
nbdime Documentation

Release 0.4.1

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Version: 0.4.1

nbtime provides tools for diffing and merging Jupyter notebooks.

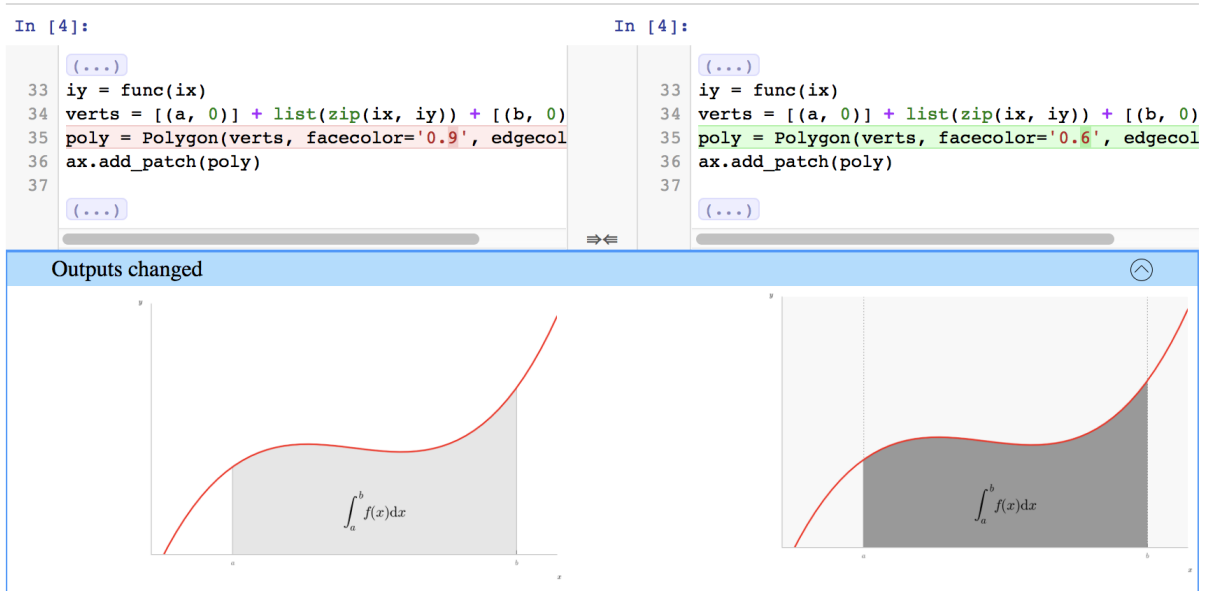


Fig. 1: Figure: nbtime example

Why is nbdiff needed?

Jupyter notebooks are useful, rich media documents stored in a plain text JSON format. This format is relatively easy to parse. However, primitive line-based diff and merge tools do not handle well the logical structure of notebook documents. These tools yield diffs like this:

```
$ diff a.ipynb b.ipynb
76,77d75
<     "plt.rc('axes', grid=False)\n",
<     "plt.rc('axes', facecolor='white')\n",
90c88
<     "image/png": "iVBORw0KGgoAAAANSUHEUgAABLkAAAMQCAYAAADLj7d1AAAABHNCSVQICAgIFAhki
AAAAA1wSFlz\nAAAWJQAAFiUBSVIk8AAAIABJREFUeJzsvXeYZFd57b12h0maPNJII2LG0aCAKEBCFgozIxBap
LY\n1waDyDZg8MX+zMU2F4Mx1x8PwAwxmBjg4yNi2BfQMa20iiAQFKIjXKWRtJIE3tSz3TXuX+8vV2n\nqyucv
N+9z/o9zzynprvq1D6nqqqr1prbRNFEQghhBBCCCGEEEEI8Zkh1wMghBBCCCGEEEEIISQv\nFLkIIYQQQgghhB
BCiPdQ5CKEEEEIIYQQQggh3k0RixBCCCGEEEEIYR4D0UuQgghhBBCCCGEE0I9\nFLkIIYQQQgghhBBCiPdQ5CK
EEEEIIYQQQggh3k0RixBCCCGEEEEIYR4D0UuQgghhBBCCCGEE0I9\nFLkIIYQQQgghhBBCiPdQ5CKEEEEIIYQQ
Qggh3k0RixBCCCGEEEEIYR4D0UuQgghhBBCCCGEE0I9\nFLkIIYQQQjzEGH0JMaZljPmo67EkZWq8D7keByGEE
ELChCIXIYQQQirDGP0mKaFj3BhzkMNx/H/G\nnmG3GmP/pagwFEbkeQJUY75gjNljHmD67EQQgghRB8UuQghhB
BSJe+DCDMjAH7L4TjeAmA+gLc5\nHEMRGNcDqJi3AVGI4DddD4QQQggh+qDIRQghhJBKMMacCuBMAFsg4sy7jTH
DjobzZwBuBvBxR/dP\nnsvERADcC+LTrgRBCCCFEHxS5CCGEEFIVH4C4uP4SI1QcBOD1LgYSRVEziqIXR1H0fRf3
T7IRRdFf\nR1H0K1EUXe96LIQQQgRB0UuQgghhJSOMWYpgP8BoAXg7wH8HcTN9Tsx0UIIYQQQsKBIhchhBBC\
nqRdAOYAuDyKocBfByAl_gBnGhQe73PkhBBCCCFkCChvEHTTtPliDECUHtF0DyciK7eDMR3n65C\nnNychhBBC
```

Fig. 1.1: Figure: diff using traditional line-based diff tool

nbdiff, on the other hand, provides “content-aware” diffing and merging of Jupyter notebooks. It understands the structure of notebook documents. Therefore, it can make intelligent decisions when diffing and merging notebooks, such as:

- eliding base64-encoded images for terminal output
- using existing diff tools for inputs and outputs
- rendering image diffs in a web view

- auto-resolving conflicts on generated values such as execution counters

nbtime yields diffs like this:

