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# Jupyter Format

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Source code repository and issue tracker: <https://github.com/mgeier/jupyter-format/>

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### Note

All source files for this documentation are Jupyter notebooks stored in the proposed new storage format.

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## WARNING

This is in an experimental state. Neither the format nor the implementation is stable and either can change at any time without prior notice.

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## 1 Installation

Since `jupyter_format` is in an experimental state, it is deliberately *not* available on [PyPI](https://pypi.org)<sup>1</sup>.

But if you want to play around with it, you can get it from [Github](https://github.com/mgeier/jupyter-format)<sup>2</sup> and make an “editable” installation with

```
git clone https://github.com/mgeier/jupyter-format.git
cd jupyter-format
python3 -m pip install -e . --user
```

If you install it in a virtual environment, you can drop the `--user` option.

If you don’t need a local Git checkout, you can also directly install it with

```
python3 -m pip install git+https://github.com/mgeier/jupyter-format.git@master --user
```

### 1.1 JupyterLab and Classic Notebook Integration

If you want to be able to load and save Jupyter notebooks in the new format, you can specify a custom “contents manager” in your configuration.

You can find your configuration directory with

```
python3 -m jupyter --config-dir
```

If you don’t yet have a configuration file there, you can generate it with JupyterLab:

```
python3 -m jupyterlab --generate-config
```

If you still use the Classic Notebook, generate the file with

```
python3 -m notebook --generate-config
```

To enable the custom “contents manager”, simply open the file `jupyter_notebook_config.py` and add this line:

```
c.NotebookApp.contents_manager_class = 'jupyter_format.contents_manager.FileContentsManager
→'
```

---

At the time of writing this, JupyterLab is not yet able to open `*.jupyter` files by double-clicking. You have to right-click and use “Open With” → “Notebook”. See also <https://github.com/jupyterlab/jupyterlab/issues/4924> and <https://github.com/jupyterlab/jupyterlab/pull/5247>.

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<sup>1</sup> <https://pypi.org>

<sup>2</sup> <https://github.com/mgeier/jupyter-format>

## 1.2 Usage on Binder

If you want to use the new format on <https://mybinder.org> (which is great!), just create a configuration file in your repository using the path

```
.jupyter/jupyter_notebook_config.py
```

... and put the above-mentioned line in it.

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## 2 Motivation

### 2.1 Status Quo

The original format for [Jupyter](#)<sup>3</sup> notebooks uses [JSON](#)<sup>4</sup> as underlying storage format. This has the great advantage that such files are very easy to handle programmatically in many different environments, because JSON parsers are readily available for many programming languages.

One disadvantage, however, is that the format is only semi-human-readable and not very well human-editable. All textual content (e.g. text in Markdown cells and source code in code cells) is stored in lists of JSON strings – one string for each line. This means that each line is surrounded by quotes (") and strings are separated by commas (,), while lists of strings are surrounded by brackets ([ and ]). On top of that, several common characters are not allowed in JSON strings, which means that they have to be escaped by backslashes, e.g. \" and \n. And since a backslash is used for escaping, a literal backslash occurring in the text (which is quite common in programming languages and markup languages) has to be escaped itself (\\).

As an example, let's create a notebook containing the previous two sentences:

```
[1]: import nbformat
nb = nbformat.v4.new_notebook()
nb.cells.append(nbformat.v4.new_markdown_cell(
r"""On top of that,
several common characters are not allowed in JSON strings,
which means that they have to be escaped by backslashes,
e.g. \" and \n.
And since a backslash is used for escaping,
a literal backslash occurring in the text
(which is quite common in programming languages and markup languages)
has to be escaped itself (\\)."""))
```

The JSON-based storage of this minimal notebook looks like this:

```
[2]: print(nbformat.writes(nb))
{
  "cells": [
    {
      "cell_type": "markdown",
      "metadata": {},
      "source": [
        "On top of that,\n",
        "several common characters are not allowed in JSON strings,\n",
        "which means that they have to be escaped by backslashes,\n",
```

