Sankey-view Documentation

Release 2.0.1

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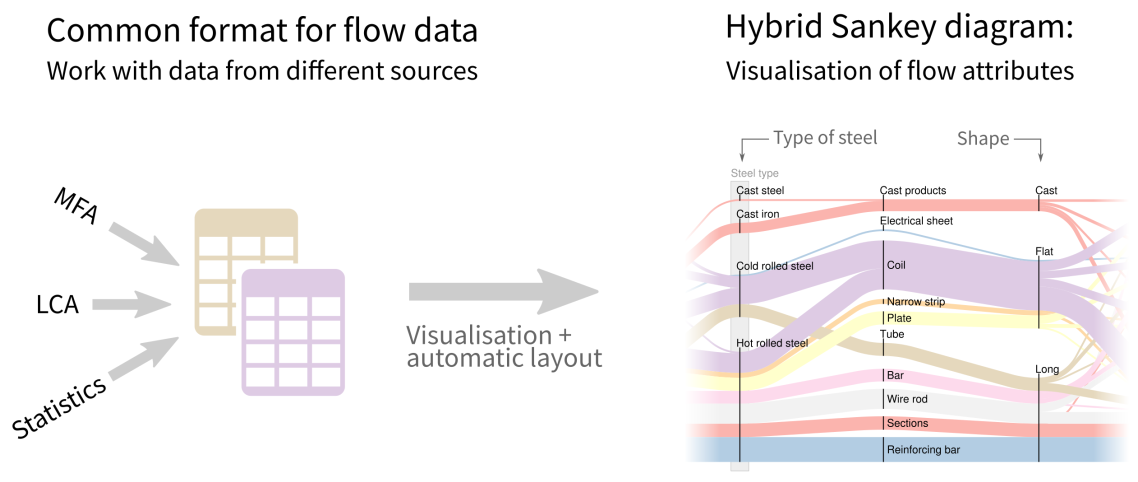
CONTENTS



floWeaver generates Sankey diagrams from a dataset of flows. For a descriptive introduction, see the paper Hybrid Sankey diagrams: Visual analysis of multidimensional data for understanding resource use. For a more hands-on introduction, read on.

CHAPTER

ONE

GETTING STARTED

Note: You can try the tutorials online without installing anything! Click here to open MyBinder.

Start by installing floWeaver:

1.1 Installation

See below for more detailed instructions for Linux, Windows and OS X. In brief: install floweaver using pip:

```
$ pip install floweaver
```

If you use Jupyter notebooks – a good way to get started – you will also want to install ipysankeywidget, an IPython widget to interactively display Sankey diagrams:

```
$ pip install ipysankeywidget
$ jupyter nbextension enable --py --sys-prefix ipysankeywidget
```

Note: If this is the first time you have installed IPython widgets, you also need to make sure they are enabled:

```
$ jupyter nbextension enable --py --sys-prefix widgetsnbextension
```

If you use multiple virtualenvs or conda environments, make sure `ipywidgets` and `ipysankeywidget` are installed and enabled in both the environment running the notebook server and the kernel.

Note: If you apply Floweaver in restricted environments (e.g., Jupyter is hosted on university servers), use `--user` instead of `--sys-prefix` in the above commands. Pip needs the switch too: `pip install --user floweaver ipysankeywidget`.

1.1.1 Install on Windows

Floweaver requries the latest version of Python to be installed. This can be done by installing the Anaconda platform from Link here .

The procedure described in section *Installation* should be performed in the Anaconda Prompt, which can be found among the installed programs.

To open Jupyter Notebook and begin to work on the Sankey. Write in the Anaconda Prompt the following

```
$ jupyter notebook
```

1.1.2 Install on macOS

Floweaver requries the latest version of Python to be installed. This can be done by installing the Anaconda platform from Link here .

The procedure described in section *Installation* should be performed in the Command Line

To open Jupyter Notebook and begin to work on the Sankey. Write in the Command Line the following

```
$ jupyter notebook
```

[not sure about this :D]

1.2 Changelog

1.2.1 v2.0.0 (renamed to floWeaver)

- sankeyview is now called floWeaver!
- There is a new top-level interface to creating a Sankey diagram, the `floweaver.weave()` function. This gives more flexibility about the appearance of the diagram, and lets you save the results in different formats (other than showing directly in the Jupyter notebook), while still being simple to use for the most common cases.
- No longer any need for `from sankeyview.jupyter import show_sankey`; use `floweaver.weave()` instead.
- New way to specify link colours using `floweaver.CategoricalScale` and `floweaver.QuantitativeScale`, replacing `hue` and related arguments to `show_sankey`. See *Colour-intensity scales* for examples.

1.3 Migrating from sankeyview

Starting with version 2.0, *sankeyview* has been renamed to *floWeaver*. At the same time, there were a few changes to tidy up the API and make it more flexible. This document describes the steps needed to update from an earlier version to *floWeaver*.

1.3.1 Imports

Where you had this before:

```
from sankeyview import *
from sankeyview.jupyter import show_sankey
```

You should now have one of the following:

```
# More explicit about where names are coming from: use e.g. "fw.Dataset"
import floweaver as fw

# Less typing: use just e.g. "Dataset"
from floweaver import *
```

1.3.2 `show_sankey` function

The `show_sankey` function (from module `sankeyview.jupyter`) aimed to provide an easy interface for showing Sankey diagrams in Jupyter notebooks, but it was limited in its flexibility and had grown a long and confusing arguments list. It has been replaced by the `floweaver.weave()` function.

For example, this old code:

```
show_sankey(sdd, dataset, width=800, height=500)
```

now becomes:

```
weave(sdd, dataset).to_widget(width=800, height=500)
```

For more details see `floweaver.weave()` and `floweaver.SankeyData`.

1.3.3 Link colours

While basic use should continue to work with the minor changes above, more complicated uses involving these parameters of `show_sankey` will need to be rewritten:

- `agg_measures`
- `hue`

See the colour scales tutorial for more details.

Then the tutorials introduce the concepts used to generate and manipulate Sankey diagrams:

1.4 Quickstart tutorial

This tutorial will go through the basic ways to use `floweaver` to process and transform data into many different Sankey diagrams.

> If you are reading the static documentation, you can also try an interactive version of this tutorial online using MyBinder

Let's start by making a really simple dataset. Imagine we have some farms, which grow apples and bananas to sell to a few different customers. We can describe the *flow* of fruit from the farms (the *source* of the flow) to the customers (the *target* of the flow):

```
[1]: import pandas as pd
     flows = pd.read_csv('simple_fruit_sales.csv')
     flows
```

```
[1]:   source target     type  value
     0  farm1   Mary   apples      5
     1  farm1  James   apples      3
     2  farm2   Fred   apples     10
     3  farm2   Fred  bananas     10
     4  farm2  Susan  bananas      5
     5  farm3  Susan   apples     10
     6  farm4  Susan  bananas      1
     7  farm5  Susan  bananas      1
     8  farm6  Susan  bananas      1
```

Drawn directly as a Sankey diagram, this data would look something like this:

```
[2]: from ipysankeywidget import SankeyWidget
     SankeyWidget(links=flows.to_dict('records'))
```

```
[2]: SankeyWidget(links=[{'source': 'farm1', 'target': 'Mary', 'type': 'apples', 'value':␣
     ↪5}, {'source': 'farm1', '...
```

But you don't always want a direct correspondence between the flows in your data and the links that you see in the Sankey diagram. For example:

- Farms 4, 5 and 6 are all pretty small, and to make the diagram clearer we might want to group them in an "other" category.
- The flows of apples are mixed in with the flows of bananas – we might want to group the kinds of fruit together to make them easier to compare
- We might want to group farms or customers based on some other attributes – to see difference between genders, locations, or organic/non-organic farms, say.

This introduction shows how to use `floweaver` to do some of these for this simple example, in the simplest possible way. Later tutorials will show how to use it on real data, and more efficient ways to do the same things.