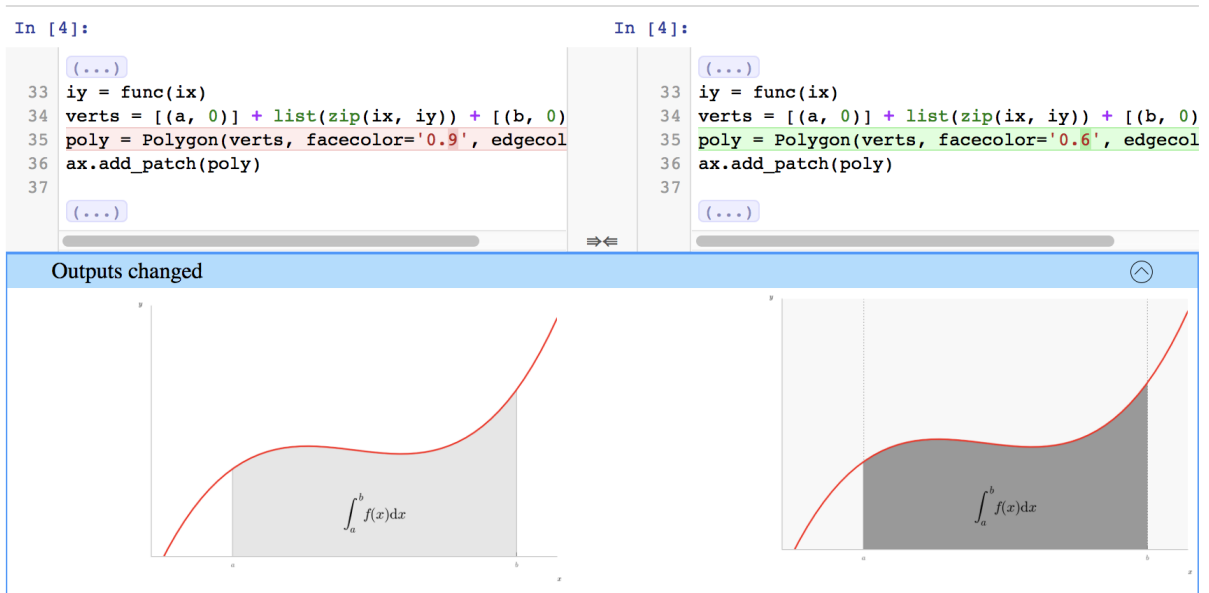


Fig. 1.2: Figure: nbtime's content-aware diff

To get started with `nbdime`, install with `pip`:

```
pip install nbdime
```

And you can be off to the races by diffing notebooks in your terminal with **`nbdiff`**:

```
nbdiff notebook_1.ipynb notebook_2.ipynb
```

or viewing a rich web-based rendering of the diff with **`nbdiff-web`**:

```
nbdiff-web notebook_1.ipynb notebook_2.ipynb
```

For more information about `nbdime`'s commands, see *Console commands*.

2.1 Git integration quickstart

Many of us who are writing and sharing notebooks do so with `git` and GitHub. `Git` doesn't handle diffing and merging notebooks very well by default, but you can configure `git` to use `nbdime` and it will get a lot better.

The quickest way to get set up for `git` integration is to call:

```
nbdime config-git --enable --global
```

New in version 0.3: `nbdime config-git`. Prior to 0.3, each `nbdime` entrypoint had to enable `git` integration separately.

This will enable the both the drivers and the tools for both `diff` and `merge`.

Now when you do **`git diff`** or **`git merge`** with notebooks, you should see a nice diff view, like this:

To use the web-based GUI viewers of notebook diffs, call:

```
nbdiff-web [ref [ref]]
```

```
$ nbdiff c.ipynb b.ipynb
nbdiff c.ipynb b.ipynb
--- c.ipynb 2016-11-30 15:12:21
+++ b.ipynb 2016-11-30 15:12:30
## modified /cells/9/outputs/0/data/text/plain:
- <matplotlib.figure.Figure at 0x10ea05940>
+ <matplotlib.figure.Figure at 0x10eb21860>

## replaced /cells/14/outputs/0/data/image/png:
- iVBORw0K...<snip base64, md5=3f7d4e61ee33aaae...>
+ iVBORw0K...<snip base64, md5=1d6960ad89e9de61...>

## modified /cells/14/outputs/0/data/text/plain:
- <matplotlib.figure.Figure at 0x1110200b8>
+ <matplotlib.figure.Figure at 0x11112bf28>

## modified /cells/14/source:
@@ -25,14 +25,14 @@ x = np.linspace(0, 10)
y = func(x)

fig, ax = plt.subplots()
plt.plot(x, y, 'g','r', linewidth=2)
plt.ylim(ymin=0)

# Make the shaded region
ix = np.linspace(a, b)
iy = func(ix)
verts = [(a, 0)] + list(zip(ix, iy)) + [(b, 0)]
poly = Polygon(verts, facecolor='0.9', edgecolor='0')facecolor='0.6', edgecolor='0.5')
ax.add_patch(poly)
```

Fig. 2.1: Figure: nbdime’s ‘content-aware’ command-line diff

New in version 0.3: support for passing git refs to nbtime commands

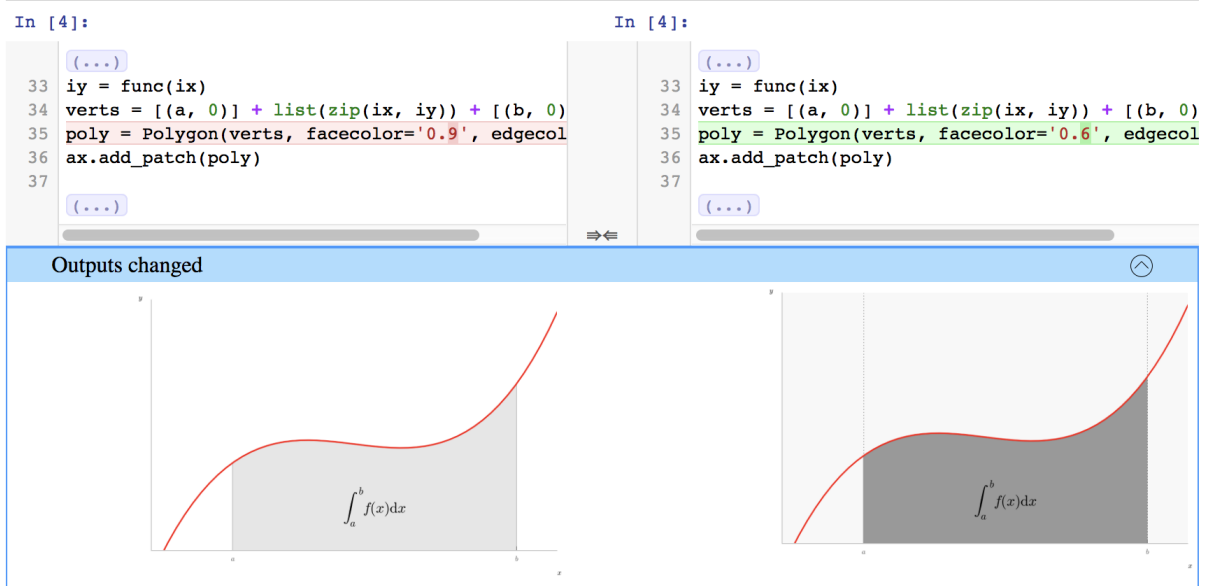


Fig. 2.2: Figure: nbtime’s content-aware diff

If you have a merge conflict in a notebook, the merge driver will ensure that the conflicted notebook is a valid notebook that can be viewed in the normal notebook viewer. In it, the conflicts will be marked similarly to how git would normally indicate conflicts, and they can be resolved manually. Alternatively, nbtime provides a web-base mergetool for visualizing and resolving merge conflicts, and it can be launched by calling:

```
nbtime mergetool
```

For more detailed information on integrating nbtime with version control, see [Version control integration](#).

