

D3.js 圖表優化二三事

Kuro Hsu @ Modern Web Conf 2015

先別管 D3 了，
你聽過資訊視覺化嗎？

同樣是 Web 記錄，哪個易理解？

```
18525 24.10.2010 15:24:54 - [10/May/2010:15:24:54 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18526 128.10.2010 15:24:55 - [10/May/2010:15:24:55 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 8816 "-" "Opera\\9.64"
18527 99.10.2010 15:24:56 - [10/May/2010:15:24:56 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 8788 "-" "Opera\\9.64"
18528 72.10.2010 15:24:56 - [10/May/2010:15:24:56 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8796 "-" "Opera\\9.64"
18529 24.10.2010 15:24:56 - [10/May/2010:15:24:56 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 9012 "-" "Opera\\9.64"
18530 99.10.2010 15:24:56 - [10/May/2010:15:24:56 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18531 72.10.2010 15:24:56 - [10/May/2010:15:24:56 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18532 24.10.2010 15:24:57 - [10/May/2010:15:24:57 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18533 21.10.2010 15:24:57 - [10/May/2010:15:24:57 -0500] "POST /wp-content/plugins/cforms/js/include/installed.php HTTP/1.1" 200 5249 "http://10.10.10.10"
18534 70.10.2010 15:24:58 - [10/May/2010:15:24:58 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 9013 "-" "Opera\\9.64"
18535 71.10.2010 15:24:58 - [10/May/2010:15:24:58 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 9013 "-" "Opera\\9.64"
18536 12.10.2010 15:24:58 - [10/May/2010:15:24:58 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 9013 "-" "Opera\\9.64"
18537 70.10.2010 15:24:58 - [10/May/2010:15:24:58 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18538 12.10.2010 15:24:58 - [10/May/2010:15:24:58 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18539 71.10.2010 15:24:58 - [10/May/2010:15:24:58 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18540 128.10.2010 15:24:59 - [10/May/2010:15:24:59 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 9013 "-" "Opera\\9.64"
18541 128.10.2010 15:24:59 - [10/May/2010:15:24:59 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18542 98.10.2010 15:24:59 - [10/May/2010:15:24:59 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8824 "-" "Opera\\9.64"
18543 98.10.2010 15:25:00 - [10/May/2010:15:25:00 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18544 75.10.2010 15:25:01 - [10/May/2010:15:25:01 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8817 "-" "Opera\\9.64"
18545 69.10.2010 15:25:01 - [10/May/2010:15:25:01 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8817 "-" "Opera\\9.64"
18546 75.10.2010 15:25:01 - [10/May/2010:15:25:01 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18547 69.10.2010 15:25:01 - [10/May/2010:15:25:01 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18548 72.10.2010 15:25:02 - [10/May/2010:15:25:02 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8817 "-" "Opera\\9.64"
18549 72.10.2010 15:25:02 - [10/May/2010:15:25:02 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18550 98.10.2010 15:25:03 - [10/May/2010:15:25:03 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8824 "-" "Opera\\9.64"
18551 68.10.2010 15:25:03 - [10/May/2010:15:25:03 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8817 "-" "Opera\\9.64"
18552 98.10.2010 15:25:03 - [10/May/2010:15:25:03 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18553 67.10.2010 15:25:03 - [10/May/2010:15:25:03 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 9013 "-" "Opera\\9.64"
18554 68.10.2010 15:25:03 - [10/May/2010:15:25:03 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18555 67.10.2010 15:25:04 - [10/May/2010:15:25:04 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18556 68.10.2010 15:25:04 - [10/May/2010:15:25:04 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 9013 "-" "Opera\\9.64"
18557 68.10.2010 15:25:05 - [10/May/2010:15:25:05 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18558 64.10.2010 15:25:07 - [10/May/2010:15:25:07 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8873 "-" "Opera\\9.64"
18559 24.10.2010 15:25:07 - [10/May/2010:15:25:07 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 8809 "-" "Opera\\9.64"
18560 64.10.2010 15:25:07 - [10/May/2010:15:25:07 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18561 24.10.2010 15:25:07 - [10/May/2010:15:25:07 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18562 96.10.2010 15:25:08 - [10/May/2010:15:25:08 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8817 "-" "Opera\\9.64"
18563 96.10.2010 15:25:08 - [10/May/2010:15:25:08 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18564 80.10.2010 15:25:09 - [10/May/2010:15:25:09 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 9012 "-" "Opera\\9.64"
18565 79.10.2010 15:25:09 - [10/May/2010:15:25:09 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 8781 "-" "Opera\\9.64"
18566 218.10.2010 15:25:09 - [10/May/2010:15:25:09 -0500] "POST /wp-content/plugins/cforms/js/include/installed.php HTTP/1.1" 200 4222 "http://10.10.10.10"
18567 79.10.2010 15:25:10 - [10/May/2010:15:25:10 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18568 71.10.2010 15:25:11 - [10/May/2010:15:25:11 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8803 "-" "Opera\\9.64"
18569 71.10.2010 15:25:11 - [10/May/2010:15:25:11 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18570 86.10.2010 15:25:12 - [10/May/2010:15:25:12 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 9012 "-" "Opera\\9.63"
18571 24.10.2010 15:25:12 - [10/May/2010:15:25:12 -0500] "GET /wp-content/plugins/cforms/js/include/usapart.exe HTTP/1.1" 404 8824 "-" "Opera\\9.64"
18572 24.10.2010 15:25:12 - [10/May/2010:15:25:12 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18573 99.10.2010 15:25:14 - [10/May/2010:15:25:14 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 8823 "-" "Opera\\9.64"
18574 24.10.2010 15:25:14 - [10/May/2010:15:25:14 -0500] "GET /wp-content/plugins/cforms/js/include/picsof.exe HTTP/1.1" 404 8823 "-" "Opera\\9.64"
18575 99.10.2010 15:25:14 - [10/May/2010:15:25:14 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
18576 24.10.2010 15:25:14 - [10/May/2010:15:25:14 -0500] "GET /xmlrpc.php HTTP/1.1" 200 54 "-" "Opera\\9.64"
```


