Regular Notebook

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1 A presentation about presentations

Lab Meeting 8.6.2017 @ IKW Osnabrueck, Johannes Leugering

In [1]:
```
%%html
<script>
var code_show=false;
function code_toggle() {
 if (code_show){
 $('div.input').hide();
 } else {
 $('div.input').show();
 }
 code_show = !code_show;
};

$(document).ready(code_toggle());

</script>
<a href="javascript:code_toggle()" style="float: right">Toggle Input Cells</a>
```

```
<IPython.core.display.HTML object>
```

1.1 Capabilities of jupyter notebooks

- document code with MarkDown text, MathJax etc.
- run code
  - supports many languages, but most importantly python
- present results
  - depending on the type of result, it can be visualized nicely
  - output such as matplotlib figures are included as well
  - for custom data types, custom display methods can be defined (see e.g. `pandas.DataFrame` next slide)

1.1.1 Example: Loading and displaying a dataset

How a pandas.DataFrame object is presented

```
In [2]: from sklearn.datasets import load_iris
        import pandas
        import numpy as np
        import matplotlib
        %matplotlib inline
        matplotlib.style.use("ggplot")
        from matplotlib import pyplot as pp, style, patheffects

        iris = load_iris()
        iris_data = pandas.DataFrame(data=iris.data, columns=iris.feature_names)
        iris_data["class id"] = iris.target
        iris_data["class name"] = iris.target_names[iris.target]
        iris_data.head(10)
```

Out[2]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	class id	class name
0	5.1	3.5	1.4	0.2	0	setosa
1	4.9	3.0	1.4	0.2	0	setosa
2	4.7	3.2	1.3	0.2	0	setosa
3	4.6	3.1	1.5	0.2	0	setosa
4	5.0	3.6	1.4	0.2	0	setosa
5	5.4	3.9	1.7	0.4	0	setosa
6	4.6	3.4	1.4	0.3	0	setosa
7	5.0	3.4	1.5	0.2	0	setosa
8	4.4	2.9	1.4	0.2	0	setosa
9	4.9	3.1	1.5	0.1	0	setosa