Loading Matplotlib demos with %load

Cell deleted locally

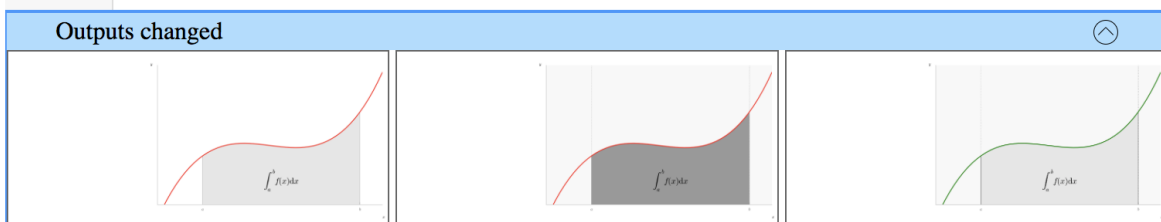
Delete cell

1 IPython's `%load` magic can be used to load any Matplotlib demo by

Cell deleted locally		<input checked="" type="checkbox"/> Delete cell	
<pre> 26 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'r', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 39 40 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 47 48 49 50 51 plt.show() 52 53 </pre>	<pre> 26 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'r', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 39 40 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 47 48 49 50 51 plt.show() 52 53 </pre>	<pre> 26 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'g', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 39 40 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 47 48 49 50 51 plt.show() 52 53 </pre>	

```

26
27 fig, ax = plt.subplots()
28 plt.plot(x, y, 'g', linewidth=2)
29 plt.ylim(ymin=0)
30
31 # Make the shaded region
32 ix = np.linspace(a, b)
33 iy = func(ix)
34 verts = [(a, 0)] + list(zip(ix, iy)) + [(b, 0)]
35 poly = Polygon(verts, facecolor='0.6', edgecolor='0.5')
36 ax.add_patch(poly)
37
38
39
40
41 plt.figtext(0.9, 0.05, '$x$')
42 plt.figtext(0.1, 0.9, '$y$')
43
44 ax.spines['right'].set_visible(False)
45 ax.spines['top'].set_visible(False)
46
47
48
49
50
51 plt.show()
52
53
                    
```



3.1 Installation

3.1.1 Installing nbdime

To install the latest stable release using **pip**:

```
pip install --upgrade nbdime
```

To install and enable the nbdime notebook extensions, run:

```
nbdime reg-extensions [--sys-prefix/--user/--system]
```

The `--system` (default) and `--user` flags determine which users the extensions will be installed and enabled for. Note that you should use `--sys-prefix` to only enable it for the currently active virtual environment (e.g. with `conda` or `virtualenv`). For manual registration see *Notebook Extensions*.

Dependencies

nbdime requires Python version 3.3 or higher. If you are using Python 2, nbdime requires 2.7.1 or higher.

nbdime depends on the following Python packages, which will be installed by **pip**:

- six
- nbformat
- tornado
- colorama
- backports.shutil_which (on python 2.7)

and nbdime's web-based viewers depend on the following Node.js packages:

- codemirror

- json-stable-stringify
- jupyter-js-services
- jupyterlab
- phosphor

3.1.2 Installing latest development version

Installing a development version of nbtime requires [Node.js](#).

Installing nbtime using **pip** will install the Python package dependencies and will automatically run `npm` to install the required Node.js packages.

Setting up a virtualenv with Node.js

The following steps will: create a virtualenv, named `myenv`, in the current directory; activate the virtualenv; and install `npm` inside the virtualenv using `nodeenv`:

```
python3 -m venv myenv          # For Python 2: python2 -m virtualenv myenv
source myenv/bin/activate
pip install nodeenv
nodeenv -p
```

With this environment active, you can now install nbtime and its dependencies using **pip**.

For example with Python 3.5, the steps with output are:

```
$ python3 -m venv myenv
$ source myenv/bin/activate
(myenv) $ pip install nodeenv
Collecting nodeenv
  Downloading nodeenv-1.0.0.tar.gz
Installing collected packages: nodeenv
  Running setup.py install for nodeenv ... done
Successfully installed nodeenv-1.0.0
(myenv) $ nodeenv -p
* Install prebuilt node (7.2.0) ..... done.
* Appending data to /Users/username/myenv/bin/activate
(myenv) $
```

Using Python 2.7, the steps with output are (note: you may need to install `virtualenv` as shown here):

```
$ python2 -m pip install virtualenv
Collecting virtualenv
  Downloading virtualenv-15.1.0-py2.py3-none-any.whl (1.8MB)
    100% || 1.8MB 600kB/s
Installing collected packages: virtualenv
Successfully installed virtualenv-15.1.0
$ python2 -m virtualenv myenv
New python executable in /Users/username/myenv/bin/python
Installing setuptools, pip, wheel...done.
$ source myenv/bin/activate
(myenv) $ pip install nodeenv
Collecting nodeenv
  Downloading nodeenv-1.0.0.tar.gz
Installing collected packages: nodeenv
```

```
Running setup.py install for nodeenv ... done
Successfully installed nodeenv-1.0.0
(myenv) $ nodeenv -p
* Install prebuilt node (7.2.0) ..... done.
* Appending data to /Users/username/myenv/bin/activate
(myenv) $
```

Install the development version

Download and install directly from source:

```
pip install -e git+https://github.com/jupyter/nbdime#egg=nbdime
```

Or clone the [nbdime repository](https://github.com/jupyter/nbdime) and use `pip` to install:

```
git clone https://github.com/jupyter/nbdime
cd nbdime
pip install -e .
```

3.2 Notebook Extensions

3.2.1 Installation

To install and enable the nbdime notebook extensions, run:

```
nbdime reg-extensions [--sys-prefix/--user/--system]
```

Or, if you prefer full control, you can run the individual steps:

```
jupyter serverextension enable --py nbdime [--sys-prefix/--user/--system]
jupyter nbextension install --py nbdime [--sys-prefix/--user/--system]
jupyter nbextension enable --py nbdime [--sys-prefix/--user/--system]
```

This will install the nbdime notebook server extension, and the notebook frontend extension.

3.2.2 Usage

After installing the extensions, one or two buttons should show up in the notebook toolbar, as shown in the figure below.

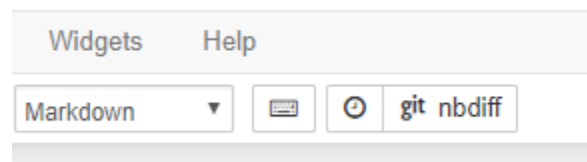


Fig. 3.1: Figure: nbdime’s buttons in the notebook extension.

Clicking the `git` button will open a new tab showing the diff between the the last commit and the *currently saved* version of the notebook. Note that this button will only be visible if the notebook is currently in a git repository.

Clicking the checkpoint button will similarly show the diff between the *checkpointed* and *currently saved* versions of the notebook.

3.3 Console commands

nbtime provides the following CLI commands:

```
nbshow
nbdiff
nbdiff-web
nbmerge
nbmerge-web
mergetool
config-git
```

Pass `--help` to each command to see help text for the command's usage.

Additional commands are available for *Git integration*.