1.4.1 Basic diagram

Let's start with the first example: grouping farms 4, 5 and 6 into an "other" category. `floweaver` works by setting up a "Sankey diagram definition" which describes the structure of the diagram we want to see. In this case, we need to set up some groups:

```
[3]: from floweaver import *

     # Set the default size to fit the documentation better.
     size = dict(width=570, height=300)

     nodes = {
         'farms': ProcessGroup(['farm1', 'farm2', 'farm3',
                                'farm4', 'farm5', 'farm6']),
         'customers': ProcessGroup(['James', 'Mary', 'Fred', 'Susan']),
     }
```

We need to describe roughly how these groups should be placed in the final diagram by defining an "ordering" – a list of vertical slices, each containing a list of node ids:

```
[4]: ordering = [
         ['farms'],        # put "farms" on the left...
         ['customers'],    # ... and "customers" on the right.
     ]
```

And we also need to say which connections should appear in the diagram (sometimes you don't want to actually see all the connections). This is called a "bundle" because it bundles up multiple flows – in this case all of them.

```
[5]: bundles = [
         Bundle('farms', 'customers'),
     ]
```

Putting that together into a Sankey diagram definition (SDD) and applying it to the data gives this result:

```
[6]: sdd = SankeyDefinition(nodes, bundles, ordering)
     weave(sdd, flows).to_widget(**size)
```

```
[6]: SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': 'farms^*',
     ↪'target': 'customers^*', '...
```

That's not very useful. What's happened? Every farm and every customer has been lumped together into one group. To get the picture we want – like the first one, but with an "other" group containing farms 4, 5 and 6 – we need to *partition* the groups:

```
[7]: # The first argument is the dimension name -- for now we're using
     # "process" to group by process ids. The second argument is a list
     # of groups.
     farms_with_other = Partition.Simple('process', [
         'farm1',  # the groups within the partition can be a single id...
         'farm2',
         'farm3',
         ('other', ['farm4', 'farm5', 'farm6']),    # ... or a group
     ])

     # This is another partition.
     customers_by_name = Partition.Simple('process', [
         'James', 'Mary', 'Fred', 'Susan'
     ])

     # Update the ProcessGroup nodes to use the partitions
     nodes['farms'].partition = farms_with_other
     nodes['customers'].partition = customers_by_name

     # New Sankey!
     weave(sdd, flows).to_widget(**size)
```

```
[7]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
     ↪farm1', 'farms^farm2', '...
```

That's better: now the farms are split up appropriately with an "other" category, and the customers are shown separately as well. We don't have to stop there – what about showing sales to men and women?

```
[8]: customers_by_gender = Partition.Simple('process', [
         ('Men', ['Fred', 'James']),
         ('Women', ['Susan', 'Mary']),
     ])

     nodes['customers'].partition = customers_by_gender
```

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```
weave(sdd, flows).to_widget(**size).auto_save_png('quickstart_example1.png')
```

[8]:
```
SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm2', '...
```

There is a better way of specifying this type of partition that doesn't involve hard-coding who's a man and who's a woman into the code – see the later tutorial on using *dimension tables*.

1.4.2 Distinguishing flow types

These diagrams have lost sight of the kind of fruit that is actually being sold – are the men buying apples, bananas or both from farm1? To show this we need to split up the flows in the diagram based on their *type*. Just like we split up the `ProcessGroups` by defining a partition of processes, we split up flows by defining a partition of flows.

(While we're at it let's choose some colours that look vaguely like apples and bananas)

[9]:
```
# Another partition -- but this time the dimension is the "type"
# column of the flows table
fruits_by_type = Partition.Simple('type', ['apples', 'bananas'])

# Set the colours for the labels in the partition.
palette = {'apples': 'yellowgreen', 'bananas': 'gold'}

# New SDD with the flow_partition set
sdd = SankeyDefinition(nodes, bundles, ordering,
                       flow_partition=fruits_by_type)

weave(sdd, flows, palette=palette).to_widget(**size)
```

[9]:
```
SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm2', '...
```

As a last step, it would be nice to label which flows are apples and which are bananas. One way to do this would be to use a legend next to the diagram, or to put labels on every flow. Here, we'll add a new layer in the middle of the diagram which temporarily groups together the different fruit types on their way from the farms to the customers. This temporary/additional grouping point is called a *waypoint*.

To add a waypoint, we need to do three things:

1. Define it as a node
2. Position it in the ordering (between `farms` and `customers`)
3. Add it to the bundle

[10]:
```
# 1. Define a new waypoint node
nodes['waypoint'] = Waypoint()

# 2. Update the ordering to show where the waypoint goes: in the middle
ordering = [
    ['farms'],
    ['waypoint'],
    ['customers'],
]

# 3. Update the bundle definition to send the flows via the waypoint
```

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```
bundles = [
    Bundle('farms', 'customers', waypoints=['waypoint']),
]

# Update the SDD with the new nodes, ordering & bundles.
sdd = SankeyDefinition(nodes, bundles, ordering,
                       flow_partition=fruits_by_type)

weave(sdd, flows, palette=palette).to_widget(**size)
```

```
[10]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm2', '...
```

That's not yet very useful. Just like above, the default for Waypoints is to group everything togeter. We need to set a partition on the waypoint to split apart apples and bananas:

```
[11]: # Redefine the waypoint with a partition (same one defined above)
nodes['waypoint'] = Waypoint(fruits_by_type)

weave(sdd, flows, palette=palette).to_widget(**size)
```

```
[11]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm2', '...
```

1.4.3 Summary

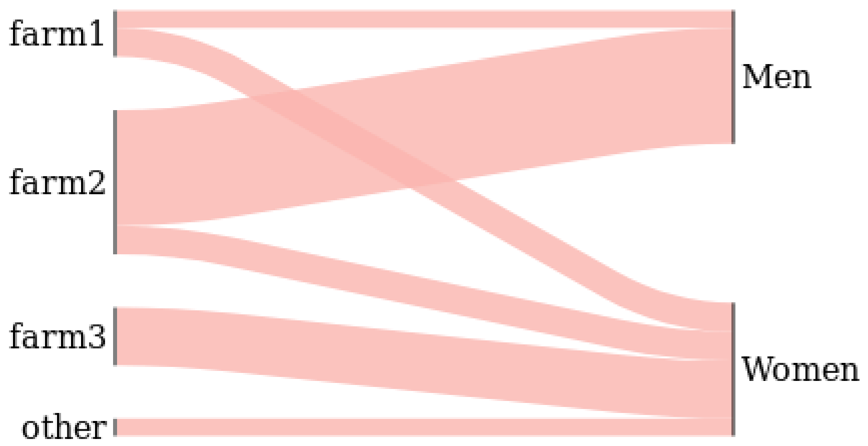
This has demonstrated the basic usage of `floweaver`: defining `ProcessGroups`, `Waypoints`, `Partitions`, and `Bundles`. If you are reading the interactive version, why not go back and try out some different ways to present the data? Here are some suggestions:

1. Farms 1, 3 and 5 are organic. Can you change the farm Partition to show two groups, organic and non-organic?
2. What happens if you remove `"farm1"` from the original definition of the `farms` `ProcessGroup`? (Hint: those apples that James and Mary are eating have to come from somewhere – so they are shown as coming from "elsewhere". See later tutorial on moving the system boundary)

If you are reading the static documentation, you can easily experiment with editing and rerunning this tutorial online using MyBinder, or download it to run on your computer from GitHub.

1.5 Dimension tables: efficiently adding details of processes and flows

In the Quickstart tutorial we saw how to draw some simple Sankey diagrams and partition them in different ways, such as this:



But to do the grouping on the right-hand side we had to explicitly list which people were “Men” and which were “Women”, using a partition like this:

```
customers_by_gender = Partition.Simple('process', [
    ('Men', ['Fred', 'James']),
    ('Women', ['Susan', 'Mary']),
])
```

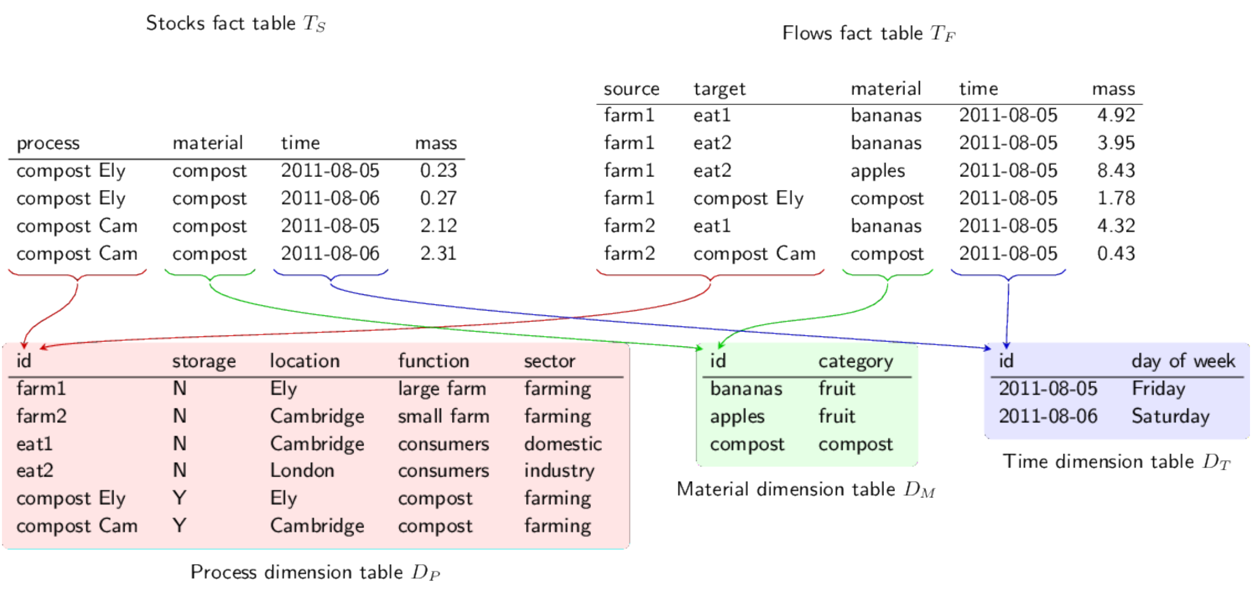
We can show this type of information more efficiently – and with less code – by using *dimension tables*.