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<sup>3</sup> <https://jupyter.org/>

<sup>4</sup> <http://json.org/>

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```
"e.g. `\\` and `\\n`.\\n",
"And since a backslash is used for escaping,\\n",
"a literal backslash occurring in the text\\n",
"(which is quite common in programming languages and markup languages)\\n",
"has to be escaped itself (\\\\).\"
]
}
],
"metadata": {},
"nbformat": 4,
"nbformat_minor": 4
}
```

Escaped characters and JSON syntax elements make this harder than necessary to read, and even harder to modify with a text editor. When editing this by hand, it is easy to mess up the JSON representation by e.g. forgetting a comma.

As a comparison, the same notebook is stored like this in the proposed new format:

```
[3]: import jupyter_format
print(jupyter_format.serialize(nb))

nbformat 4
nbformat_minor 4
markdown
  On top of that,
  several common characters are not allowed in JSON strings,
  which means that they have to be escaped by backslashes,
  e.g. `\\` and `\\n`.
  And since a backslash is used for escaping,
  a literal backslash occurring in the text
  (which is quite common in programming languages and markup languages)
  has to be escaped itself (\\\\).
```

This is exactly the same as the original Markdown content, except that it is indented by 4 spaces.

## 2.2 YAML as Almost-Solution

It has been known for a long time (probably since the inception of Jupyter/IPython notebooks) that lists of JSON strings are not nicely readable for humans. An obvious alternative would be to use [YAML](https://yaml.org)<sup>5</sup>, which provides multiple ways to store text content. One of those ways is the so-called [literal style](https://yaml.org/spec/1.2/spec.html#style/block/literal)<sup>6</sup>, which doesn't require any escaping, making the text much more readable.

This was already suggested in several blog posts:

- <https://matthiasbussonnier.com/posts/05-YAML%20Notebook.html>
- <http://droettboom.com/blog/2018/01/18/diffable-jupyter-notebooks/>

And there are even some implementations available:

- <https://github.com/prabhuramachandran/ipyaml>
- [https://github.com/mdboom/nbconvert\\_vc](https://github.com/mdboom/nbconvert_vc)

This is an example how a YAML-based storage format could look like:

<sup>5</sup> <https://yaml.org>

<sup>6</sup> <https://yaml.org/spec/1.2/spec.html#style/block/literal>

```
[4]: yml_content = """
nbformat: 4
nbformat_minor: 2
cells:
- cell_type: markdown
  source: |+2
    # A Jupyter Notebook

    This is a code cell:
  metadata: {}
- cell_type: code
  source: |+2
    print('Hello, world!')
  outputs:
  - output_type: stream
    name: stdout
    text: |+2
      Hello, world!
  execution_count: 1
  metadata: {}
metadata: {}
"""
```

This is valid YAML, compatible with both version 1.1 and 1.2.

Let's use [PyYAML](https://pyyaml.org)<sup>7</sup> to read this:

```
[5]: import yaml
nb_dict = yaml.safe_load(yml_content)
nb_dict

[5]: {'nbformat': 4,
      'nbformat_minor': 2,
      'cells': [{'cell_type': 'markdown',
                  'source': '# A Jupyter Notebook\n\nThis is a code cell:\n',
                  'metadata': {}},
                {'cell_type': 'code',
                  'source': "print('Hello, world!')\n",
                  'outputs': [{'output_type': 'stream',
                               'name': 'stdout',
                               'text': 'Hello, world!\n'}]},
                {'execution_count': 1,
                  'metadata': {}}],
      'metadata': {}}
```

This Python dictionary can easily be converted to a notebook node:

```
[6]: nb = nbformat.from_dict(nb_dict)
```

And we can use `nbconvert` to convert this to HTML:

```
[7]: from nbconvert.exporters import HTMLExporter
html_content, resources = HTMLExporter().from_notebook_node(nb)
```

```
[8]: import urllib
data_uri = 'data:text/html;charset=utf-8,' + urllib.parse.quote(html_content)
```

---

<sup>7</sup> <https://pyyaml.org>

```
[9]: from IPython.display import IFrame
      IFrame(data_uri, width='100%', height='250')
[9]: <IPython.lib.display.IFrame at 0x7f2907dfa940>
```

This looks promising, doesn't it?

The problem is, as so often, in the details. It's great that we can use *literal style* without littering the text with quotes and escape characters, but sadly, YAML only allows [printable characters](#)<sup>8</sup>. This means that we cannot use some control characters which might occur in cell outputs, for example ANSI escape characters.

There are two options here:

- Go back to escaped strings, at least in some circumstances. But that's exactly what we wanted to avoid by using YAML!
- Don't use YAML after all

## 2.3 Other Partial Solutions

Some alternative notebook formats are supported by the very popular projects <https://github.com/aaren/notedown> (Markdown) and <https://github.com/mwouts/jupyterx> (Markdown, Rmd, Julia/Python/R-scripts etc.).

Those can be very useful, but none of them can store cell outputs, therefore they cannot be a full replacement for the current storage format.

## 2.4 The Need for a Custom Format

Looks like none of the existing formats are sufficient. Probably we can achieve our goals with a custom format.

Having to implement a custom parser for such a custom format is of course a disadvantage, but if we keep it really simple, probably we can get away with it?

Remember the YAML example from *above* (page 4)?

```
[10]: print(yaml_content)

nbformat: 4
nbformat_minor: 2
cells:
- cell_type: markdown
  source: |+2
    # A Jupyter Notebook

    This is a code cell:
  metadata: {}
- cell_type: code
  source: |+2
    print('Hello, world!')
  outputs:
  - output_type: stream
    name: stdout
    text: |+2
      Hello, world!
```

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<sup>8</sup> <https://yaml.org/spec/1.2/spec.html#printable%20character>

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```
execution_count: 1
metadata: {}
metadata: {}
```

The contained text (Markdown and Python source code) is quite readable, but it is still stuffed with many distracting things inbetween.

Since we are not limited by YAML anymore, we can aggressively reduce this to only contain the absolutely necessary information:

```
[11]: content = """nbformat 4
nbformat_minor 2
markdown
    # A Jupyter Notebook

    This is a code cell:
code 1
    print('Hello, world!')
stream stdout
    Hello, world!
"""
```

And that's the proposed new format!

It can be converted to a notebook node (which will look the same as in the YAML example above):

```
[12]: jupyter_format.deserialize(content)
[12]: {'nbformat': 4,
      'nbformat_minor': 2,
      'metadata': {},
      'cells': [{'cell_type': 'markdown',
                  'source': '# A Jupyter Notebook\n\nThis is a code cell:',
                  'metadata': {}},
                {'cell_type': 'code',
                  'metadata': {},
                  'execution_count': 1,
                  'source': "print('Hello, world!')",
                  'outputs': [{'output_type': 'stream',
                               'name': 'stdout',
                               'text': 'Hello, world!'}]}}]
```

Just to make sure it is a valid Jupyter notebook node:

```
[13]: nbformat.validate(_)
```

## 2.5 Complementary Tools

Oftentimes cell outputs (e.g. plots) stored in notebooks make it hard to read and manipulate the text representation of such notebooks. They make it also hard to use with version control systems (e.g. Git).

The proposed new format has the same problem, outputs are still stored in the notebook file, right next to the code cells that generated them.

It is recommended to remove all outputs from a notebook before storing it in version control or before doing any manipulations with a text editor.