3.3.1 nbshow

nbshow gives you a nice, terminal-optimized summary view of a notebook. You can use it to quickly peek at notebooks without launching the full notebook web application.


```

$ nbshow -s -o c.ipynb
markdown cell 0:
source:
  # Plotting with Matplotlib

  IPython works with the [Matplotlib](http://matplotlib.org/) plotting library,
  which integrates Matplotlib with IPython's display system and event loop
  handling.

  ## matplotlib mode

  To make plots using Matplotlib, you must first enable IPython's matplotlib
  mode.

  To do this, run the `%matplotlib` magic command to enable plotting in the
  current Notebook.

  This magic takes an optional argument that specifies which Matplotlib backend
  should be used.
  Most of the time, in the Notebook,
  you will want to use the `inline` backend, which will embed plots inside
  the Notebook:
code cell 1:
source:
  %matplotlib inline
  import matplotlib.pyplot as plt
  import numpy as np
code cell 2:
source:
  x = np.linspace(0, 3*np.pi, 500)
  plt.plot(x, np.sin(x**2))
  plt.title('A simple chirp');
outputs:
output 0:
  output_type: display_data
  data:
    image/png: iVBORw0K...<snip base64, md5=7665fcc01cfdaa71...>
    text/plain: <matplotlib.figure.Figure at 0x10ea05940>
  metadata (unknown keys):
    image/png:
      height: 392
      width: 604
markdown cell 3:

```

3.3.2 Diffing

nbdime offers two commands for viewing the diff between two notebooks:

- **nbdiff** for command-line diffing
- **nbdiff-web** for rich web-based diffing of notebooks

See also:

For more technical details on how nbdime compares notebooks, see [diff format](#).

nbdiff

nbdiff does a terminal-optimized rendering of notebook diffs. Pass it the two notebooks you would like to compare, and it returns a nice, readable presentation of the changes in the notebook.

```
$ nbdiff c.ipynb b.ipynb
nbdiff c.ipynb b.ipynb
--- c.ipynb 2016-11-30 15:12:21
+++ b.ipynb 2016-11-30 15:12:30
## modified /cells/9/outputs/0/data/text/plain:
- <matplotlib.figure.Figure at 0x10ea05940>
+ <matplotlib.figure.Figure at 0x10eb21860>

## replaced /cells/14/outputs/0/data/image/png:
- iVBORw0K...<snip base64, md5=3f7d4e61ee33aaae...>
+ iVBORw0K...<snip base64, md5=1d6960ad89e9de61...>

## modified /cells/14/outputs/0/data/text/plain:
- <matplotlib.figure.Figure at 0x1110200b8>
+ <matplotlib.figure.Figure at 0x11112bf28>

## modified /cells/14/source:
@@ -25,14 +25,14 @@ x = np.linspace(0, 10)
y = func(x)

fig, ax = plt.subplots()
plt.plot(x, y, 'g','r', linewidth=2)
plt.ylim(ymin=0)

# Make the shaded region
ix = np.linspace(a, b)
iy = func(ix)
verts = [(a, 0)] + list(zip(ix, iy)) + [(b, 0)]
poly = Polygon(verts, facecolor='0.9', edgecolor='0')
ax.add_patch(poly)
```

nbdiff-web

Like **nbdiff**, **nbdiff-web** compares two notebooks.

Instead of a terminal rendering, **nbdiff-web** opens a web browser, compares the two notebooks, and displays the rich rendered diff of images and other outputs.

In [4]:

```

33 (...
34 iy = func(ix)
35 verts = [(a, 0)] + list(zip(ix, iy)) + [(b, 0)]
36 poly = Polygon(verts, facecolor='0.9', edgecol
37 ax.add_patch(poly)
38 (...

```

In [4]:

```

33 (...
34 iy = func(ix)
35 verts = [(a, 0)] + list(zip(ix, iy)) + [(b, 0)]
36 poly = Polygon(verts, facecolor='0.6', edgecol
37 ax.add_patch(poly)
38 (...

```

Outputs changed

Common diff options

You can specify which parts of the notebooks to compare for the diff, by supplying the following flags to any of the diff commands:

- `--sources / -s`
- `--outputs / -o`
- `--metadata / -m`
- `--attachments / -a`

These flags can be combined, e.g. `-sm` will only process source and metadata. Alternatively, you can supply some arguments to process everything *except* some parts:

- `--ignore-sources / -S`
- `--ignore-outputs / -O`
- `--ignore-metadata / -M`
- `--ignore-attachments / -A`

3.3.3 Merging

Merging notebook changes and dealing with merge conflicts are important parts of a development workflow. With notebooks, merging changes is a non-trivial technical task. Traditional, line-based tools can produce invalid notebooks that you have to fix by hand, which is no fun at all, or can risk unintended data loss.

nbdime provides some improved tools for merging notebooks, taking into account knowledge of the notebook file format to ensure that a valid notebook is always produced. Further, by understanding details of the notebook format, nbdime can automatically resolve conflicts on generated fields.

See also:

For more details on how nbdime merges notebooks, see [Merge details](#).

nbmerge

nbmerge merges two notebooks with a common parent. If there are conflicts, they are stored in metadata of the destination file. **nbmerge** will exit with nonzero status if there are any unresolved conflicts.

nbmerge writes the output to `stdout` by default, so you can use pipes to send the result to a file, or the `-o`, `--output` argument to specify a file in which to save the merged notebook.

Because there are several categories of data in a notebook (such as input, output, and metadata), **nbmerge** has several ways to deal with conflicts, and can take different actions based on the type of data with the conflict.

The `-m`, `--merge-strategy` option lets you select a global strategy to use. The following options are currently implemented:

inline This is the default. Conflicts in input and output are recorded with conflict markers, while conflicts on metadata are stored in the appropriate metadata (actual values are kept as their base values).

This gives you a valid notebook that you can open in your usual notebook editor and resolve conflicts by hand, just like you might for a regular source file in your text editor.

use-base When a conflict is encountered, use the value from the base notebook.

use-local When a conflict is encountered, use the value from the local notebook.

use-remote When a conflict is encountered, use the value from the remote notebook.

union When a conflict is encountered, include both the local and the remote value, in that order (local then remote). Conflicts on non-sequence types (anything not list or string) are left unresolved.

Note: The union strategy might resolve to nonsensical values, while still marking conflicts as resolved, so use this carefully.

The `--input-strategy` and `--output-strategy` options lets you specify a strategy to use for conflicts on inputs and outputs, respectively. They accept the same values as the `--merge-strategy` option. If these are set, they will take precedence over `--merge-strategy` for inputs and/or outputs. `--output-strategy` takes two additional options: `remove` and `clear-all`:

remove When a conflict is encountered on a single output, remove that output.

clear-all When a conflict is encountered on any output in a given code cell, clear all outputs for that cell.

To use **nbmerge**, pass it three notebooks:

- `base`: the base, common parent notebook
- `local`: your local changes to base
- `remote`: other changes to base that you want to merge with yours

For example:

```
nbmerge base.ipynb local.ipynb remote.ipynb > merged.ipynb
```

```
$ nbmerge v1.ipynb v2.ipynb v3.ipynb -o merged.ipynb
[W autoresolve:162] autoresolving conflict at /cells/0/outputs with inline-outputs
[W autoresolve:162] autoresolving conflict at /cells/0/execution_count with clear
[W autoresolve:162] autoresolving conflict at /cells/1/execution_count with clear
[W nbmergeapp:47] Conflicts occurred during merge operation.
[I nbmergeapp:60] Merge result written to merged.ipynb
```

nbmerge-web

nbmerge-web is just like **nbmerge** above, but instead of automatically resolving or failing on conflicts, a webapp for manually resolving conflicts is displayed:

```
nbmerge-web base.ipynb local.ipynb remote.ipynb -o merged.ipynb
```

