEMPLATES LOADER PLUGINS

Template loaders responsible for loading template text from various sources.

9.1 Base Template Loader

Reference name `base`

Base loader loads templates content in `templates_dict` dictionary using other loader plugins following this order:

0. Check if template with given name already exists in `templates_dict`, use it if so
1. Check if template name starts with `ttr://`, load it using `ttr_template_loader`
2. If template name references file, load it using `file_template_loader`
3. If `templates` is a directory load template content using `dir_template_loader`
4. If `templates` referring to `.xlsx` file load all templates using `xlsx_template_loader`

On failure to load template file, base loader will log an error message and TTR will continue processing other data items.

`ttr.plugins.templates.base_template_loader.`**`load`**(*template_name*, *templates_dict*, *templates*, ***kwargs*)

Function to locate template file and return it's content

Attributes

Parameters

- **`template_name`** – (str) - name of template to load
- **`templates`** – (str) - location of templates
- **`templates_dict`** – (dict) - dictionary of to store template content in
- **`kwargs`** – (dict) any additional arguments ignored

Returns `True` on success and `False` on failure to load template

On success loads template content in `templates_dict` and returns `True`, on failure returns `False`.

9.2 File Template Loader

Reference name `file`

Loads template for rendering from file.

`ttr.plugins.templates.file_template_loader.`**`load`**(*template_name*, *templates_dict*, *filepath=None*, ***kwargs*)

Function to load template content from `file` path.

Parameters

- **`template_name`** – (str) name of template to load, should point to file if no `filepath` argument provided
- **`templates_dict`** – (str) dictionary to store template content in
- **`filepath`** – (str) optional, path to file to open
- **`kwargs`** – (dict) any additional arguments ignored

Returns `True` on success and `False` on failure to load template

9.3 Directory Template Loader

Reference name `dir`

Loads template for rendering from file in directory

`ttr.plugins.templates.dir_template_loader.`**`load`**(*template_name*, *templates_dict*, *templates*, ***kwargs*)

Function to load template content from file in directory.

Parameters

- **`template_name`** – (str) name of template to load, should point to file
- **`templates_dict`** – (str) dictionary to store template content in
- **`templates`** – (str) OS path to directory with template file
- **`kwargs`** – (dict) any additional arguments ignored

Returns `True` on success and `False` on failure to load template

9.4 TTR Template Loader

Reference name `ttr`

Loads templates for rendering from TTR package.

`ttr.plugins.templates.ttr_template_loader.`**`load`**(*template_name*, *templates_dict*, ***kwargs*)

Function to load template content from `ttr://...` path.

Parameters

- **`template_name`** – (str) name of template to load
- **`templates_dict`** – (str) dictionary to store template content in
- **`kwargs`** – (dict) any additional arguments ignored

Returns `True` on success and `False` on failure to load template

9.5 XLSX Template Loader

Plugin reference name: `xlsx`

Spreadsheet might contain multiple tabs with names starting with `template`, these tabs can contain templates to use for rendering data from other tabs. All the templates loaded line by line, `template:{{ template_name }}` lines used to identify end of previous and start of next template, where `template_name` used for referencing template.

Sample table that contains rendering templates, no headers required:

template:interface
interface {{ interface }}
description {{ description }}
template:logging
logging host {{ log_server }}

Above templates loaded in a dictionary:

```
{
    "interface": 'interface {{ interface }}\n'
                 '  description {{ description }}',
    "logging": 'logging host {{ log_server }}'
}
```

In this case templates referenced in data using `interface` and `logging` template names

`ttr.plugins.templates.xlsx_template_loader.`**`load`**(*templates_dict*, *templates=None*, *sheet=None*, ***kwargs*)

Function to load **all** templates from `xlsx` spreadsheets.

Parameters

- **`templates`** – OS path to `.xlsx` file
- **`sheet`** – openpyxl `sheet` object
- **`templates_dict`** – (dict) dictionary of `{template name: template content}` to load templates in
- **`kwargs`** – (dict) any additional arguments ignored

Returns `True` on success and `False` on failure to load template

CHAPTER

TEN

RENDERER PLUGINS

Renderers responsible for combining data with templates and producing text output.

10.1 Jinja2 Renderer Plugin

Prerequisites:

- Requires jinja2 library

> **Warning:** data keys or table headers must be valid Python variable names for Jinja2 engine to work correctly, e.g. a variable name must start with a letter or the underscore character.

This renderer uses Jinja2 templates to render data and produce text results.

For example, if this is a data to render expressed in YAML format:

```
- interface: Gi1/1
  description: Customer A
  dot1q: 100
  ip: 10.0.0.1
  mask: 255.255.255.0
  vrf: cust_a
  template: ttr://interfaces.cisco_ios
  device: rt-1
- interface: Gi1/2
  description: Customer B
  dot1q: 200
  ip: 10.0.2.1
  mask: 255.255.255.0
  vrf: cust_b
  template: ttr://interfaces.cisco_ios
  device: rt-2
```

`template_name_key` corresponds to `template` key in above data, `result_name_key` corresponds to `device` key in above data.