Outputs can be removed manually in the Jupyter user interface, but there are also tools to remove outputs programmatically:

- <https://github.com/kynan/nbstripout>
- <https://github.com/choldgraf/nbclean>
- [https://github.com/toobaz/ipynb\\_output\\_filter](https://github.com/toobaz/ipynb_output_filter)

If you want to present your notebooks publicly, you often want to show the outputs to your audience, without them having to run the notebooks themselves. So do you have to store your outputs after all?

No! You can still store your notebooks without outputs and run your notebooks on a server that will re-create the outputs. One tool to do this is:

- <https://nbsphinx.readthedocs.io/>

This is a [Sphinx<sup>9</sup>](#) extension that can convert a bunch of Jupyter notebooks (and other source files) to HTML and PDF pages (and other output formats). This way you have the best of both worlds: No outputs in your (version controlled) notebook files, but full outputs in the public HTML (or PDF) version.

There are still some cases where you do want to store the outputs for some reason. Because of the outputs, it is hard to see the changes to the text/code content of the notebook with traditional tools like diff. But luckily, there is a tool that can make meaningful “diffs” for Jupyter notebooks:

- <https://github.com/jupyter/nbdime>

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### 3 Specification

The exact specification is very much up for discussion!

For now, you can simply *convert* (page 8) an existing notebook and have a look at the resulting file in a text editor. And of course you can have a look at the source code.

If you have ideas for improving the (currently informal) specification or the example implementation, please open an issue or pull request at <https://github.com/mgeier/jupyter-format/>.

..... doc/spec.jupyter ends here.

The following section was generated from doc/nbconvert.jupyter .....

### 4 Notebook format conversions with nbconvert

During the installation of `jupyter_format` (see *Installation* (page 2)), so-called “entry points” for `nbconvert` are configured automatically.

You can convert `.ipynb` notebooks to `.jupyter` notebooks with

```
python3 -m nbconvert --to jupyter my-old-notebook.ipynb
```

To convert a `.jupyter` notebook to any format supported by `nbconvert`, just append `-from-jupyter` to the desired format.

For example, you can convert a `.jupyter` notebook to the traditional `.ipynb` format:

```
python3 -m nbconvert --to ipynb-from-jupyter my-new-notebook.jupyter
```

Or you can convert a `.jupyter` file to an HTML file:

<sup>9</sup> <http://www.sphinx-doc.org/>



```
python3 -m nbconvert --to html-from-jupyter my-new-notebook.jupyter
```

Same for `slides-from-jupyter`, `latex-from-jupyter`, `pdf-from-jupyter` etc.

But enough for the theory, let's try it with this very notebook, shall we?

```
[1]: !python3 -m nbconvert --to ipynb-from-jupyter nbconvert.jupyter --output=my-new-notebook
```

```
[NbConvertApp] Converting notebook nbconvert.jupyter to ipynb-from-jupyter
[NbConvertApp] Writing 4032 bytes to my-new-notebook.ipynb
```

Just to make sure it is actually using Jupyter's JSON format, let's peek at the beginning of the file:

```
[2]: !head my-new-notebook.ipynb
```

```
{
  "cells": [
    {
      "cell_type": "markdown",
      "metadata": {
        "nbsphinx": "hidden"
      },
      "source": [
        "This notebook is part of the `jupyter_format` documentation:\n",
        "https://jupyter-format.readthedocs.io/."
      ]
    }
  ]
}
```

Here's a link to the new file for your perusal: [my-new-notebook.ipynb](#).

Now let's convert this back to `.jupyter`:

```
[3]: !python3 -m nbconvert --to jupyter my-new-notebook.ipynb
```

```
[NbConvertApp] Converting notebook my-new-notebook.ipynb to jupyter
[NbConvertApp] Writing 2686 bytes to my-new-notebook.jupyter
```

Again, we take a peek:

```
[4]: !head my-new-notebook.jupyter
```

```
nbformat 4
nbformat_minor 2
markdown
  This notebook is part of the `jupyter_format` documentation:
  https://jupyter-format.readthedocs.io/.
cell_metadata
  {
    "nbsphinx": "hidden"
  }
markdown
```

And a link for closer inspection: [my-new-notebook.jupyter](#).