Loading Matplotlib demos with %load

Cell deleted locally

Delete cell

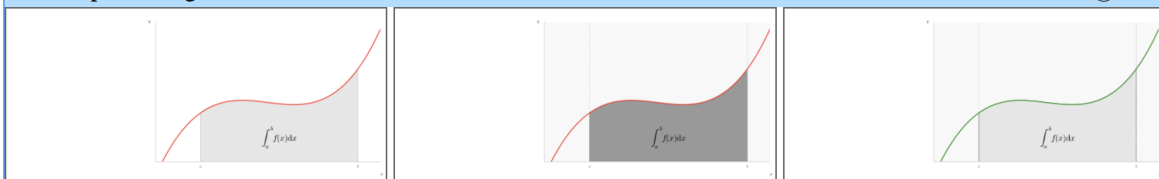
1 IPython's `%load` magic can be used to load any Matplotlib demo by

		<input type="checkbox"/> Delete cell	
<pre> 26 (...) 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'r', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 (...) 39 40 (...) 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 (...) 47 48 (...) 49 50 (...) 51 plt.show() 52 53 </pre>	<pre> 26 (...) 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'r', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 (...) 39 40 (...) 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 (...) 47 48 (...) 49 50 (...) 51 plt.show() 52 53 </pre>	<pre> 26 (...) 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'g', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 (...) 39 40 (...) 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 (...) 47 48 (...) 49 50 (...) 51 plt.show() 52 53 </pre>	

```

26 (...)
27 fig, ax = plt.subplots()
28 plt.plot(x, y, 'g', linewidth=2)
29 plt.ylim(ymin=0)
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31 # Make the shaded region
32 ix = np.linspace(a, b)
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34 verts = [(a, 0)] + list(zip(ix, iy)) + [(b, 0)]
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36 ax.add_patch(poly)
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41 plt.figtext(0.9, 0.05, '$x$')
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44 ax.spines['right'].set_visible(False)
45 ax.spines['top'].set_visible(False)
46 (...)
47
48 (...)
49
50 (...)
51 plt.show()
52
53
                    
```

Outputs changed



3.4 Version control integration

Note: Currently only integration with git is supported out of the box.

Integration with other version control software should be possible if the version control software allows for external drivers and/or tools. For integration, follow the same patterns as outlined in the manual registration sections.

3.4.1 Git integration

Git integration of nbdime is supported in two ways:

- through **drivers** for diff and merge operations, where nbdime takes on the responsibility for performing the diff/merge:
 - *Diff driver*
 - *Merge driver*
- through defining nbdime as diff and merge **tools**, which allow nbdime to display the diff/merge to the user without having to actually depend on git:
 - *Diff web tool*
 - *Merge web tool*

Configure git integration by editing the `.gitconfig` (or `.git/config`) and `.gitattributes` in each git repository or in the `home/etc` directory for global effect. Details for how to individually configure the different drivers/tools are given below.

To configure all diff/merge drivers and tools, simply call:

```
nbdime config-git (--enable | --disable) [--global | --system]
```

This command will register nbdime with git for the current project (repository), or on the global (user), or system level according to the `--global` or `--system` options.

New in version 0.3: `nbdime config-git`. Prior to 0.3, each nbdime entrypoint had to enable git integration separately.

Note: When neither the global or system flag is given, the configuration is only applied to the current project (repository). The command will therefore need to be run from within a git repository.

Usage

Once configured, the diff/merge drivers should simply work out of the box. For example, the normal git diff command:

```
git diff [<commit> [<commit>]] [--] [<path>...]
```

should give you the standard diff for any non-notebook files, but use nbdime's command-line diff for all `.ipynb` files. Nbdime will also be used for all merges on notebook files (no specific commands needed). To launch the rich, web-based tools (for diff visualization and merge conflict visualization/resolution), the following commands will need to be executed:

```
nbdiff-web [ref [ref]]
```

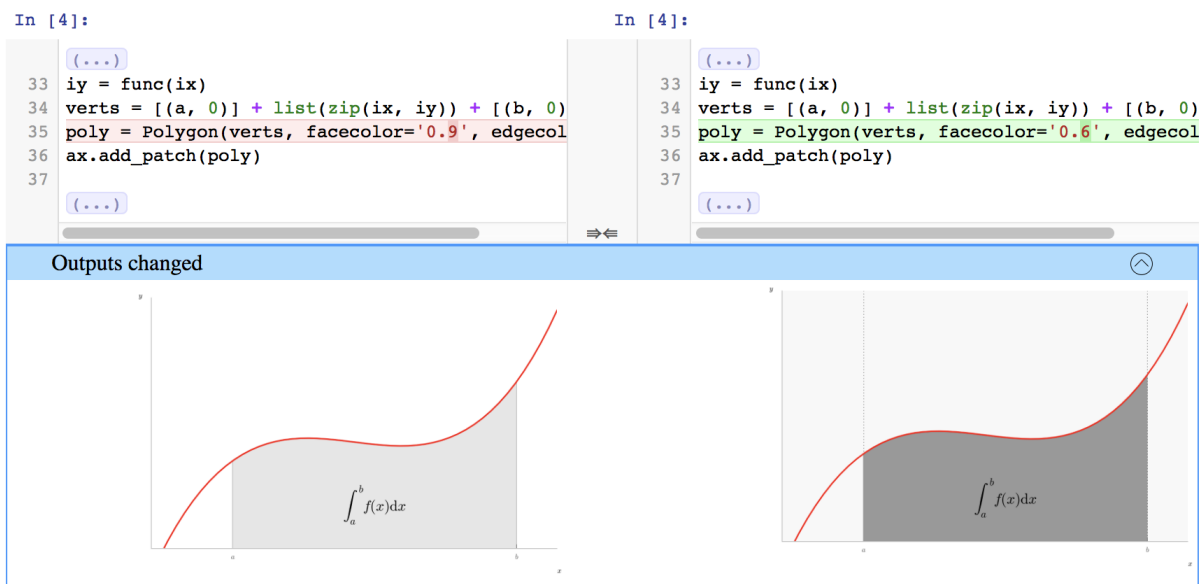


Fig. 3.2: Figure: nbdiff’s content-aware diff

and:

```
git mergetool --tool nbdiff -- *.ipynb
```

Note: Using `git-nbdiffdriver config` overrides the ability to call `git difftool` with notebooks.

You can still call `nbdiff-web` to diff files directly, but getting the files from git refs is still on our TODO list.

Note: If you simply call `git mergetool -tool nbdiff`, it will be called for all merge conflicts, even on filetypes that it cannot handle. To only call on notebooks, add a filter on file paths, e.g. `git mergetool -tool nbdiff - *.ipynb`. **This command has also been aliased as ‘nbdiff mergetool’ for easy access**, and you can also add your own git alias for this command.

Diff driver

Registering an external diff driver with git tells git to call that application to calculate and display diffs to the user. The driver will be called for commands such as `git diff`, but will not be used for all git commands (e.g. `git add --patch` will not use the driver). Consult the git documentation for further details.

Registration can be done in two ways – at the command line or manually.