1.5.1 Dimension tables

The table we’ve seen before is a **flow fact table** – it lists basic information about each flow:

- *source*: where the flow comes from
- *target*: where the flow goes to
- *type* or *material*: what is flowing
- *value*: the size (in tonnes, GJ, £ etc) of the flow

An example of this type of table is shown at the top right of this diagram:



Stocks fact table T_S

process	material	time	mass
compost Ely	compost	2011-08-05	0.23
compost Ely	compost	2011-08-06	0.27
compost Cam	compost	2011-08-05	2.12
compost Cam	compost	2011-08-06	2.31

Flows fact table T_F

source	target	material	time	mass
farm1	eat1	bananas	2011-08-05	4.92
farm1	eat2	bananas	2011-08-05	3.95
farm1	eat2	apples	2011-08-05	8.43
farm1	compost Ely	compost	2011-08-05	1.78
farm2	eat1	bananas	2011-08-05	4.32
farm2	compost Cam	compost	2011-08-05	0.43

id	storage	location	function	sector
farm1	N	Ely	large farm	farming
farm2	N	Cambridge	small farm	farming
eat1	N	Cambridge	consumers	domestic
eat2	N	London	consumers	industry
compost Ely	Y	Ely	compost	farming
compost Cam	Y	Cambridge	compost	farming

Process dimension table D_P

id	category
bananas	fruit
apples	fruit
compost	compost

Material dimension table D_M

id	day of week
2011-08-05	Friday
2011-08-06	Saturday

Time dimension table D_T

The **dimension tables** add extra information about the source/target and type of the flows (the diagram above also shows extra information about the time period the flow relates to, but we're not worrying about time in this tutorial). For example, "farm2" has a *location* attribute set to "Cambridge".

This tutorial will show how to use dimension tables in floweaver.

[1]:
```
# Load the same data used in the quickstart tutorial
import pandas as pd
flows = pd.read_csv('simple_fruit_sales.csv')
flows
```

[1]:
```
  source target     type  value
0  farm1   Mary   apples      5
1  farm1  James   apples      3
2  farm2   Fred   apples     10
3  farm2   Fred  bananas     10
4  farm2  Susan  bananas      5
5  farm3  Susan   apples     10
6  farm4  Susan  bananas      1
7  farm5  Susan  bananas      1
8  farm6  Susan  bananas      1
```

[2]:
```
# Load another table giving extra information about the
# farms and customers. `index_col` says the first column
# can be used to lookup rows.
processes = pd.read_csv('simple_fruit_sales_processes.csv',
                        index_col=0)
processes
```

[2]:
```
           type   location organic    sex
id
farm1      farm     Barton     yes    NaN
farm2      farm     Barton     yes    NaN
farm3      farm        Ely      no    NaN
farm4      farm        Ely     yes    NaN
farm5      farm    Duxford      no    NaN
farm6      farm     Milton     yes    NaN
Mary   customer  Cambridge     NaN  Women
```

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```
James   customer      Milton      NaN     Men
Fred    customer   Cambridge      NaN   Women
Susan   customer   Cambridge      NaN     Men
```

Each id in this table matches a source or target in the flows table above. We can use this extra information to build the Sankey.

[3]:
```
# Setup
from floweaver import *

# Set the default size to fit the documentation better.
size = dict(width=570, height=300)
```

Because we now have two tables (before we only had one so didn't have to worry) we must put them together into a Dataset:

[4]:
```
dataset = Dataset(flows, dim_process=processes)
```

Now we can use the type column in the process table to more easily pick out the relevant processes:

[5]:
```
nodes = {
    'farms': ProcessGroup('type == "farm"'),
    'customers': ProcessGroup('type == "customer"'),
}
```

Compare this to how the same thing was written in the Quickstart:

```
nodes = {
    'farms': ProcessGroup(['farm1', 'farm2', 'farm3',
                           'farm4', 'farm5', 'farm6']),
    'customers': ProcessGroup(['James', 'Mary', 'Fred', 'Susan']),
}
```

Because we already know from the process dimension table that James, Mary, Fred and Susan are "customers", we don't have to list them all by name in the ProcessGroup definition – we can write the *query* type == "customer" instead.

Note: See the API Documentation for *floweaver.ProcessGroup* for more details.

The rest of the Sankey diagram definition is the same as before:

[6]:
```
ordering = [
    ['farms'],        # put "farms" on the left...
    ['customers'],    # ... and "customers" on the right.
]
bundles = [
    Bundle('farms', 'customers'),
]
sdd = SankeyDefinition(nodes, bundles, ordering)
weave(sdd, dataset).to_widget(**size)
```

[6]:
```
SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': 'farms^*',
↪'target': 'customers^*', '...
```

Again, we need to set the partition on the ProcessGroups to see something interesting. Here again, we can use the process dimension table to make this easier:

```
[7]: # Create a Partition which splits based on the `sex` column
     # of the dimension table
     customers_by_gender = Partition.Simple('process.sex',
                                            ['Men', 'Women'])

     nodes['customers'].partition = customers_by_gender
     weave(sdd, dataset).to_widget(**size)
```

```
[7]: SankeyWidget(groups=[{'id': 'customers', 'type': 'process', 'title': '', 'nodes': [
     ↪'customers^Men', 'customers...
```

For reference, this is what we wrote before in the Quickstart:

```
customers_by_gender = Partition.Simple('process', [
    ('Men', ['Fred', 'James']),
    ('Women', ['Susan', 'Mary']),
])
```

And we can use other columns of the dimension table to set other partitions:

```
[8]: farms_by_organic = Partition.Simple('process.organic', ['yes', 'no'])

     nodes['farms'].partition = farms_by_organic
     weave(sdd, dataset).to_widget(**size)
```

```
[8]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
     ↪yes', 'farms^no']}, {'id...
```

Finally, a tip for doing quick exploration of the data with partitions: you can automatically get a Partition which includes all the values that actually occur in your dataset using the `dataset.partition` method:

```
[9]: # This is the logical thing to write but
     # it doesn't actually work at the moment :(
     # nodes['farms'].partition = dataset.partition('process.organic')

     # It works with 'source.organic'... we can explain later
     nodes['farms'].partition = dataset.partition('source.organic')

     # This should be the same as before
     weave(sdd, dataset).to_widget(**size)
```

```
[9]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
     ↪yes', 'farms^no']}, {'id...
```

1.5.2 Summary

The process dimension table adds extra information about each process. You can use this extra information to:

1. Pick out the processes you want to include in a ProcessGroup (selection); and
2. Split apart groups of processes based on different attributes (partitions).

Things to try:

- Make a diagram showing the locations of farms on the left and the locations of customers on the right

```
[ ]:
```

1.6 System boundaries

Often we don't want to show all of the data in one Sankey diagram: you focus on one part of the system. But we still want conservation of mass (or whatever is being shown in the diagram) to work, so we end up with flows to & from "elsewhere". These can also be thought of as *imports* and *exports*.

Let's start by recreating the Quickstart example:

```
[1]: import pandas as pd
     flows = pd.read_csv('simple_fruit_sales.csv')
```

```
[2]: from floweaver import *

     # Set the default size to fit the documentation better.
     size = dict(width=570, height=300)

     # Same partitions as the Quickstart tutorial
     farms_with_other = Partition.Simple('process', [
         'farm1',
         'farm2',
         'farm3',
         ('other', ['farm4', 'farm5', 'farm6']),
     ])

     customers_by_name = Partition.Simple('process', [
         'James', 'Mary', 'Fred', 'Susan'
     ])

     # Define the nodes, this time setting the partition from the start
     nodes = {
         'farms': ProcessGroup(['farm1', 'farm2', 'farm3',
                                'farm4', 'farm5', 'farm6'],
                               partition=farms_with_other),
         'customers': ProcessGroup(['James', 'Mary', 'Fred', 'Susan'],
                                   partition=customers_by_name),
     }

     # Ordering and bundles as before
     ordering = [
         ['farms'],        # put "farms" on the left...
         ['customers'],    # ... and "customers" on the right.
     ]

     bundles = [
         Bundle('farms', 'customers'),
     ]
```

```
[3]: sdd = SankeyDefinition(nodes, bundles, ordering)
     weave(sdd, flows).to_widget(**size)
```

```
[3]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
     ↪farm1', 'farms^farm2', '...
```

What happens if we remove `farm2` from the ProcessGroup?