Finally, let's try to convert this `.jupyter` file to an HTML page:

```
[5]: !python3 -m nbconvert --to html-from-jupyter my-new-notebook.jupyter
```

```
[NbConvertApp] Converting notebook my-new-notebook.jupyter to html-from-jupyter
[NbConvertApp] Writing 277758 bytes to my-new-notebook.html
```

```
[6]: from IPython.display import IFrame
IFrame('my-new-notebook.html', width='100%', height=350)
```

```
[6]: <IPython.lib.display.IFrame at 0x7f6ece999c18>
```

And for completeness' sake, a link: [my-new-notebook.html](#).

..... doc/nbconvert . jupyter ends here.

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This notebook contains mostly "raw" cells in `reStructuredText`<sup>10</sup> format, which are used to auto-generate the ...

## 5 API Documentation

`jupyter_format.generate_lines(nb)`

Generator yielding lines to be written to `.jupyter` files.

Each of the lines has a line separator at the end, therefore it can e.g. be used in `writelines()`<sup>11</sup>.

**Parameters** `nb` (`nbformat.NotebookNode`<sup>12</sup>) – A notebook node.

`jupyter_format.serialize(nb)`

Convert a Jupyter notebook to a string in `.jupyter` format.

**Parameters** `nb` (`nbformat.NotebookNode`<sup>13</sup>) – A notebook node.

**Returns** `.jupyter` file content.

**Return type** `str`<sup>14</sup>

`jupyter_format.deserialize(source)`

Convert `.jupyter` string representation to Jupyter notebook.

Lines have to be terminated with `'\n'` (a.k.a. `universal newlines`<sup>15</sup> mode).

If `source` is an iterable, line terminators may be omitted.

**Parameters** `source` (`str`<sup>16</sup> or iterable of `str`) – Content of `.jupyter` file.

**Returns** A notebook node.

**Return type** `nbformat.NotebookNode`<sup>17</sup>

**exception** `jupyter_format.ParseError`

Exception that is thrown on errors during reading.

This reports the line number where the error occurred.

<sup>10</sup> <http://docutils.sourceforge.net/rst.html>

<sup>11</sup> <https://docs.python.org/3/library/io.html#io.IOBase.writelines>

<sup>12</sup> <https://nbformat.readthedocs.io/en/latest/api.html#nbformat.NotebookNode>

<sup>13</sup> <https://nbformat.readthedocs.io/en/latest/api.html#nbformat.NotebookNode>

<sup>14</sup> <https://docs.python.org/3/library/stdtypes.html#str>

<sup>15</sup> <https://docs.python.org/3/glossary.html#term-universal-newlines>

<sup>16</sup> <https://docs.python.org/3/library/stdtypes.html#str>

<sup>17</sup> <https://nbformat.readthedocs.io/en/latest/api.html#nbformat.NotebookNode>

## 5.1 Contents Manager

`class jupyter_format.contents_manager.FileContentsManager(*args, **kwargs)`  
JupyterLab and Classic Notebook integration.

Add the following line to your `jupyter_notebook_config.py`:

```
c.NotebookApp.contents_manager_class = 'jupyter_format.contents_manager.  
FileContentsManager'
```

## 5.2 Exporters for nbconvert

`class jupyter_format.exporters.JupyterImportMixin`

Allow \*.jupyter files as input to exporters.

This is used in all exporters as a “mixin” class.

`from_file(file, resources=None, jupyter_format=None, **kw)`

`from_filename(filename, resources=None, **kw)`

`class jupyter_format.exporters.JupyterExporter(*args, **kwargs)`

Convert Jupyter notebooks to .jupyter format.