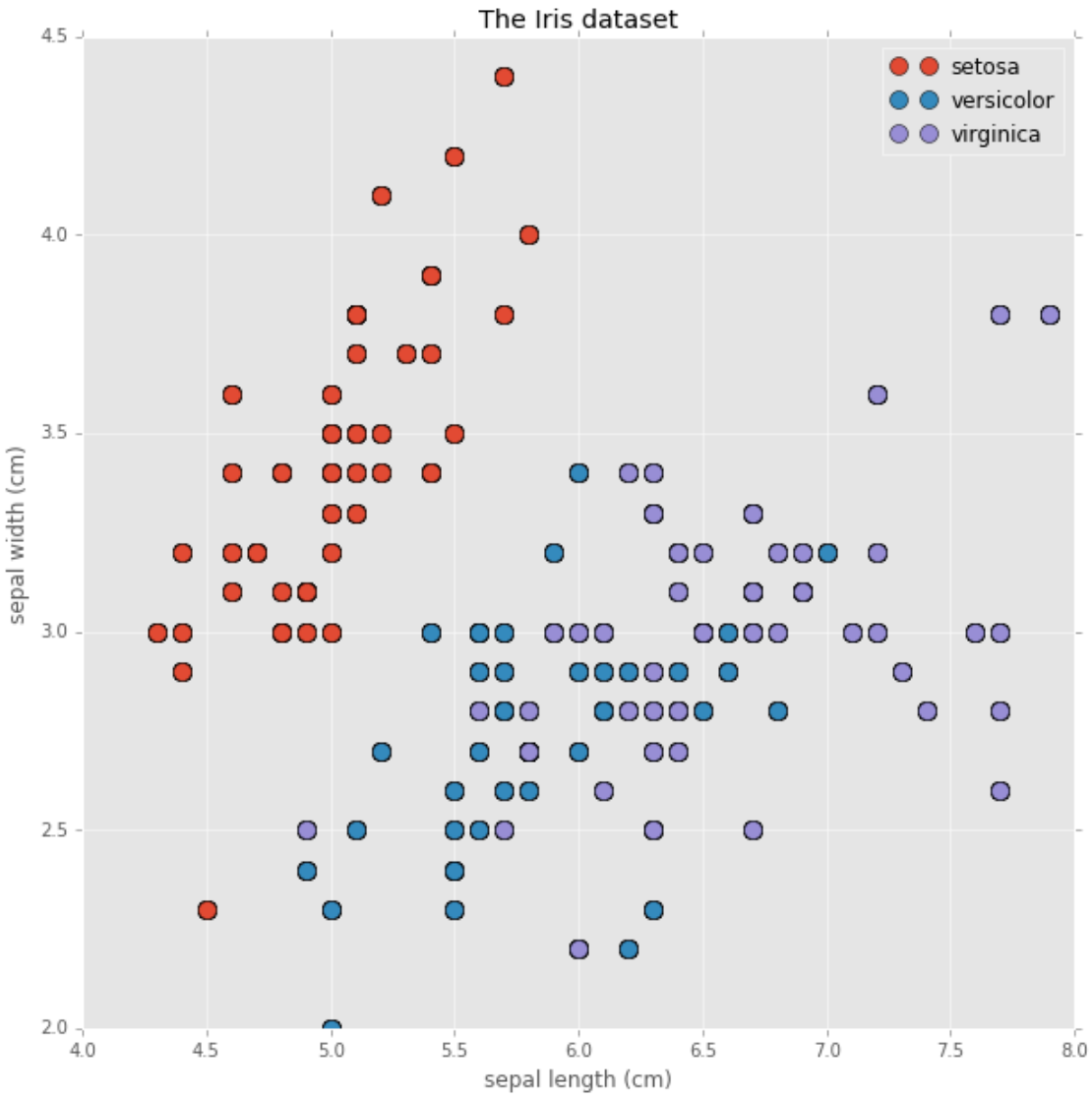
Figures can be rendered inline:

```
In [3]: data = iris_data[["sepal length (cm)", "sepal width (cm)", "class name"]].copy()
        data.columns = ["x", "y", "class"]

        def plot_data(ax, data):
            all_pts = []
```

```
    for label in data["class"]:
        subset = data.where(lambda x: x["class"] == label)
        pts, = ax.plot(subset["x"], subset["y"], "o", markersize=10)
        all_pts.append(pts)
    return all_pts

fig = pp.figure(figsize=(10, 10))
ax = fig.add_subplot(111)
pts = plot_data(ax, data)
ax.set_xlabel("sepal length (cm)")
ax.set_ylabel("sepal width (cm)")
ax.set_title("The Iris dataset")
colors = [p.get_color() for p in pts]
colors = dict(zip(iris.target_names, colors))
ax.legend(pts, iris.target_names);
```



```
In [4]: %%html
        <script>
        var code_show=true;
        function code_toggle() {
         if (code_show){
         $('div.input').hide();
         } else {
         $('div.input').show();
         }
         code_show = !code_show
        }
        </script>
        <a href="javascript:code_toggle()">Toggle Input Cells</a>
```

```
<IPython.core.display.HTML object>
```

1.2 "Inline" capabilities of Jupyter's MarkDown text

1.2.1 Supports lists

- lists can be unordered
  - like this example
  - with a sublist
- lists can also be ordered
  1. like this list
     1. with this sub-example
     2. and this one

1.2.2 Supports basic text formatting

You can write *cursive* and **bold** text, embed `monospace text`.
Use double spaces at the end of a line to force a break, an empty line starts a new paragraph.
You can embed block-quotes as in email:

> A SQL query goes into a bar, walks up to two tables and asks, "Can I join you?"

1.2.3 Supports embedding/linking other content

embed links to other things (e.g. the documentation of all the features) or images in the local directory 

1.2.4 Supports embedding code blocks with syntax highlighting (most languages):

Example algorithm in *erlang*

```
-module(fibonacci). % This is the file 'fibonacci.erl', the module and the filename must match
-export([fib/1]). % This exports the function 'fib' of arity 1

fib(0) -> 0; % If 0, then return 0, otherwise (note the semicolon ; meaning 'else')
fib(1) -> 1; % If 1, then return 1, otherwise
fib(N) when N > 1 -> fib(N - 1) + fib(N - 2).
```

1.2.5 Supports (limited) inline html and css

```
<div id="somediv" style="position: absolute; height: 100px; width: 100px; background-color: red;
<div id="somediv" style="position: absolute; height: 100px; width: 100px; background-color: gree
<div id="somediv" style="position: absolute; height: 100px; width: 100px; background-color: blue
```

1.2.6 Supports inline tables

First Header	Second Header	Third Header
Content Cell	Content Cell	Content Cell
Content Cell	Content Cell	Content Cell