```
[4]: nodes['farms'].selection = [
         'farm1', 'farm3', 'farm4', 'farm5', 'farm6'
```

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```
]
weave(sdd, flows).to_widget(**size)
```

```
[4]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm3', '...
```

The flow is still there! But it is labelled with a little arrow to show that it is coming "from elsewhere". This is important because we are still showing Susan and Fred in the diagram, and they get fruit from farm2. If we didn't show those flows, Susan's and Fred's inputs and outputs would not balance.

Try now removing Susan and Fred from the diagram:

```
[5]: nodes['customers'].selection = ['James', 'Mary']
weave(sdd, flows).to_widget(**size)
```

```
[5]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm3', '...
```

Now they're gone, we no longer see the incoming flows from `farm2`. But we see some outgoing flows "to elsewhere" from `farm3` and the `other` group. This is because `farm3` is within the system boundary – it is shown in the diagram – so its output flow has to go somewhere.

1.6.1 Controlling Elsewhere flows

These flows are added automatically to make sure that mass is conserved, but because they are automatic, we have little control over them. By explicitly adding a flow to or from Elsewhere to the diagram, we can control where they appear and what they look like.

To do this, add a Waypoint for the outgoing flows to 'pass through' on their way across the system boundary:

```
[6]: # Define a new Waypoint
nodes['exports'] = Waypoint(title='exports here')

# Update the ordering to include the waypoint
ordering = [
    ['farms'],                  #     put "farms" on the left...
    ['customers', 'exports'],   # ... and "exports" below "customers"
]                               #     on the right.

# Add a new bundle from "farms" to Elsewhere, via the waypoint
bundles = [
    Bundle('farms', 'customers'),
    Bundle('farms', Elsewhere, waypoints=['exports']),
]

sdd = SankeyDefinition(nodes, bundles, ordering)
weave(sdd, flows).to_widget(**size)
```

```
[6]: SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm3', '...
```

This is pretty similar to what we had already, but now the waypoint is explicitly listed as part of the `SankeyDefinition`, we have more control over it.

For example, we can put the exports above James and Mary by changing the ordering:

[7]:
```
ordering = [
    ['farms'],
    ['exports', 'customers'],
]
sdd = SankeyDefinition(nodes, bundles, ordering)
weave(sdd, flows).to_widget(**size)
```

[7]:
```
SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm3', '...
```

Or we can partition the exports Waypoint to show how much of it is apples and bananas:

[8]:
```
fruits_by_type = Partition.Simple('type', ['apples', 'bananas'])
nodes['exports'].partition = fruits_by_type
weave(sdd, flows).to_widget(**size)
```

[8]:
```
SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm3', '...
```

1.6.2 Horizontal bands

Often, import/exports and loss flows are shown in a separate horizontal "band" either above or below the main flows. We can do this by modifying the `ordering` a little bit.

The `ordering` style we have used so far looks like this:

```
ordering = [
    [list of nodes in layer 1],  # left-hand side
    [list of nodes in layer 2],
    ...
    [list of nodes in layer N],  # right-hand side
]
```

But we can add another layer of nesting to make it look like this:

```
ordering = [
    # |top band|   |bottom band|
    [ [........], [...........] ],   # left-hand side
    [ [........], [...........] ],
    ...
    [ [........], [...........] ],   # right-hand side
]
```

Here's an example:

[9]:
```
ordering = [
    [[],           ['farms'     ]],
    [['exports'], ['customers']],
]
sdd = SankeyDefinition(nodes, bundles, ordering)
weave(sdd, flows).to_widget(**size)
```

[9]:
```
SankeyWidget(groups=[{'id': 'farms', 'type': 'process', 'title': '', 'nodes': ['farms^
↪farm1', 'farms^farm3', '...
```

1.6.3 Summary

- All the flows to/from a ProcessGroup are shown, even if the other end of the flow is outside the system boundary (i.e. not part of any ProcessGroup)
- You can control the automatic flows by explicitly adding Bundles to/from `Elsewhere` with a `Waypoint`
- The `ordering` can contain horizontal bands

1.7 Colour-intensity scales

In this tutorial we will look at how to use colours in the Sankey diagram. We have already seen how to use a palette, but in this tutorial we will also create a Sankey where the intensity of the colour is proportional to a numerical value.

First step is to import all the required packages and data:

[1]:
```
import pandas as pd
import numpy as np
from floweaver import *

df1 = pd.read_csv('holiday_data.csv')
```

Now take a look at the dataset we are using. This is a very insightful [made-up] dataset about how different types of people lose weight while on holiday enjoying themselves.

[2]:
```
dataset = Dataset(df1)
df1
```

[2]:
```
      source          target  Calories Burnt  Enjoyment Employment Job  \
0   Activity  Employment Job             2.5         35        Student
1   Activity  Employment Job             4.5         20        Student
2   Activity  Employment Job             8.0          5        Student
3   Activity  Employment Job             1.0          5        Student
4   Activity  Employment Job             8.0         30        Student
5   Activity  Employment Job             1.0         35        Trainee
6   Activity  Employment Job             3.0         40        Trainee
7   Activity  Employment Job             2.0         40        Trainee
8   Activity  Employment Job             6.0          5        Trainee
9   Activity  Employment Job            12.0         45        Trainee
10  Activity  Employment Job             4.5         20  Administrator
11  Activity  Employment Job             9.0         10  Administrator
12  Activity  Employment Job             7.5         50  Administrator
13  Activity  Employment Job             1.5         35  Administrator
14  Activity  Employment Job             1.5         50  Administrator
15  Activity  Employment Job            11.0         55        Manager
16  Activity  Employment Job             2.0         45        Manager
17  Activity  Employment Job             7.5         10        Manager
18  Activity  Employment Job             1.5         90        Manager
19  Activity  Employment Job             2.0         40        Manager
20  Activity  Employment Job             3.0         35      Pensioner
21  Activity  Employment Job             9.0         15      Pensioner
22  Activity  Employment Job             9.0         15      Pensioner
23  Activity  Employment Job             3.0         60      Pensioner
24  Activity  Employment Job             0.0          0      Pensioner

       Activity
0       Reading
```

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```
1      Swimming
2      Sleeping
3    Travelling
4   Working out
5       Reading
6    Travelling
7      Swimming
8      Sleeping
9   Working out
10     Swimming
11     Sleeping
12  Working out
13      Reading
14   Travelling
15  Working out
16      Reading
17     Sleeping
18   Travelling
19     Swimming
20      Reading
21     Swimming
22     Sleeping
23   Travelling
24  Working out
```

We now define the partitions of the data. Rather than listing the categories by hand, we use `np.unique` to pick out a list of the unique values that occur in the dataset.

[3]:
```
partition_job = Partition.Simple('Employment Job', np.unique(df1['Employment Job']))
partition_activity = Partition.Simple('Activity', np.unique(df1['Activity']))
```

In fact, this is pretty common so there is a built-in function to do this:

[4]:
```
# these statements or the ones above do the same thing
partition_job = dataset.partition('Employment Job')
partition_activity = dataset.partition('Activity')
```

We then go on to define the structure of our sankey. We define nodes, bundles and the order. In this case its pretty straightforward:

[5]:
```
nodes = {
    'Activity': ProcessGroup(['Activity'], partition_activity),
    'Job': ProcessGroup(['Employment Job'], partition_job),
}

bundles = [
    Bundle('Activity', 'Job'),
]

ordering = [
    ['Activity'],
    ['Job'],
]
```

Now we will plot a Sankey that shows the share of time dedicated to each activity by each type of person.