Command line registration

nbdiff supplies an entry point for registering its driver with git:

Loading Matplotlib demos with %load

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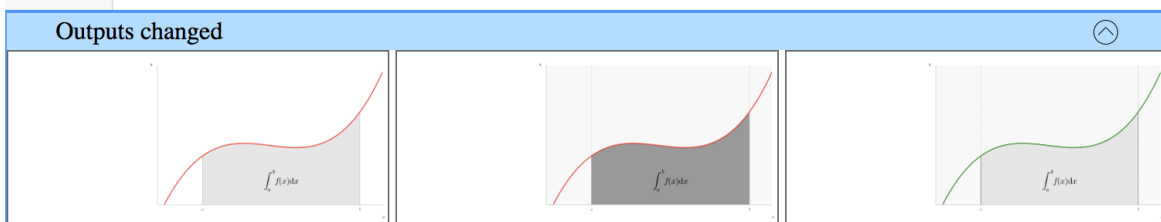
1 IPython's `%load` magic can be used to load any Matplotlib demo by

Delete cell

<pre> 26 (...) 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'r', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 (...) 39 40 (...) 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 (...) 47 48 (...) 49 50 (...) 51 plt.show() 52 53 </pre>	<pre> 26 (...) 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'r', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 (...) 39 40 (...) 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 (...) 47 48 (...) 49 50 (...) 51 plt.show() 52 53 </pre>	<pre> 26 (...) 27 fig, ax = plt.subplots 28 plt.plot(x, y, 'g', li 29 plt.ylim(ymin=0) 30 31 # Make the shaded regi 32 ix = np.linspace(a, b) 33 iy = func(ix) 34 verts = [(a, 0)] + lis 35 poly = Polygon(verts, : 36 ax.add_patch(poly) 37 38 (...) 39 40 (...) 41 plt.figtext(0.9, 0.05, 42 plt.figtext(0.1, 0.9, 43 44 ax.spines['right'].set_ 45 ax.spines['top'].set_v 46 (...) 47 48 (...) 49 50 (...) 51 plt.show() 52 53 </pre>
--	--	--

```

26 (...)
27 fig, ax = plt.subplots()
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45 ax.spines['top'].set_visible(False)
46 (...)
47
48 (...)
49
50 (...)
51 plt.show()
52
53
                    
```



```
git-nbdiffdriver config --enable [--global | --system]
```

This command will register the nbtime diff driver with git, and associate the diff driver with the `.ipynb` file extension. The `-global` | `-system` flags work as explained above.

Manual registration

Alternatively, the diff driver can be registered manually with the following steps:

- To register the driver with git under the name "jupyternotebook", add the following entries to the appropriate `.gitconfig` file (`git config [-global | -system] -e` to edit):

```
[diff "jupyternotebook"]  
command = git-nbdiffdriver diff
```

or if you prefer to use webdiff: `[diff "jupyternotebook"] command = git-nbdiffdriver webdiff [-ip IP]`

- To associate the diff driver with a file type, add the following entry to the appropriate `.gitattributes` file:

```
*.ipynb diff=jupyternotebook
```

Merge driver

Registering an external merge driver with git tells git to call that driver application to calculate merges of certain files. This allows nbtime to become responsible for merging all notebooks.

Registration can be done in two ways – at the command line or manually.

Command line registration

nbtime supplies an entry point for registering its merge driver with git:

```
git-nbmergedriver config --enable [--global | --system]
```

This command will register the nbtime merge driver with git, and associate the merge driver with the `.ipynb` file extension. The `-global` | `-system` flags work as explained above.

Manual registration

Alternatively, the merge driver can be registered manually with the following steps:

- To register the driver with git under the name "jupyternotebook", add the following entries to the appropriate `.gitconfig` file (`git config [-global | -system] -e` to edit):

```
[merge "jupyternotebook"]  
command = git-nbmergedriver merge %O %A %B %L %P
```

- To associate the merge driver with a file type, add the following entry to the appropriate `.gitattributes` file:

```
*.ipynb merge=jupyternotebook
```

Merge web tool

The rich, web-based merge view can be installed as a *git merge tool*. This enables nbdime to process merge conflicts during merging in git, and present them for resolution.

Command line registration

To register nbdime as a git merge tool, run the command:

```
git-nbmergetool config --enable [--global | --system]
```

Once registered, the merge tool can be started by running the git command:

```
git mergetool --tool=nbdime [<file>...]
```

If you want to avoid specifying the tool each time, nbdime can be set as the default tool by adding the `--set-default` flag to the registration command:

```
git-nbmergetool config --enable --set-default [--global | --system]
```

This will allow the merge tool to be launched simply by:

```
git mergetool [<file>...]
```

Note: Git does not allow to select different tools per file type, so if you set nbdime as the default tool it will be called for *all merge conflicts*. This includes non-notebooks, which nbdime will fail to process. For most repositories, it will therefore not make sense to have nbdime as the default, but rather to call it selectively.

Manual registration

Alternatively, the merge tool can be registered manually with the following steps:

- To register both the merge tool with git under the name “nbdime”, add the following entry to the appropriate `.gitconfig` file (`git config [-global | -system] -e` to edit):

```
[mergetool "nbdime"]
cmd = git-nbmergetool "$BASE" "$LOCAL" "$REMOTE" "$MERGED"
```

- To set nbdime as the default merge tool, add or modify the following entry in the appropriate `.gitconfig` file:

```
[merge]
tool = nbdime
```

3.4.2 Mercurial integration

Integration of mercurial is similar to that for manual git registration, but it uses a separate set of entry points since amongst others, mercurial requires the diff extension to handle directories.

Differs

To tell mercurial about nbdimes differs, open the appropriate config file (`hg config --edit` for the default user level one), and add the following entries:

```
[extensions]
extdiff =

[extdiff]
cmd.nbdiff = hg-nbdiff
cmd.nbdiffweb = hg-nbdiffweb
opts.nbdiffweb = --log-level ERROR
```

This will:

- enable the external diff extension
- register both the command line diff and web diff
- set the default log level of the webdiff

`opts.<cmdname>` allows you to customize which flags nbtime are called with.

To use nbtime from mercurial, you can then call it like this:

```
hg nbdiff <same arguments as for 'hg diff'>
hg nbdiffweb <same arguments as for 'hg diff'>
```

Mergetools

Add the following entries to the appropriate mercurial config file:

```
[merge-tools]
nbtime.priority = 2
nbtime.premerge = False
nbtime.executable = hg-nbmerge
nbtime.args = $base $local $other $output
nbtimeweb.priority = 1
nbtimeweb.premerge = False
nbtimeweb.executable = hg-nbmergeweb
nbtimeweb.args = --log-level ERROR $base $local $other $output
nbtimeweb.gui = True

[merge-patterns]
**.ipynb = nbtime
```

This will:

- use the merge driver by default for notebook files
- register the web tool

The typical usage pattern for the webtool is like this:

```
> hg merge <other branch>
merging ***.ipynb
0 files updated, 0 files merged, 0 files removed, 1 files unresolved
use 'hg resolve' to retry unresolved file merges or 'hg update -C .' to abandon
```

```
> hg resolve --tool nbdimeweb
```

3.5 Glossary

diff object A diff object represents the difference $B-A$ between two objects, A and B , as a list of operations (ops) to apply to A to obtain B .

merge decision An object describing a part of the merge operation between two objects with a common base. Contains both the information about local and remote changes, and the decision taken to resolve the merge.

JSONPatch JSON Patch defines a JSON document structure for expressing a sequence of operations to apply to a JavaScript Object Notation (JSON) document; it is suitable for use with the `HTTP PATCH` method. See [RFC 6902 JavaScript Object Notation \(JSON\) Patch](#).