`from_notebook_node(nb, resources=None, **kw)`

The rest of the exporters are just the ones from `nbconvert.exporters`<sup>18</sup>, enhanced with the `JupyterImportMixin` (page 11).

`class jupyter_format.exporters.ASCIIDocExporter(*args, **kwargs)`

`class jupyter_format.exporters.HTMLExporter(*args, **kwargs)`

See `nbconvert.exporters.HTMLExporter`<sup>19</sup>.

`class jupyter_format.exporters.LatexExporter(*args, **kwargs)`

See `nbconvert.exporters.LatexExporter`<sup>20</sup>.

`class jupyter_format.exporters.MarkdownExporter(*args, **kwargs)`

See `nbconvert.exporters.MarkdownExporter`<sup>21</sup>.

`class jupyter_format.exporters.NotebookExporter(*args, **kwargs)`

See `nbconvert.exporters.NotebookExporter`<sup>22</sup>.

`class jupyter_format.exporters.PDFExporter(*args, **kwargs)`

See `nbconvert.exporters.PDFExporter`<sup>23</sup>.

`class jupyter_format.exporters.PythonExporter(*args, **kwargs)`

See `nbconvert.exporters.PythonExporter`<sup>24</sup>.

`class jupyter_format.exporters.RSTExporter(*args, **kwargs)`

See `nbconvert.exporters.RSTExporter`<sup>25</sup>.

`class jupyter_format.exporters.ScriptExporter(*args, **kwargs)`

`class jupyter_format.exporters.SlidesExporter(*args, **kwargs)`

See `nbconvert.exporters.SlidesExporter`<sup>26</sup>.

<sup>18</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#module-nbconvert.exporters>

<sup>19</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.HTMLExporter>

<sup>20</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.LatexExporter>

<sup>21</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.MarkdownExporter>

<sup>22</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.NotebookExporter>

<sup>23</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.PDFExporter>

<sup>24</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.PythonExporter>

<sup>25</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.RSTExporter>

<sup>26</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.SlidesExporter>

`class jupyter_format.exporters.TemplateExporter(*args, **kwargs)`  
See `nbconvert.exporters.TemplateExporter`<sup>27</sup>.

### 5.3 Batch Conversion with `replace_all`

Script to recursively replace `.ipynb` with `.jupyter` files.

Usage:

```
python3 -m jupyter_format.replace_all --recursive --yes
```

WARNING: This deletes all original files!

Usage to apply this to the whole history of a Git branch:

```
git filter-branch --tree-filter "python3 -m jupyter_format.replace_all --recursive --yes"
```

`jupyter_format.replace_all.ipynb_to_jupyter(path)`  
Replace given `.ipynb` file with a `.jupyter` file.

WARNING: This deletes the original file!

**Parameters** `path` (`os.PathLike`<sup>28</sup> or `str`<sup>29</sup>) – Path to `.ipynb` file.

`jupyter_format.replace_all.replace_all_recursive(start_dir, mapfunction=<class 'map'>)`

Replace all `.ipynb` files recursively.

WARNING: This deletes all original files!

#### Parameters

- `path` (`os.PathLike`<sup>30</sup> or `str`<sup>31</sup>) – Starting directory.
- `mapfunction` – `map()`<sup>32</sup>-like function that can be provided in order to enable parallelization.

..... doc/api.jupyter ends here.  
..... doc/index.jupyter ends here.

<sup>27</sup> <https://nbconvert.readthedocs.io/en/latest/api/exporters.html#nbconvert.exporters.TemplateExporter>

<sup>28</sup> <https://docs.python.org/3/library/os.html#os.PathLike>

<sup>29</sup> <https://docs.python.org/3/library/stdtypes.html#str>

<sup>30</sup> <https://docs.python.org/3/library/os.html#os.PathLike>

<sup>31</sup> <https://docs.python.org/3/library/stdtypes.html#str>

<sup>32</sup> <https://docs.python.org/3/library/functions.html#map>

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