And this is the content of `ttr://interfaces.cisco_ios` template:

```
interface {{ interface }}
 description {{ description }}
```

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```
 encapsulation dot1q {{ vid }}
 vrf forwarding  {{ vrf }}
 ip address {{ ip }} {{ mask }}
 ipv6 address {{ ipv6 }}/{{ maskv6 }}
!
```

This renderer will combine each item in above data with `ttr://interfaces.cisco_ios` template and return results for further processing.

`ttr.plugins.renderers.jinja2_renderer.`**`render`**(*data*, *template_name_key*, *templates*, *templates_dict*, *result_name_key*, ***renderer_kwargs*)

Render function takes data, templates and produces text output.

Parameters

- **`data`** – (list), list of dictionaries render
- **`templates_dict`** – (dict), dictionary keyed by template name with template content as a value
- **`template_name_key`** – (str), name of template key to use for data rendering, default - `template`
- **`result_name_key`** – (str), name of result key to use to combine rendering results, default - `device`
- **`renderer_kwargs`** – (dict), kwargs to pass on to `jinja2.Template(.., **kwargs)` object instantiation

By default `renderer_kwargs` will include:

```
{"trim_blocks": True, "lstrip_blocks": True}
```

CHAPTER

ELEVEN

RETURNER PLUGINS

Returners responsible for returning produced results to various destinations.

11.1 Self Returner Plugin

Plugin Name: `self`

This plugin does nothing with results, implementing behavior where results stored in TTR object for further programmatic consumption.

`ttr.plugins.returners.self_returner.`**`dump`**(*data_dict*, ***kwargs*)

This function applying no actions to results, implemented to keep plugins API consistent.

Parameters

- **`data_dict`** – (dict) dictionary keyed by `result_name_key` where values are rendered results string
- **`kwargs`** – (dict) any additional arguments ignored

11.2 Terminal Returner Plugin

Plugin Name: `terminal`

This plugin prints rendered result to terminal screen applying minimal formatting to improve readability.

For instance if these are rendering results:

```
{'rt-1': 'interface Gi1/1\n'
         ' description Customer A\n'
         ' encapsulation dot1q 100\n'
         ' vrf forwarding  cust_a\n'
         ' ip address 10.0.0.1 255.255.255.0\n'
         ' exit\n'
         '!\n'
         'interface Gi1/2\n'
         ' description Customer C\n'
         ' encapsulation dot1q 300\n'
         ' vrf forwarding  cust_c\n'
         ' ip address 10.0.3.1 255.255.255.0\n'
         ' exit\n'
         '!',
```

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```
 'rt-2': 'interface Gi1/2\n'
         ' description Customer B\n'
         ' encapsulation dot1q 200\n'
         ' vrf forwarding  cust_b\n'
         ' ip address 10.0.2.1 255.255.255.0\n'
         ' exit\n'
         '!'}
```

Terminal returner will print to screen:

```
# ------------------------------------------------------------------------------
# rt-1 rendering results
# ------------------------------------------------------------------------------
interface Gi1/1
 description Customer A
 encapsulation dot1q 100
 vrf forwarding  cust_a
 ip address 10.0.0.1 255.255.255.0
 exit
!
interface Gi1/2
 description Customer C
 encapsulation dot1q 300
 vrf forwarding  cust_c
 ip address 10.0.3.1 255.255.255.0
 exit
!

# ------------------------------------------------------------------------------
# rt-2 rendering results
# ------------------------------------------------------------------------------
interface Gi1/2
 description Customer B
 encapsulation dot1q 200
 vrf forwarding  cust_b
 ip address 10.0.2.1 255.255.255.0
 exit
!
```

This returner useful for debugging or, for instance, when it is easier to copy produced results from terminal screen.

ttr.plugins.returners.terminal_returner.**dump**(*data_dict*, ***kwargs*)

This function prints results to terminal screen

Parameters

- **data_dict** – (dict) dictionary keyed by `result_name_key` where values are rendered results string
- **kwargs** – (dict) any additional arguments ignored

11.3 File Returner Plugin

Plugin Name: `file`

This plugin responsible for saving results to text files iterating over results dictionary keyed by `result_name_key`.

For example, if results `data_dict` might look like this:

```
{"rt-1": "interface Gi1/1\n"
         " description Customer A\n"
         " encapsulation dot1q 100\n"
         " vrf forwarding  cust_a\n"
         " ip address 10.0.0.1 255.255.255.0\n"
         " exit\n"
         "!\n"
         "interface Gi1/2\n"
         " description Customer C\n"
         " encapsulation dot1q 300\n"
         " vrf forwarding  cust_c\n"
         " ip address 10.0.3.1 255.255.255.0\n"
         " exit\n"
         "!",
 "rt-2": "interface Gi1/2\n"
         " description Customer B\n"
         " encapsulation dot1q 200\n"
         " vrf forwarding  cust_b\n"
         " ip address 10.0.2.1 255.255.255.0\n"
         " exit\n"
         "!"}
```

If `result_dir` argument set to `./Output/`, file returner will iterate over `data_dict` using keys as filenames populating files with values at the end `./Output/` directory will contain two files named `rt-1.txt` and `rt-2.txt` with respective content.