3.6 Changes in nbdime

3.6.1 0.4

0.4.1 - 2017-12

- Fixed layout issue in web diff for cells added/removed/patched in the same location.
- Dropped support for Python 3.3.
- Ensure Ctrl+C will shut down the nbdime web server on Windows.
- Ensure server extension works with 4.x version of notebook server.
- Various fixes and adjustments.

0.4.0 - 2017-11

- Fixed issues with the diff filtering options.
- Added git diffdriver using web-diff.
- Added mercurial integration code and entry points.
- Added notebook extensions for integration into its web interface.
- Changed layout for web diff such that chunks of added/removed cells or outputs are shown side-by-side. For small monitors, they will still be shown below each other.
- In the web-diff, relative images in rendered markdown will now show a placeholder image instead of broken images.
- Various fixes and performance improvements.

3.6.2 0.3

- Handle git refs directly in nbdime, so you can `nbdiff HEAD notebook.ipynb`, etc. in git repos. This replaces the never-quite-working git difftool

- Support filtering options on all entrypoints, e.g. `nbdiff -s` to only show diff of sources. See `nbdiff -h` for details
- Fix MathJax CDN URL, now that `cdn.mathjax.org` has shutdown
- Use `jupyter-packaging` to build javascript sources in `setup.py`
- Various fixes and performance improvements

3.6.3 0.2

- Support `ip`, `base-url` arguments to web entrypoints
- Enable export of web diff to static HTML
- Various fixes and improvements

3.6.4 0.1

0.1.2 - 2017-01

- Fix inclusion of webapp sources in wheels

0.1.1 - 2017-01

- Fix default location of `--global git` attributes file
- Support `--system` argument for git configuration, allowing easy setup of nbdime system-wide
- Render tracebacks and colors in stream output in web view
- Render output as long as one MIME-type is safe in web view
- Improve styling of web view
- Fix a bug in inline-merge

0.1.0 - 2016-12

First release of nbdime!

3.7 Testing

See the latest automated build, test, and coverage status at:

- [Build and test on Travis](#)
- [Coverage on codecov](#)

3.7.1 Dependencies

Install the test dependencies:

```
pip install "nbtime[test]"
```

3.7.2 Running tests locally

To run python tests, locally, enter:

```
pytest
```

from the project root. If you have Python 2 and Python 3 installed, you may need to enter:

```
python3 -m pytest
```

to run the tests with Python 3. See the [pytest documentation](#) for more options.

To run javascript/typescript tests, enter:

```
npm test
```

3.7.3 Submitting test cases

If you have notebooks with interesting merge challenges, please consider [contributing them](#) to nbtime as test cases!

3.8 diff format

This sections provide details on how nbtime represents diffs, and will mostly be relevant for those who want to use nbtime as a library, or that want to contribute to nbtime.

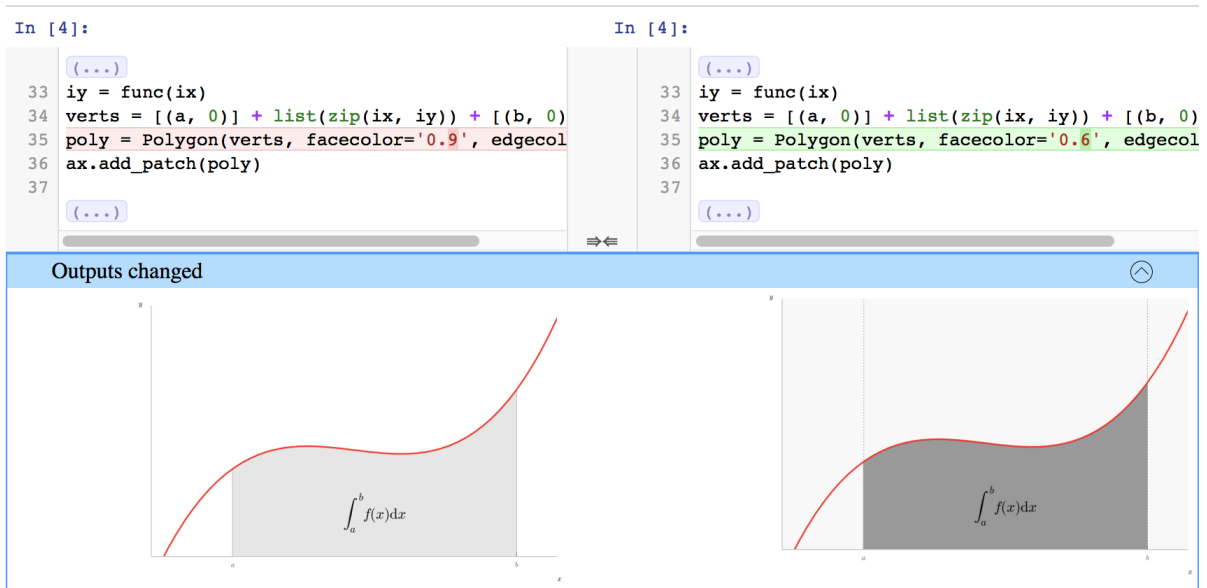


Fig. 3.4: Figure: nbtime's content-aware diff

3.8.1 Basics

A *diff object* represents the difference $B-A$ between two objects, A and B, as a list of operations (ops) to apply to A to obtain B. Each operation is represented as a dict with at least two items:

```
{ "op": <opname>, "key": <key> }
```

The objects A and B are either mappings (dicts) or sequences (lists or strings). A different set of ops are legal for mappings and sequences. Depending on the op, the operation dict usually contains an additional argument, as documented below.

The diff objects in nbdime are:

- json-compatible nested structures of dicts (with string keys) and
- lists of values with heterogeneous datatypes (strings, ints, floats).

The difference between these input objects is represented by a json-compatible results object. A JSON schema for validating diff entries is available in `diff_format.schema.json`.

3.8.2 Diff format for mappings

For mappings, the key is always a **string**.

Valid operations (ops) are:

- **remove** - delete existing value at key:

```
{ "op": "remove", "key": <string> }
```

- **add** - insert new value at key not previously existing:

```
{ "op": "add", "key": <string>, "value": <value> }
```

- **replace** - replace existing value at key with new value:

```
{ "op": "replace", "key": <string>, "value": <value> }
```

- **patch** - patch existing value at key with another diffobject:

```
{ "op": "patch", "key": <string>, "diff": <diffobject> }
```

3.8.3 Diff format for sequences

For sequences (list and string) the key is always an **integer index**. This index is relative to object A of length N.

Valid operations (ops) are:

- **removerange** - delete the values $A[key:key+length]$:

```
{ "op": "removerange", "key": <string>, "length": <n> }
```

- **addrange** - insert new items from `valuelist` before $A[key]$, at end if $key=len(A)$:

```
{ "op": "addrange", "key": <string>, "valuelist": <values> }
```

- **patch** - patch existing value at key with another diffobject:


```
{ "op": "patch", "key": <string>, "diff": <diffobject> }
```

3.8.4 Relation to JSONPatch

The above described diff representation format has similarities with the *JSONPatch* standard but is also different in a few ways:

operations

- JSONPatch contains operations `move`, `copy`, `test` not used by nbdime.
- nbdime contains operations `addrange`, `removerange`, and `patch` not in JSONPatch.

patch

- JSONPatch uses a deep JSON pointer based `path` item in each operation instead of providing a recursive `patch op`.
- nbdime uses a `key` item in its `patch op`.

diff object

- JSONPatch can represent the diff object as a *single list*.
- nbdime uses a *tree of lists*.