同樣是 Web 記錄，哪個易理解？



AGENDA

- D3 基本介紹
- D3 效能與優化
- D3 on Mobile



Data-Driven Documents



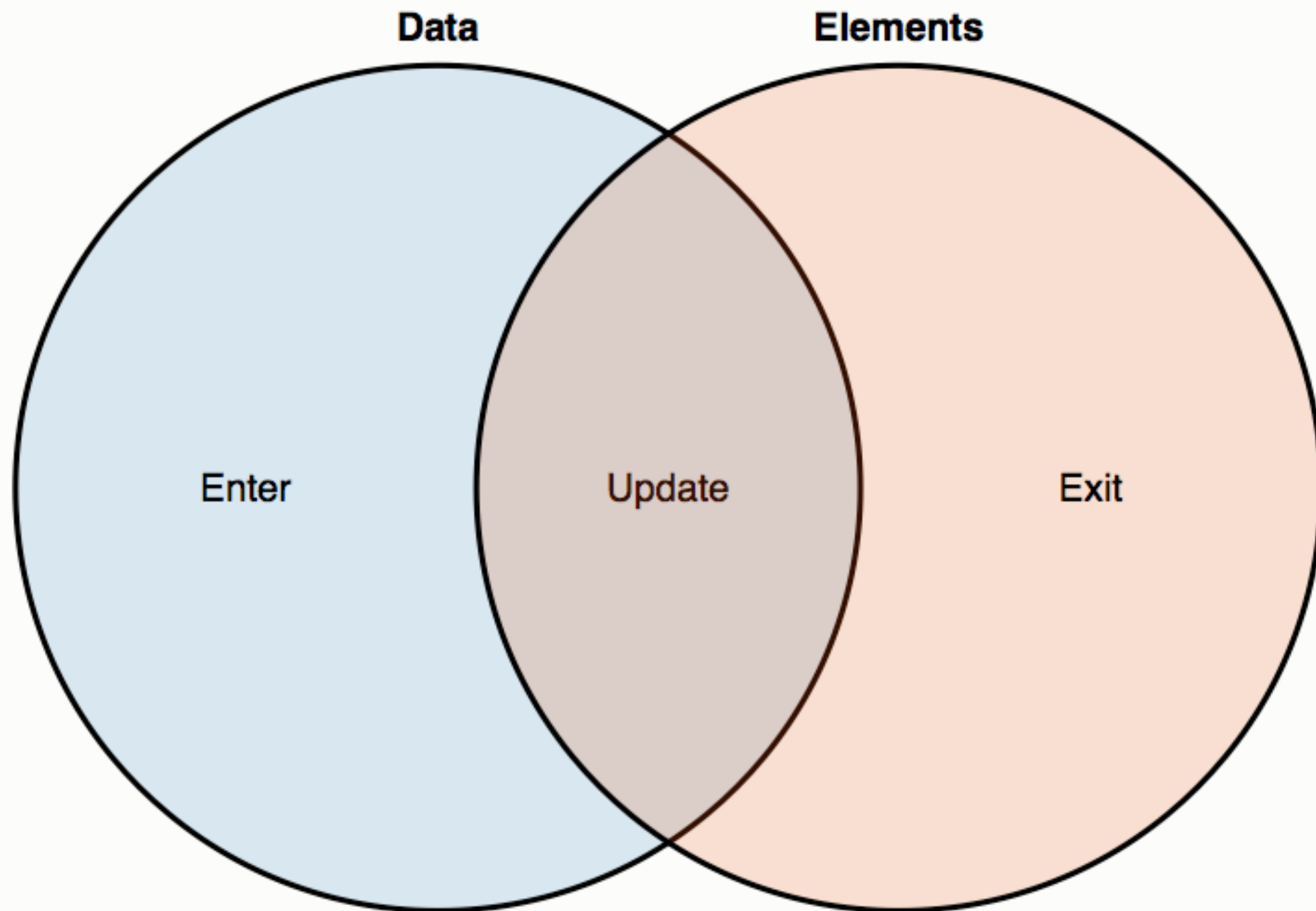
<http://d3js.org/>

MAJOR BROWSER COMPATIBILITY

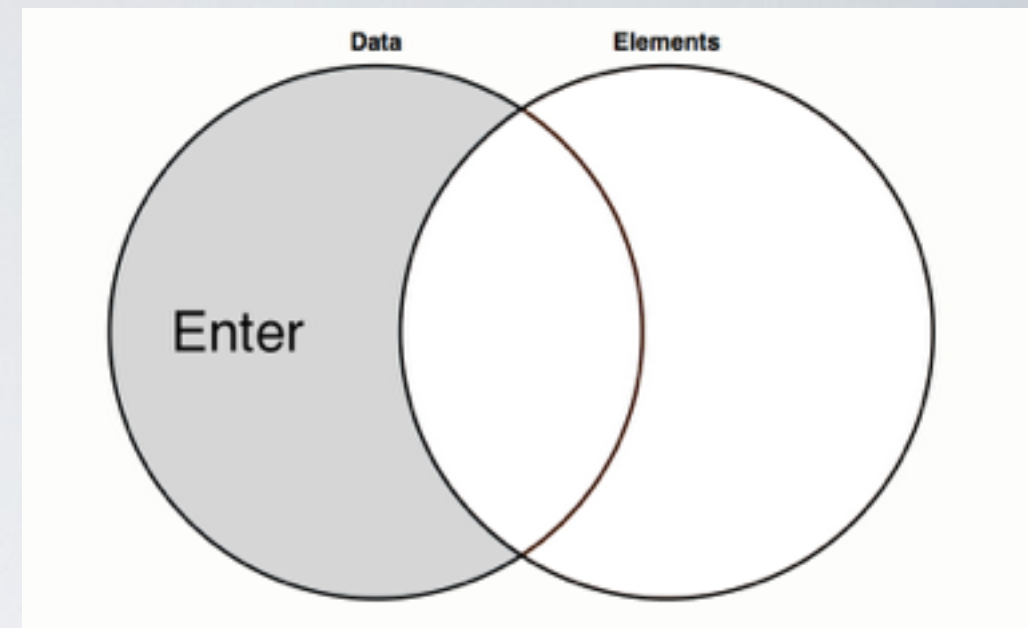


* svg 繪圖需要 IE9+

D3 起手式：從資料到圖像



Enter - Update - Exit



```
var data = [1, 2, 3, 4, 5];
```

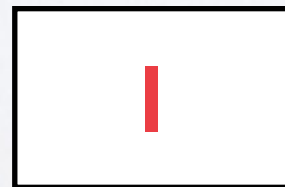
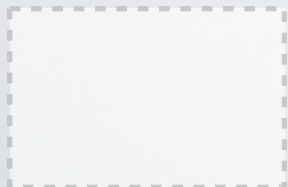
```
d3.select('body').selectAll('div')
```

```
.data( data )
```