`ttr.plugins.returners.file_returner.`**`dump`**(*data_dict*, *result_dir='./Output/'*, ***kwargs*)

Function to save results in text files.

Parameters

- **`data_dict`** – (dict) dictionary keyed by `result_name_key` where values are strings to save in text files
- **`result_dir`** – (str) OS path to directory to save results in
- **`kwargs`** – (dict) any additional arguments ignored

CHAPTER

TWELVE

JINJA2 TEMPLATES COLLECTION

TBD

CHAPTER

THIRTEEN

API REFERENCE

TTR main class reference

class ttr.**ttr**(*data=None*, *data_plugin=None*, *data_plugin_kwargs=None*, *renderer='jinja2'*, *validator='yangson'*, *renderer_kwargs=None*, *templates='./Templates/'*, *models_dir='./Models/'*, *template_name_key='template'*, *model_name_key='model'*, *returner='self'*, *returner_kwargs=None*, *result_name_key='device'*, *processors=None*, *processors_kwargs=None*, *templates_dict=None*, *models_dict=None*, *validator_kwargs=None*)

Main class to instantiate TTR object.

Parameters

- **data** – (str) type depends on data plugin in use, but can be an OS path string referring to YAML structured text file or CSV spreadsheet
- **data_plugin** – (str) name of data plugin to use to load data
- **data_plugin_kwargs** – (dict) arguments to pass on to data plugin
- **renderer** – (str) name of renderer plugin to use, default `jinja2`
- **renderer_kwargs** – (dict) arguments to pass on to renderer plugin
- **templates** – (str) OS pat to directory or excel spreadsheet file with templates, defaults to `./Templates/` folder
- **template_name_key** – (str) name of the key in data items that reference template to use to render that particular datum, default `template`
- **returner** – (str) name of returner plugin to use, default `self`
- **returner_kwargs** – (dict) arguments to pass on to returner plugin
- **result_name_key** – (str) name of the key in data items value of which should be used as a key in results dictionary, default `device`
- **processors** – (list) list of processor plugins names to pass loaded data through, default is empty list - no processors applied
- **templates_dict** – (dict) dictionary of {template_name: template_content}
- **models_dir** – (str) OS path to directory or with data models, defaults to `./Models/` folder
- **model_name_key** – (str) name of the key in data items that reference model to use to validate that particular datum, default `model`
- **models_dict** – (dict) dictionary of {model_name: model_content}
- **validator** – (str) validator plugin to use to validate provided data against models, default is `yangson`

- **validator_kwargs** – (dict) arguments to pass on to validator plugin

load_data(*data*, *data_plugin=None*)
Method to load data to render.

Parameters

- **data** – (str) data to load, either OS path to data file or text
- **data_plugin** – (str) name of data plugin to load data, by default will choose data loader plugin based on file extension e.g. `xlsx, csv, yaml/yml`

load_models(*models_dir=None*, *model_plugin=None*, ***kwargs*)
Function to load models content to models dictionary.

Parameters

- **models_dir** – (str) OS path to directory with models, defaults to `./Models/` directory
- **model_plugin** – (str) models loader plugin to use - `yangson` (default)
- **kwargs** – any additional `**kwargs` to pass on to `model_plugin` call

load_templates(*template_name=''*, *template_content=''*, *templates=''*, *templates_plugin=''*, ***kwargs*)
Function to load templates content in templates dictionary.

Parameters

- **template_name** – (str) name of template to load
- **template_content** – (str) template content to save in templates dictionary under `template_name`
- **templates** – (str) OS pat to directory or file with templates, default `./Templates/`
- **templates_plugin** – (str) templates loader plugin to use - `base, xlsx, dir, file, ttr`
- **kwargs** – any additional `**kwargs` to pass on to `templates_plugin`

Decision logic:

1. If `template_content` provided add it to templates dictionary under `template_name` key
2. If valid `templates_plugin` name given use it to load template
3. Use `base` templates loader plugin to load template content

process_data(*data*)
Function to pass loaded data through a list of processor plugins.

Parameters **data** – (list) list of dictionaries data to process

Returns processed data

run()
Method to render templates with data and produce dictionary results keyed by `result_name_key`.

If returner set to `self`, will return results dictionary.

run_returner(*results=None*, *returner=None*, ***kwargs*)
Function to run returner to return results via plugin of choice.

Parameters

- **results** – (dict) results to run returner for
- **returner** – (str) returner plugin name e.g. self, file, terminal

- **kwargs** – (dict) additional arguments for returner plugin

validate_data(*data*)

Function to validate provided data

Parameters **data** – (list) list of dictionaries data to validate

Returns None

Running validation raises or logs error on validation failure depending on value of `on_fail` argument in `validator_kwargs`

PYTHON MODULE INDEX

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INDEX

V