To convert a nbdime diff object to the JSONPatch format, use the `to_json_patch` function:

```
from nbdime.diff_format import to_json_patch
jp = to_json_patch(diff_obj)
```

Note: This function `to_json_patch` is currently a draft, subject to change, and not yet covered by tests.

3.8.5 Examples

For examples of diffs using nbdime, see `test_patch.py`.

3.9 Merge details

This sections provide details on how nbdime handles merges, and will mostly be relevant for those who want to use nbdime as a library, or that want to contribute to nbdime.

Loading Matplotlib demos with %load

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Delete cell

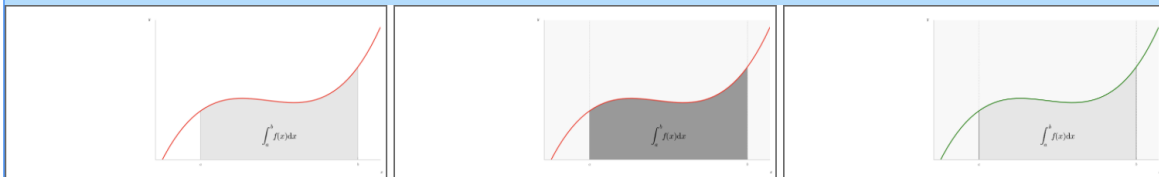
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```

26 (...
27 fig, ax = plt.subplots()
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35 poly = Polygon(verts, facecolor='0.6', edgecolor='0.5')
36 ax.add_patch(poly)
37
38 (...
39
40 (...
41 plt.figtext(0.9, 0.05, '$x$')
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43
44 ax.spines['right'].set_visible(False)
45 ax.spines['top'].set_visible(False)
46 (...
47
48 (...
49
50 (...
51 plt.show()
52
53
                    
```

Outputs changed



nbdime implements a three-way merge of Jupyter notebooks and a subset of generic JSON objects.

3.9.1 Merge Results

A merge operation with a shared origin object `base` and modified objects, `local` and `remote`, outputs these merge results:

- a fully or partially merged object
- a set of *merge decision* objects that describe the merge operation

3.9.2 Merge decision format

Each three-way notebook merge is based on the differences between the `base` version and the two changed versions – `local` and `remote`. These differences, “base“ with `local` and `base` with `remote`, are then compared, and for each change a set of decisions are made. A *merge decision* object represents such a decision, and is represented as a dict with the following entries:

```
{
  "local_diff": <diff object>,
  "remote_diff": <diff object>,
  "conflict": <boolean>,
  "action": <action taken/suggested>,
  "common_path": <JSON path>,
  "custom_diff": <diff object>
}
```

Merge conflicts

Merge conflicts are indicated with the `conflict` field on the decision object, and if true, indicates that the given differences could not be automatically reconciled.

Note: Even when conflicted, the `action` field might indicate a suggested or “best guess” resolution of the decision. If no such suggestion can be inferred, the base value will be used as the default resolution.

Merge actions

Each *merge decision* has an entry `action` which describes the resolution of the merge. It can take the following values:

- **local:** Use the `local` changes, as described by `local_diff`.
- **remote:** Use the `remote` changes as described by `remote_diff`.
- **base:** Use the original value, that is, do not apply any changes.
- **either:** Indicates that the `local` and `remote` changes are interchangeable, and that either can be used.
- **local_then_remote** - First apply the `local` changes, then the `remote` changes. This is only applicable for certain subset of merges, like insertions in the same location (for example two cells added in the same location).
- **remote_then_local** - Similar to **local_then_remote**, but `remote` changes are taken before `local` ones.
- **clear** - Remove the value(s) on the object. Can, for example, be used to clear the outputs of a cell.

- **custom** - Use the changes as described by `custom_diff`. This can be used for more complex resolutions than those described by the other actions above. A simple example would be for the case of multiple cells (or alternatively, multiple lines of text) inserted both locally and remotely in the same location. Here, the correct resolution might be to take the first element from `local`, then the `remote` changes, and finally the rest of the `local` changes.

Common path

The `common_path` entry of a merge decision describes the path in which the local and remote changes diverge. For example if the local changes are specified as:

```
patch "cells"
  patch index 0
    patch "source"
      addrange <some lines of source to add>
    patch "outputs"
      addrange <a new output added>
```

and the remote changes are specified as:

```
patch "cells"
  patch index 0
    patch "outputs"
      removerange <all outputs removed>
```

then the common path will be `["cells", 0]`, and the *diff object* will omit the patch "cells" and patch 0 operations.

3.10 REST API

The following is a preliminary REST API for nbtime. It is not yet frozen but is guided on preliminary work and likely close to the final result.

The Python package, commandline, and web API should cover the same functionality using the same names but different methods of passing input/output data. Thus consider the request to be the input arguments and response to be the output arguments for all APIs.

3.10.1 Definitions

*json_** : always a JSON object

json_notebook : a full Jupyter notebook

json_diff_object : diff result in nbtime diff format as specified in *diff format*

json_merge_decisions : merge decisions as specified in *Merge details*

3.10.2 /api/diff

Compute diff of two notebooks provided as filenames local to the server working directory, and/or as URLs.

Request:

```
{
  "base": "filename.ipynb" | "http://your-domain/url/path",
  "remote": "filename.ipynb" | "http://your-domain/url/path"
}
```

Response:

```
{
  "base": json_notebook,
  "diff": json_diff_object
}
```

3.10.3 /api/merge

Compute merge of three notebooks provided as filenames local to the server working directory, and/or as URLs.

Request:

```
{
  "base": "filename.ipynb" | "http://your-domain/url/path",
  "local": "filename.ipynb" | "http://your-domain/url/path",
  "remote": "filename.ipynb" | "http://your-domain/url/path"
}
```

Response:

```
{
  "base": json_notebook,
  "merge_decisions": json_merge_decisions
}
```

3.11 Use cases

Use cases for nbdime are envisioned to be mainly in the categories of a merge command for version control integration and diff command for inspecting changes and automated regression testing. At the core of nbdime is the diff algorithms, which must handle not only text in source cells but also a number of data formats based on mime types in output cells.

3.11.1 Basic diffing use cases

While developing basic correct diffing is fairly straightforward, there are still some issues to discuss.

Other tasks (issues will be created for these):

- Plugin framework for mime type specific diffing.
- Diffing of common output types (png, svg, etc.)
- Improve fundamental sequence diff algorithm. Current algorithm is based on a brute force $O(N^2)$ longest common subsequence (LCS) algorithm. This will be rewritten in terms of a faster algorithm such as Myers $O(ND)$ LCS based diff algorithm, optionally using Python's `difflib` for some use cases where it makes sense.

3.11.2 Version control use cases

Most commonly, cell source is the primary content, and output can presumably be regenerated. Indeed, it is not possible to guarantee that merged sources and merged output is consistent or makes any kind of sense.

Some tasks:

- Merge of output cell content is not planned.
- Is it important to track source lines moving between cells?

3.11.3 Regression testing use cases

CHAPTER 4

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D

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