```
[6]: # These are the same each time, so just write them here once
size_options = dict(width=500, height=400,
                    margins=dict(left=100, right=100))

sdd = SankeyDefinition(nodes, bundles, ordering)
weave(sdd, dataset, measures='Calories Burnt').to_widget(**size_options)
```

```
[6]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
↪'Activity^Reading', 'Activit...
```

We can start using colour by specifying that we want to partition the flows according to type of person. Notice that this time we are using a pre-determined palette.

You can find all sorts of palettes listed here.

```
[7]: sdd = SankeyDefinition(nodes, bundles, ordering, flow_partition=partition_job)

weave(sdd, dataset, palette='Set2_8', measures='Calories Burnt').to_widget(**size_
↪options)
```

```
[7]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
↪'Activity^Reading', 'Activit...
```

Now, if we want to make the colour of the flow to be proportional to a numerical value. Use the `hue` parameter to set the name of the variable that you want to display in colour. To start off, let's use "value", which is the width of the lines: wider lines will be shown in a darker colour.

```
[8]: weave(sdd, dataset, link_color=QuantitativeScale('Calories Burnt'), measures=
↪'Calories Burnt').to_widget(**size_options)
```

```
[8]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
↪'Activity^Reading', 'Activit...
```

It's more interesting to use colour to show a different attribute from the flow table. But because a line in the Sankey diagram is an aggregation of multiple flows in the original data, we need to specify how the new dimension will be aggregated. For example, we'll use the *mean* of the flows within each Sankey link to set the colour. In this case we will use the colour to show how much each type of person emjoys each activity. We can be interested in either the cumulative enjoyment, or the mean enjoyment: try both!

Aggregation is specified with the `measures` parameter, which should be set to a dictionary mapping dimension names to aggregation functions (`'mean'`, `'sum'` etc).

```
[9]: weave(sdd, dataset, measures={'Calories Burnt': 'sum', 'Enjoyment': 'mean'}, link_
↪width='Calories Burnt',
      link_color=QuantitativeScale('Enjoyment')).to_widget(**size_options)
```

```
[9]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
↪'Activity^Reading', 'Activit...
```

```
[10]: weave(sdd, dataset, measures={'Calories Burnt': 'sum', 'Enjoyment': 'mean'}, link_
↪width='Calories Burnt',
      link_color=QuantitativeScale('Enjoyment', intensity='Calories Burnt')).to_
↪widget(**size_options)
```

```
/home/docs/checkouts/readthedocs.org/user_builds/floweaver/envs/stable/lib/python3.7/
↪site-packages/floweaver-2.0.1-py3.7.egg/floweaver/color_scales.py:128:␣
↪RuntimeWarning: invalid value encountered in double_scalars
  value /= measures[self.intensity]
```

```
[10]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
      ↪'Activity^Reading', 'Activit...
```

You can change the colour palette using the `palette` attribute. The palette names are different from before, because those were *categorical* (or *qualitative*) scales, and this is now a *sequential* scale. The palette names are listed here.

```
[11]: scale = QuantitativeScale('Enjoyment', palette='Blues_9')
      weave(sdd, dataset,
            measures={'Calories Burnt': 'sum', 'Enjoyment': 'mean'},
            link_width='Calories Burnt',
            link_color=scale) \
          .to_widget(**size_options)
```

```
[11]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
      ↪'Activity^Reading', 'Activit...
```

```
[12]: scale.domain
```

```
[12]: (0.0, 90.0)
```

It is possible to create a colorbar / scale to show the range of intensity values, but it's not currently as easy as it should be. This should be improved in future.

1.7.1 More customisation

You can subclass the QuantitativeScale class to get more control over the colour scale.

```
[13]: class MyScale(QuantitativeScale):
          def get_palette(self, link):
              # Choose colour scheme based on link type (here, Employment Job)
              name = 'Greens_9' if link.type == 'Student' else 'Blues_9'
              return self.lookup_palette_name(name)

          def get_color(self, link, value):
              palette = self.get_palette(link)
              return palette(0.2 + 0.8*value)
```

```
[14]: my_scale = MyScale('Enjoyment', palette='Blues_9')
      weave(sdd, dataset,
            measures={'Calories Burnt': 'sum', 'Enjoyment': 'mean'},
            link_width='Calories Burnt',
            link_color=my_scale) \
          .to_widget(**size_options)
```