1.2.7 Supports some inline Latex (via MathJax)

E.g. *align* formulas:

$$dI_t^{(j)} \leftarrow \text{ external input or } Y_t^{(j)} \tag{1}$$

$$dX_t^{(i)} = a_\eta(X_t^{(i)})dt + b_\eta(X_t^{(i)}) \sum_j W_t^{(i,j)} dI_{t-\tau^{(i,j)}}^{(j)} \tag{2}$$

$$d\bar{\phi}_t^{(i)} = \gamma(\eta(X_t^{(i)}) - \bar{\phi}_t^{(i)})dt \tag{3}$$

$$Y_t^{(i)} = \nu_{\bar{\phi}_t^{(i)}}(X_t^{(i)}) = (F_Y^{-1} \circ F_X)(X_t^{(i)}, \bar{\phi}_t^{(i)}) \tag{4}$$

$$dW_t^{(i,j)} = \delta(f_{\text{pre}}(Y_{t-\tau^{(i,j)}}^{(j)}) \cdot f_{\text{post}}(Y_t^{(i)}) - W_t^{(i,j)})dt \tag{5}$$

1.3 Further capabilities with cell magic

1.3.1 Cell magic commands can redefine the language of a cell

E.g. `%%html` turns the cell into a raw html cell. This input is not parsed through MarkDown and thus very flexible (can include `iframes`, `javascript`, ...). Similarly, `%%javascript` executes the cell as javascript code in the client browser.

1.3.2 Example: embedding external content (e.g. youtube player) as iframe

```
In [5]: %%html
        <iframe height="400" width="600" src="https://www.youtube.com/embed/ddA-QMaNxHA?list=LLE
```

```
<IPython.core.display.HTML object>
```

1.3.3 Example: javascript shenanigans in raw html

```
In [6]: %%html
        <div onclick="alert('Oy, you clicked?')" style="height:40px; widht: 40px; background-col
```

```
<IPython.core.display.HTML object>
```

1.3.4 Example: embedding d3.js

```
In [7]: %%javascript

        requirejs.config({
          paths: {
              d3: 'https://d3js.org/d3.v4.min'
          }
        });

        require(["d3"], function(d3){
            var body = element.append("<div id='body'></div>")


            var width = 960,
                height = 500,
                radius = 80,
                x = Math.sin(2 * Math.PI / 3),
                y = Math.cos(2 * Math.PI / 3),
                offset = 0,
                speed = 4,
                start = Date.now();

            var svg = d3.select('#body').append('svg')
                .attr('width', width)
                .attr('height', height)
                .append("g")
                  .attr("transform", "translate(" + width / 2 + "," + height / 2 + ")scale(.55)"
                .append("g");

            var frame = svg.append("g")
                .datum({radius: Infinity});

            frame.append("g")
                .attr("class", "annulus")
                .datum({teeth: 80, radius: -radius * 5, annulus: true})
              .append("path")
```

```
    .attr("d", gear);

frame.append("g")
    .attr("class", "sun")
    .datum({teeth: 16, radius: radius})
  .append("path")
    .attr("d", gear);

frame.append("g")
    .attr("class", "planet")
    .attr("transform", "translate(0,-" + radius * 3 + ")")
    .datum({teeth: 32, radius: -radius * 2})
  .append("path")
    .attr("d", gear);

frame.append("g")
    .attr("class", "planet")
    .attr("transform", "translate(" + -radius * 3 * x + "," + -radius * 3 * y + ")")
    .datum({teeth: 32, radius: -radius * 2})
  .append("path")
    .attr("d", gear);

frame.append("g")
    .attr("class", "planet")
    .attr("transform", "translate(" + radius * 3 * x + "," + -radius * 3 * y + ")")
    .datum({teeth: 32, radius: -radius * 2})
  .append("path")
    .attr("d", gear);

d3.selectAll("input[name=reference]")
  .data([radius * 5, Infinity, -radius])
    .on("change", function(radius1) {
      var radius0 = frame.datum().radius, angle = (Date.now() - start) * speed;
      frame.datum({radius: radius1});
      svg.attr("transform", "rotate(" + (offset += angle / radius0 - angle / radius1
    });

d3.selectAll("input[name=speed]")
    .on("change", function() { speed = +this.value; });

function gear(d) {
  var n = d.teeth,
      r2 = Math.abs(d.radius),
      r0 = r2 - 8,
      r1 = r2 + 8,
      r3 = d.annulus ? (r3 = r0, r0 = r1, r1 = r3, r2 + 20) : 20,
      da = Math.PI / n,
      a0 = -Math.PI / 2 + (d.annulus ? Math.PI / n : 0),
```

```
            i = -1,
            path = ["M", r0 * Math.cos(a0), ",", r0 * Math.sin(a0)];
          while (++i < n) path.push(
            "A", r0, ",", r0, " 0 0,1 ", r0 * Math.cos(a0 += da), ",", r0 * Math.sin(a0),
            "L", r2 * Math.cos(a0), ",", r2 * Math.sin(a0),
            "L", r1 * Math.cos(a0 += da / 3), ",", r1 * Math.sin(a0),
            "A", r1, ",", r1, " 0 0,1 ", r1 * Math.cos(a0 += da / 3), ",", r1 * Math.sin(a
            "L", r2 * Math.cos(a0 += da / 3), ",", r2 * Math.sin(a0),
            "L", r0 * Math.cos(a0), ",", r0 * Math.sin(a0));
          path.push("M0,", -r3, "A", r3, ",", r3, " 0 0,0 0,", r3, "A", r3, ",", r3, " 0 0,0
          return path.join("");
        }

        d3.timer(function() {
          var angle = (Date.now() - start) * speed,
              transform = function(d) { return "rotate(" + angle / d.radius + ")"; };
          frame.selectAll("path").attr("transform", transform);
          frame.attr("transform", transform); // frame of reference
        });
      })
```

```
<IPython.core.display.Javascript object>
```

```
In [8]: %%html
        <form>
          <input name="reference" id="ref-annulus" type="radio">
          <label for="ref-annulus">Annulus</label><br>
          <input name="reference" id="ref-planet" checked="" type="radio">
          <label for="ref-planet">Planets</label><br>
          <input name="reference" id="ref-sun" type="radio">
          <label for="ref-sun">Sun</label>
        </form>
```

```
<IPython.core.display.HTML object>
```

1.4 Using interactive widgets

```
In [9]: from ipywidgets import interact, fixed
        import IPython.display as display

        fig = pp.figure(figsize=(10,5))
        ax1 = fig.add_subplot(1,2,1)
        xx = np.linspace(0.001, 0.999, 1000)
        yy = -np.log2(xx)*xx-np.log2(1-xx)*(1-xx)
        line, = ax1.plot(xx, yy, linestyle="dashed", linewidth=2)
        #line.set_visible(False)
        dot, = ax1.plot([0.5], [1.0], "o", markersize=10)
```

```
        ax1.set_ylim([0, 1.1])
        ax1.set_xlim([-0.1, 1.1])
        ax1.axvline(0.5, color="black", linestyle="dashed")
        ax1.axhline(1, color="black", linestyle="dashed")
        ax1.set_xlabel("p")
        ax1.set_ylabel("$H_p(X)$")
        ax1.set_title("Entropy of $X\sim\mathcal{B}(p)$")

        ax2 = fig.add_subplot(1,2,2)
        ax2.set_title("PMF of $\mathcal{B}(p)$")
        pp.close(fig)

        def my_histogram(ax, hist):
            labels, counts = zip(*hist.items())
            x = np.arange(len(labels))
            ax.bar(x, counts, zorder=1, align="center")
            ax.set_xticks(x)
            ls = ax.set_xticklabels(labels, rotation=90, color="white", ha="center", va="bottom"
            pp.setp(ls, path_effects=[patheffects.withStroke(linewidth=3, foreground="black")])
            ax.xaxis.set_tick_params(pad=-10)
            ax.grid(False)
            ax.set_axisbelow(False)

        def drawEntropy_bernoulli(p, plot_line=True, redraw=False):
            dot.set_xdata([p])
            dot.set_ydata([-p*np.log2(p)-(1-p)*np.log2(1-p)])
            line.set_visible(plot_line)
            ax2.cla()
            my_histogram(ax2, {"A": p, "B": 1-p})
            ax2.set_title("PMF of $\mathcal{B}(p)$")
            ax2.set_ylim([0, 1])
            if redraw:
                display.display(fig)
            else:
                return dot, line

        interact(drawEntropy_bernoulli, p=(0.001, 0.999, 0.001), plot_line=False, redraw=fixed(T
```

```
Widget Javascript not detected.  It may not be installed or enabled properly.
```

1.5 Generating & displaying animations inline

```
In [10]: from matplotlib import animation

         anim = animation.FuncAnimation(fig, drawEntropy_bernoulli, frames=np.hstack([np.linspac
         display.HTML(anim.to_html5_video())
```

```
Out[10]: <IPython.core.display.HTML object>
```

1.6 Generating slides from a jupyter notebook

1.6.1 HTML slides are generated from the console as follows:

```
jupyter nbconvert --to slides --post serve "Regular Notebook.ipynb"
```

1.6.2 Similarly, PDF slides are generated as follows:

```
jupyter nbconvert --to pdf "Regular Notebook.ipynb"
```

1.7 Live slideshows possible

For live slideshows that behave just like full fledged notebooks, use the jupyter RISE extension. This gives the whole thing a PowerPoint-ish flavor.