```
[14]: SankeyWidget(groups=[{'id': 'Activity', 'type': 'process', 'title': '', 'nodes': [
      ↪'Activity^Reading', 'Activit...
```

CHAPTER

TWO

REAL-WORLD EXAMPLES!

The examples gallery has real-world examples of how floWeaver has been used.

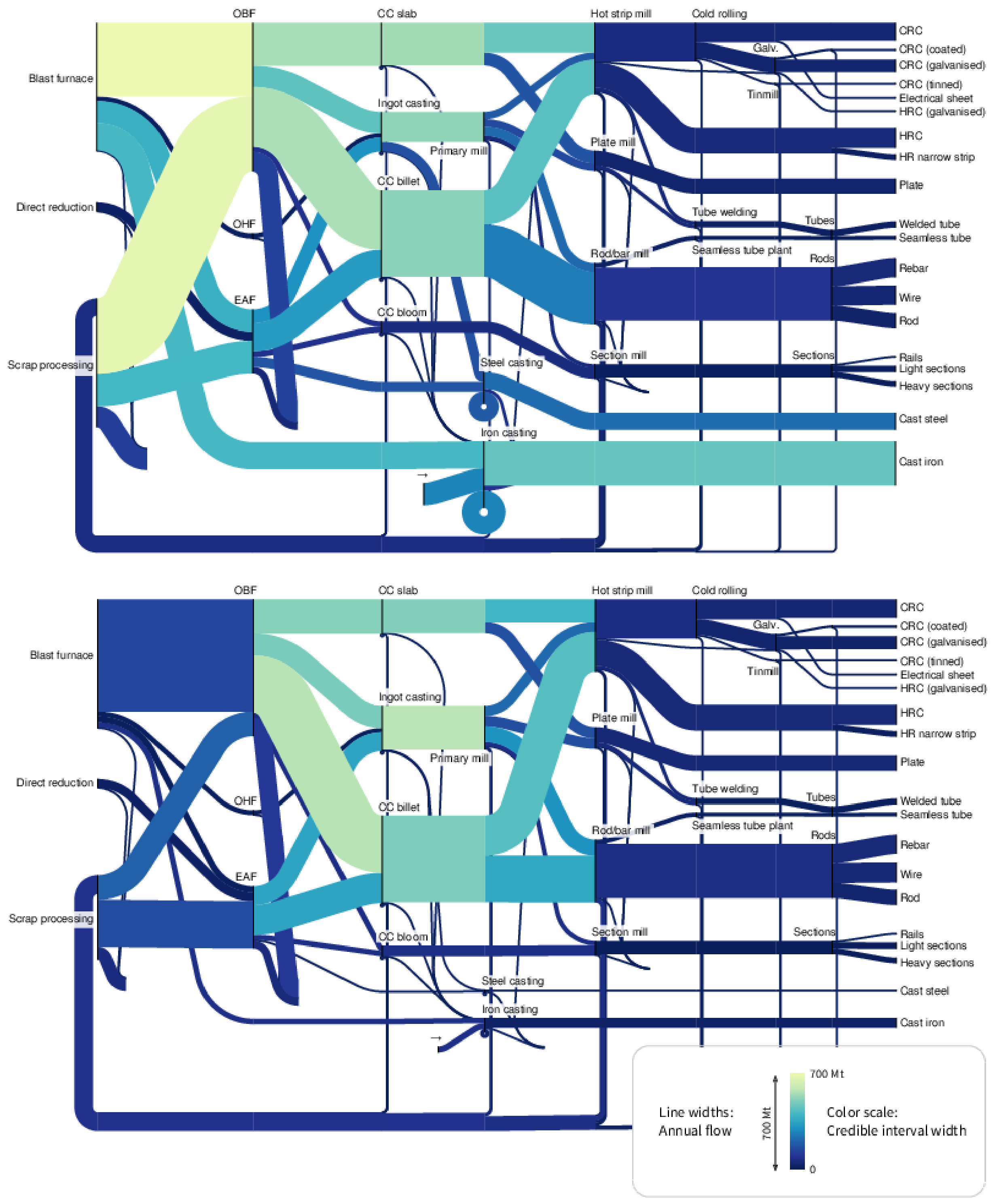
2.1 Examples gallery

These pages show real-world examples of how floWeaver has been used.

Add yours to the list!

2.1.1 Journal article: Incremental Material Flow Analysis with Bayesian Inference

This article uses Sankey diagrams to visualise the results of an uncertain Material Flow Analysis. floWeaver was used to structure the diagrams and calculate the colours, which indicate the level of uncertainty about each flow.



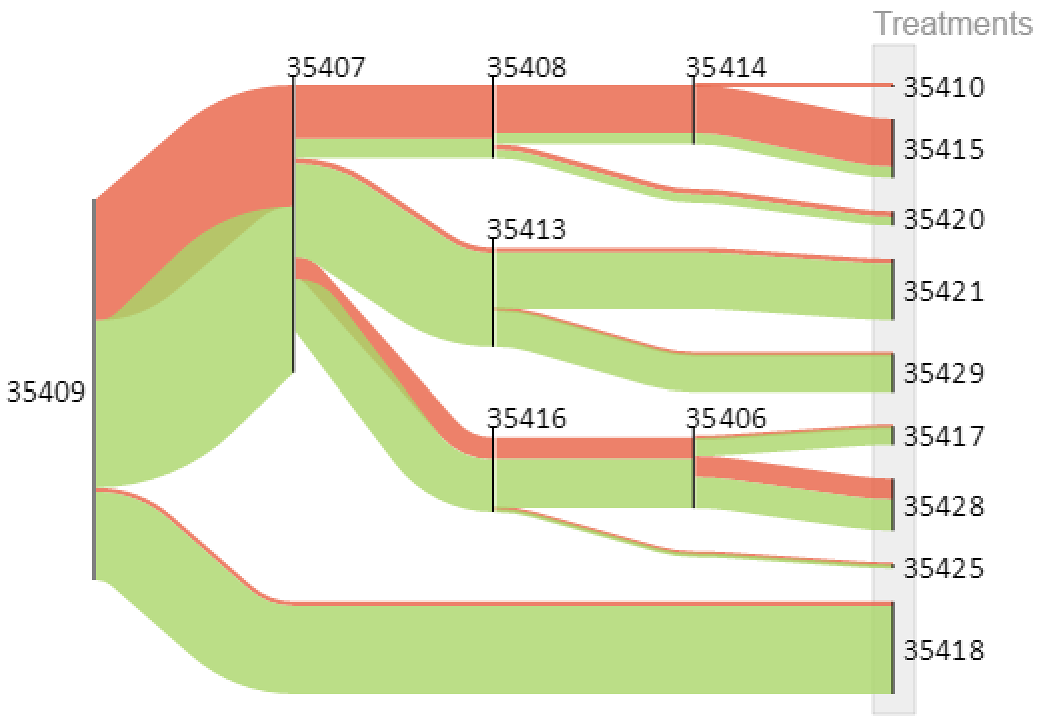
The floWeaver code to produce this diagram is available on Github. Note that this used an older version of floWeaver, where some details of the API for overriding flow colours were different.

- **Source**: R Lupton & J Allwood, Incremental Material Flow Analysis with Bayesian Inference. Journal of Industrial Ecology (2017). DOI: 10.1111/jiec.12698.

2.1.2 Visualizing flow of patients in Oncoguide using Sankey diagrams

At IKNL, we work everyday to continuously improve oncological and palliative care of the Dutch population. We have developed Oncoguide, a tool that supports healthcare professionals and patients in making the best decisions for their treatment. Oncoguide provides a graphical representation of clinical guidelines for patient therapy in the shape of decision trees.

We wanted to generate a graphical representation of the flow of patients through the decision trees. Namely, we were interested in seeing the amount of patients that were treated according to the guidelines and the amount of patients that were not. We used floWeaver to generate Sankey diagrams like the one shown below.



This is an example of a decision tree for prostate cancer. Each node of the tree represents a decision point. Based on his (disease) characteristics, the patient travels through the tree until he reaches a leaf, which represents a (suggested) treatment. In green, you can see the patients that were treated according to the guideline, while in red you can see the patients that deviated from the guideline. This isn't necessarily bad (usually the clinician has good reasons to do so), but it gives us a good idea of how patients are treated.

The floWeaver code to produce this diagram is available on Github. Furthermore, you can access Oncoguide here. It is free of charge and creating an account is optional. Look for the English version on the bottom of the main screen!

CHAPTER

THREE

COOKBOOK

Shorter examples of how to do common tasks, and the examples from the journal paper:

3.1 Imports & exports

This recipe demonstrates how to show import and export flows to/from a simple process chain.

For demonstration, the CSV data is written directly in the cell below – in practice you would want to load data a file.

[1]:
```
import pandas as pd
from io import StringIO

flows = pd.read_csv(StringIO("""
source,target,type,value
a,b,main,3
b,c,main,4
imports,b,import/export,2
b,exports,import/export,1
"""))

flows
```

[1]:
```
    source   target           type  value
0        a        b           main      3
1        b        c           main      4
2  imports        b  import/export      2
3        b  exports  import/export      1
```

Here is the basic structure of the Sankey diagram: a chain of processes `a -- b --- c`.

[2]:
```
from floweaver import *

# Set the default size to fit the documentation better.
size = dict(width=570, height=300)

nodes = {
    'a': ProcessGroup(['a']),
    'b': ProcessGroup(['b']),
    'c': ProcessGroup(['c']),
}

bundles = [
    Bundle('a', 'b'),
```

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```
    Bundle('b', 'c'),
]

ordering = [
    ['a'],
    ['b'],
    ['c'],
]

sdd = SankeyDefinition(nodes, bundles, ordering)

weave(sdd, flows).to_widget(**size)
```

```
[2]: SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': '__>b^*',
↪'target': 'b^*', 'type': '*...
```

To get more control over the appearance of the import/export flows, they can be controlled using Waypoints:

```
[3]: nodes = {
    'a': ProcessGroup(['a']),
    'b': ProcessGroup(['b']),
    'c': ProcessGroup(['c']),
    'imports': Waypoint(),
    'exports': Waypoint(),
}

bundles = [
    Bundle('a', 'b'),
    Bundle('b', 'c'),
    Bundle(Elsewhere, 'b', waypoints=['imports']),
    Bundle('b', Elsewhere, waypoints=['exports']),
]

ordering = [
    [['a'], ['imports']],
    [['b']],
    [['c'], ['exports']],
]

sdd = SankeyDefinition(nodes, bundles, ordering)

weave(sdd, flows).to_widget(**size)
```

```
[3]: SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': 'a^*',
↪'target': 'b^*', 'type': '*', ...
```

To get different colours for imports/exports, we need to modify the SDD to use the `type` column to distinguish different types of flow:

```
[4]: sdd = SankeyDefinition(nodes, bundles, ordering, flow_partition=Partition.Simple('type
↪', ['main', 'import/export']))

weave(sdd, flows).to_widget(**size)
```

```
[4]: SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': 'a^*',
↪'target': 'b^*', 'type': 'main...
```

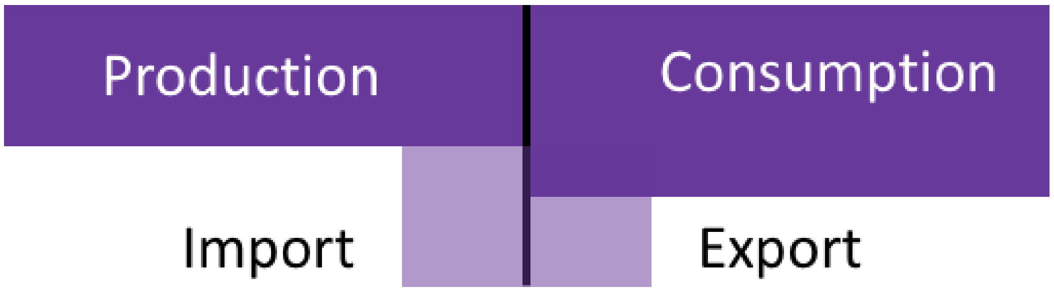
Finally, you can customise the colour scheme:

```
[5]: weave(sdd, flows, palette={'main': 'steelblue', 'import/export': 'lightblue'}).to_
     ↪widget(**size)
```

```
[5]: SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': 'a^*',
     ↪'target': 'b^*', 'type': 'main...
```

3.1.1 Alternative style

An alternative style for showing imports & exports like this isn't currently supported:



But it should be possible to support with minor changes to the Sankey diagram definition. For example, the difference between this style and the style shown above could be requested by changing:

```
Bundle(Elsewhere, 'b', waypoints=['imports'])
```

to

```
Bundle(Elsewhere, 'b', waypoints=[])
```

The lack of a waypoint would indicate that the flow should be shown as a short "stub".

3.2 Forwards & backwards flows

This recipe demonstrates how forwards and backwards flows work.

For demonstration, the CSV data is written directly in the cell below – in practice you would want to load data a file.

```
[1]: import pandas as pd
     from io import StringIO

     flows = pd.read_csv(StringIO("""
     source,target,type,value
     a,b,main,2
     a,c,main,1
```

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```
c,d,main,3
b,c,back,2
"""))

flows
```

[1]:
```
  source target  type  value
0      a      b  main      2
1      a      c  main      1
2      c      d  main      3
3      b      c  back      2
```

Here is one structure, with nodes b and c both in the same vertical slice:

[2]:
```
from floweaver import *

# Set the default size to fit the documentation better.
size = dict(width=570, height=300)

nodes = {
    'a': ProcessGroup(['a']),
    'b': ProcessGroup(['b']),
    'c': ProcessGroup(['c']),
    'd': ProcessGroup(['d']),
    'back': Waypoint(direction='L'),
}

bundles = [
    Bundle('a', 'b'),
    Bundle('a', 'c'),
    Bundle('b', 'c', waypoints=['back']),
    Bundle('c', 'd'),
    Bundle('c', 'b'),
]

ordering = [
    [['a'], []],
    [['b', 'c'], ['back']],
    [['d'], []],
]

sdd = SankeyDefinition(nodes, bundles, ordering)

weave(sdd, flows).to_widget(**size)
```

[2]:
```
SankeyWidget(layout=Layout(height='300', width='570'), links=[{'source': 'a^*',
↪'target': 'b^*', 'type': '*', ...
```

Alternatively, if b is moved to the right, extra hidden waypoints are automatically added to get the b--c flow back to the left of c:

[3]:
```
bundles = [
    Bundle('a', 'b'),
    Bundle('a', 'c'),
    Bundle('b', 'c'),
    Bundle('c', 'd'),
    Bundle('c', 'b'),
```

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```
]

ordering = [
    [['a'], []],
    [['c'], ['back']],
    [['b', 'd'], []],
]

sdd = SankeyDefinition(nodes, bundles, ordering)

weave(sdd, flows).to_widget(**size)
```

```
[3]: SankeyWidget(groups=[{'id': '__a_b_1', 'type': 'group', 'title': '', 'nodes': ['__a_b_
↪1^*']}, {'id': '__b_c_1'...
```

3.3 "Fruit" example (from Hybrid Sankey diagrams paper)

This notebook gives a fairly complicated example of building a Sankey diagram from the sample "fruit" database used in the paper Hybrid Sankey diagrams: Visual analysis of multidimensional data for understanding resource use.

For more explanation of the steps and concepts, see the tutorials.

```
[1]: from floweaver import *
```

Load the dataset:

```
[2]: dataset = Dataset.from_csv('fruit_flows.csv', 'fruit_processes.csv')
```

This made-up dataset describes flows from farms to consumers:

```
[3]: dataset._flows.head()
```

```
[3]:   source                  target material       time     value
0  farm1                    eat1   apples 2011-08-01  2.720691
1   eat1     landfill Cambridge   apples 2011-08-01  1.904484
2   eat1  composting Cambridge   apples 2011-08-01  0.816207
3  farm1                    eat1   apples 2011-08-02  8.802195
4   eat1     landfill Cambridge   apples 2011-08-02  6.161537
```

Additional information is available in the process dimension table:

```
[4]: dataset._dim_process.head()
```

```
[4]:           type   location    function   sector
id
inputs     stock          *      inputs      NaN
farm1    process  Cambridge  small farm  farming
farm2    process  Cambridge  small farm  farming
farm3    process        Ely  small farm  farming
farm4    process        Ely   allotment  farming
```

We'll also define some partitions that will be useful:

```
[5]: farm_ids = ['farm{}'.format(i) for i in range(1, 16)]
```

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```
farm_partition_5 = Partition.Simple('process', [('Other farms', farm_ids[5:])] + farm_
↪ids[:5])
partition_fruit = Partition.Simple('material', ['bananas', 'apples', 'oranges'])
partition_sector = Partition.Simple('process.sector', ['government', 'industry',
↪'domestic'])
```

Now define the Sankey diagram definition.

- Process groups represent sets of processes in the underlying database. The underlying processes can be specified as a list of ids (e.g. `['inputs']`) or as a Pandas query expression (e.g. `'function == "landfill"'`).
- Waypoints allow extra control over the partitioning and placement of flows.

[6]:
```
nodes = {
    'inputs':     ProcessGroup(['inputs'], title='Inputs'),
    'compost':    ProcessGroup('function == "composting stock"', title='Compost'),
    'farms':      ProcessGroup('function in ["allotment", "large farm", "small farm"]
↪', farm_partition_5),
    'eat':        ProcessGroup('function == "consumers" and location != "London"',␣
↪partition_sector,
                               title='consumers by sector'),
    'landfill':   ProcessGroup('function == "landfill" and location != "London"',␣
↪title='Landfill'),
    'composting': ProcessGroup('function == "composting process" and location !=
↪"London"', title='Composting'),

    'fruit':        Waypoint(partition_fruit, title='fruit type'),
    'w1':           Waypoint(direction='L', title=''),
    'w2':           Waypoint(direction='L', title=''),
    'export fruit': Waypoint(Partition.Simple('material', ['apples', 'bananas',
↪'oranges'])),
    'exports':      Waypoint(title='Exports'),
}
```

The ordering defines how the process groups and waypoints are arranged in the final diagram. It is structured as a list of vertical *layers* (from left to right), each containing a list of horizontal *bands* (from top to bottom), each containing a list of process group and waypoint ids (from top to bottom).

[7]:
```
ordering = [
    [[], ['inputs', 'compost'], []],
    [[], ['farms'], ['w2']],
    [['exports'], ['fruit'], []],
    [[], ['eat'], []],
    [['export fruit'], ['landfill', 'composting'], ['w1']],
]
```

Bundles represent flows in the underlying database:

[8]:
```
bundles = [
    Bundle('inputs', 'farms'),
    Bundle('compost', 'farms'),
    Bundle('farms', 'eat', waypoints=['fruit']),
    Bundle('farms', 'compost', waypoints=['w2']),
    Bundle('eat', 'landfill'),
    Bundle('eat', 'composting'),
    Bundle('composting', 'compost', waypoints=['w1', 'w2']),
```

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```
    Bundle('farms', Elsewhere, waypoints=['exports', 'export fruit']),
]
```

Finally, the process groups, waypoints, bundles and ordering are combined into a Sankey diagram definition (SDD). When applied to the dataset, the result is a Sankey diagram!

[9]:
```
sdd = SankeyDefinition(nodes, bundles, ordering,
                       flow_partition=dataset.partition('material'))
weave(sdd, dataset) \
    .to_widget(width=570, height=550, margins=dict(left=70, right=90))
```

[9]:
```
SankeyWidget(groups=[{'id': '__w2_compost_0', 'type': 'group', 'title': '', 'nodes': [
↪'__w2_compost_0^*']}, {'...
```

3.4 US energy consumption

This example is based on the Sankey diagrams of US energy consumption from the Lawrence Livermore National Laboratory (thanks to John Muth for the suggestion and transcribing the data). We jump straight to the final result – for more explanation of the steps and concepts, see the tutorials.

[1]:
```
from floweaver import *
```

Load the dataset:

[2]:
```
dataset = Dataset.from_csv('us-energy-consumption.csv',
                           dim_process_filename='us-energy-consumption-processes.csv')
```

This defines the order the nodes appear in:

[3]:
```
sources = ['Solar', 'Nuclear', 'Hydro', 'Wind', 'Geothermal',
           'Natural_Gas', 'Coal', 'Biomass', 'Petroleum']

uses = ['Residential', 'Commercial', 'Industrial', 'Transportation']
```

Now define the Sankey diagram definition.

[4]:
```
nodes = {
    'sources': ProcessGroup('type == "source"', Partition.Simple('process', sources),␣
↪title='Sources'),
    'imports': ProcessGroup(['Net_Electricity_Import'], title='Net electricity imports
↪'),
    'electricity': ProcessGroup(['Electricity_Generation'], title='Electricity␣
↪Generation'),
    'uses': ProcessGroup('type == "use"', partition=Partition.Simple('process',␣
↪uses)),

    'energy_services': ProcessGroup(['Energy_Services'], title='Energy services'),
    'rejected': ProcessGroup(['Rejected_Energy'], title='Rejected energy'),

    'direct_use': Waypoint(Partition.Simple('source', [
        # This is a hack to hide the labels of the partition, there should be a␣
↪better way...
        (' '*i, [k]) for i, k in enumerate(sources)
    ])),
```

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```
}

ordering = [
    [[], ['sources'], []],
    [['imports'], ['electricity', 'direct_use'], []],
    [[], ['uses'], []],
    [[], ['rejected', 'energy_services'], []]
]

bundles = [
    Bundle('sources', 'electricity'),
    Bundle('sources', 'uses', waypoints=['direct_use']),
    Bundle('electricity', 'uses'),
    Bundle('imports', 'uses'),
    Bundle('uses', 'energy_services'),
    Bundle('uses', 'rejected'),
    Bundle('electricity', 'rejected'),
]
```

Define the colours to roughly imitate the original Sankey diagram:

```
[5]: palette = {
         'Solar': 'gold',
         'Nuclear': 'red',
         'Hydro': 'blue',
         'Wind': 'purple',
         'Geothermal': 'brown',
         'Natural_Gas': 'steelblue',
         'Coal': 'black',
         'Biomass': 'lightgreen',
         'Petroleum': 'green',
         'Electricity': 'orange',
         'Rejected energy': 'lightgrey',
         'Energy services': 'dimgrey',
     }
```

And here's the result!

```
[6]: sdd = SankeyDefinition(nodes, bundles, ordering,
                            flow_partition=dataset.partition('type'))
     weave(sdd, dataset, palette=palette) \
         .to_widget(width=700, height=450, margins=dict(left=100, right=120),␣
     ↪debugging=True)

[6]: VBox(children=(SankeyWidget(groups=[{'id': 'sources', 'type': 'process', 'title':
     ↪'Sources', 'nodes': ['source...

[ ]:
```

3.5 Setting the scale

This recipe demonstrates how the scale of the Sankey diagram is set.

By default the scale is calculated for each diagram to achieve a certain whitespace-to-flow ratio within the height that is given. But in some cases, you may want to set the scale explicitly.

For demonstration, the CSV data is written directly in the cell below – in practice you would want to load data a file.

```
[1]: import pandas as pd
     from io import StringIO

     flows = pd.read_csv(StringIO("""
     year,source,target,value
     2020,A,B,10
     2025,A,B,20
     """))

     flows
```

```
[1]:    year source target  value
     0  2020      A      B     10
     1  2025      A      B     20
```

```
[2]: from floweaver import *

     # Set the default size to fit the documentation better.
     size = dict(width=100, height=100,
                 margins=dict(left=20, right=20, top=10, bottom=10))

     nodes = {
         'A': ProcessGroup(['A']),
         'B': ProcessGroup(['B']),
     }

     bundles = [
         Bundle('A', 'B'),
     ]

     ordering = [['A'], ['B']]

     sdd = SankeyDefinition(nodes, bundles, ordering)
```

If we draw the flow for the year 2020 and the year 2025 separately, they appear the same:

```
[3]: w1 = weave(sdd, flows.query('year == 2020')).to_widget(**size)
     w1
```

```
[3]: SankeyWidget(layout=Layout(height='100', width='100'), links=[{'source': 'A^*',
     ↪'target': 'B^*', 'type': '*', ...
```

```
[4]: w2 = weave(sdd, flows.query('year == 2025')).to_widget(**size)
     w2
```

```
[4]: SankeyWidget(layout=Layout(height='100', width='100'), links=[{'source': 'A^*',
     ↪'target': 'B^*', 'type': '*', ...
```

But in fact they have different scales:

```
[5]: w1.scale, w2.scale
```

```
[5]: (None, None)
```

The units of the scale are `units-of-value` per pixel.

If we draw the Sankeys again while setting the scale, we can see that the flow indeed has changed between years:

```
[6]: SCALE = 2.0

     from ipywidgets import HBox

     w1 = weave(sdd, flows.query('year == 2020')).to_widget(**size)
     w2 = weave(sdd, flows.query('year == 2025')).to_widget(**size)

     w1.scale = w2.scale = SCALE

     HBox([w1, w2])
```

```
[6]: HBox(children=(SankeyWidget(layout=Layout(height='100', width='100'), links=[{'source
     ↪': 'A^*', 'target': 'B^*'...
```

CHAPTER

FOUR

API DOCUMENTATION

4.1 Datasets

class Dataset (*flows*, *dim_process=None*, *dim_material=None*, *dim_time=None*)

4.2 Sankey diagram definitions

Sankey diagram definitions (SDDs) describe the structure of the Sankey diagram you want to end up with. They are *declarative*: you declare what you want up front, but the diagram isn't created until later. This is useful if you want to use the same diagram structure for different data sources.

class SankeyDefinition (*nodes*, *bundles*, *ordering*, *flow_selection=None*, *flow_partition=None*, *time_partition=None*)

class ProcessGroup (*selection=None*, *partition=None*, *direction='R'*, *title=None*)

A ProcessGroup represents a group of processes from the underlying dataset.

The processes to include are defined by the *selection*. By default they are all lumped into one node in the diagram, but by defining a *partition* this can be controlled.

selection

If a list of strings, they are taken as process ids. If a single string, it is taken as a Pandas query string run against the process table.

Type list or string

partition

Defines how to split the ProcessGroup into subgroups.

Type Partition, optional

direction

Direction of flow, default 'R' (left-to-right).

Type 'R' or 'L'

title

Label for the ProcessGroup. If not set, the ProcessGroup id will be used.

Type string, optional

class Waypoint (*partition=None*, *direction='R'*, *title=None*)

A Waypoint represents a control point along a `Bundle` of flows.

There are two reasons to define Waypoints: to control the routing of `Bundle` s of flows through the diagram, and to split flows according to some attributes by setting a *partition*.

partition
Defines how to split the Waypoint into subgroups.

Type Partition, optional

direction
Direction of flow, default 'R' (left-to-right).

Type 'R' or 'L'

title
Label for the Waypoint. If not set, the Waypoint id will be used.

Type string, optional

class Bundle(*source*, *target*, *waypoints=NOTHING*, *flow_selection=None*, *flow_partition=None*, *default_partition=None*)
A Bundle represents a set of flows between two :class:`ProcessGroup`s.

source
The id of the `ProcessGroup` at the start of the Bundle.

Type string

target
The id of the `ProcessGroup` at the end of the Bundle.

Type string

waypoints
Optional list of ids of :class:`Waypoint`s the Bundle should pass through.

Type list of strings

flow_selection
Query string to filter the flows included in this Bundle.

Type string, optional

flow_partition
Defines how to split the flows in the Bundle into sub-flows. Often you want the same Partition for all the Bundles in the diagram, see `SankeyDefinition.flow_partition`.

Type Partition, optional

default_partition
Defines the Partition applied to any Waypoints automatically added to route the Bundle across layers of the diagram.

Type Partition, optional

4.3 Weaving the Sankey diagram

The `weave()` function actually creates a Sankey diagram from the *Sankey diagram definitions* and a *Datasets*.

weave(*sankey_definition*, *dataset*, *measures='value'*, *link_width=None*, *link_color=None*, *palette=None*, *add_elsewhere_waypoints=True*)

CHAPTER FIVE

CONTRIBUTING

Contributions are very welcome.

5.1 Contributing to floWeaver

Contributions are welcome! Please get in touch via email or creating a GitHub issue with any questions.

5.1.1 Documentation

These are draft guidelines for getting started contributing to the documentation on Windows. Improvements are welcome, or get in touch if you need better instructions.

1. *Required software*: Anaconda, Github Desktop App.

   a) **Install pandoc package.**

   b) Clone Github Repository using the following URL: https://github.com/ricklupton/floweaver.git

2. *Modify Content*. The content is kept in the `/docs` directory. Each page is saved as a text file formatted in reStructured Text.

3. *Save Modifications*. To save the changes made to the content, open the Anaconda Prompt, go to the `/floweaver/docs` directory and run

```
make.bat html
```

CHAPTER

SIX

CITING FLOWEAVER

If floweaver has been significant in a project that leads to a publication, please acknowledge that by citing the paper linked above:

R. C. Lupton and J. M. Allwood, ‘Hybrid Sankey diagrams: Visual analysis of multidimensional data for understanding resource use’, Resources, Conservation and Recycling, vol. 124, pp. 141–151, Sep. 2017. DOI: 10.1016/j.resconrec.2017.05.002

CHAPTER

SEVEN

INDICES AND TABLES

- genindex
- modindex
- search

INDEX