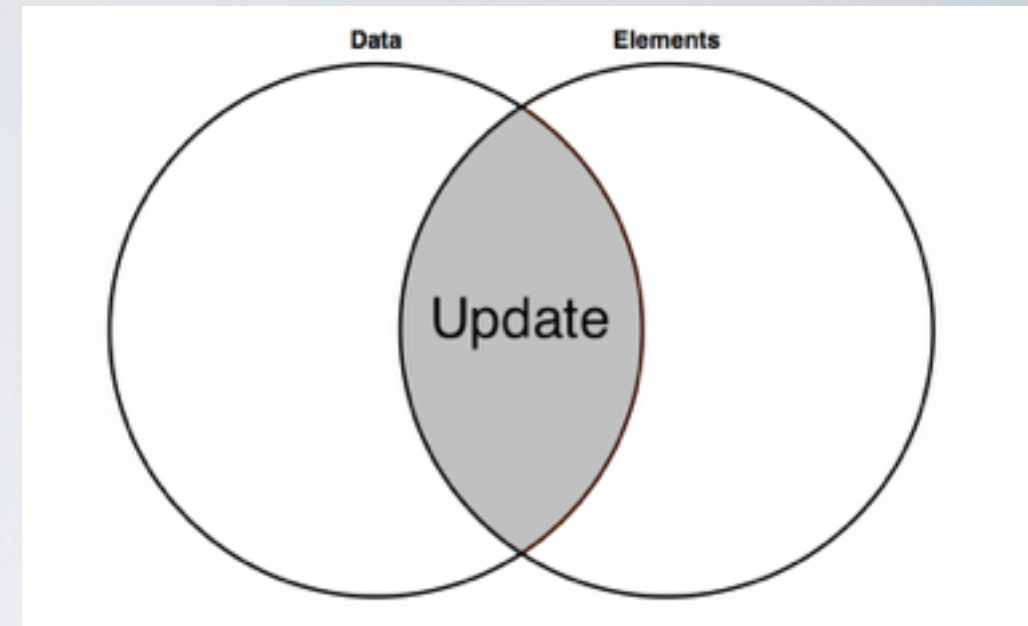
```
.enter()
```

```
.append('div')
```

```
.text(function(d, i){ return d; });
```



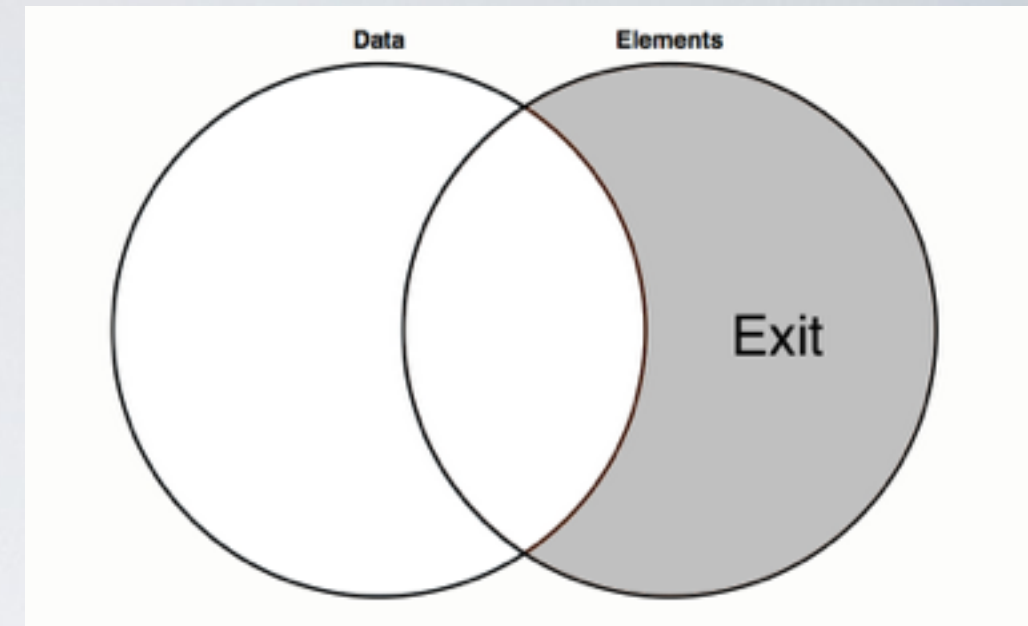
Enter - **Update** - Exit



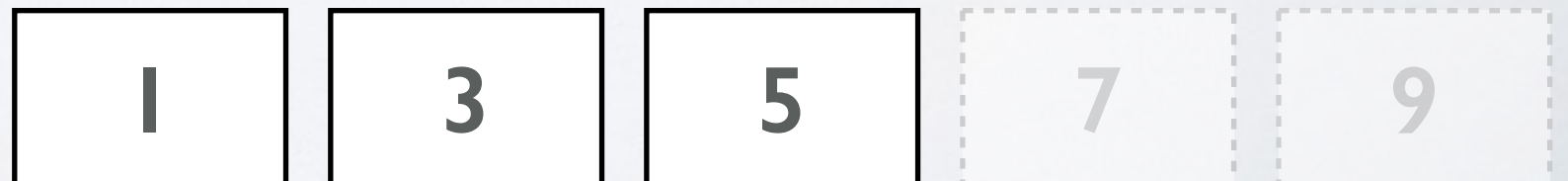
```
data = [1, 3, 5, 7, 9];  
d3.select('body').selectAll('div')  
  .data( data )  
  .text(function(d, i){  
    return d;  
  });
```



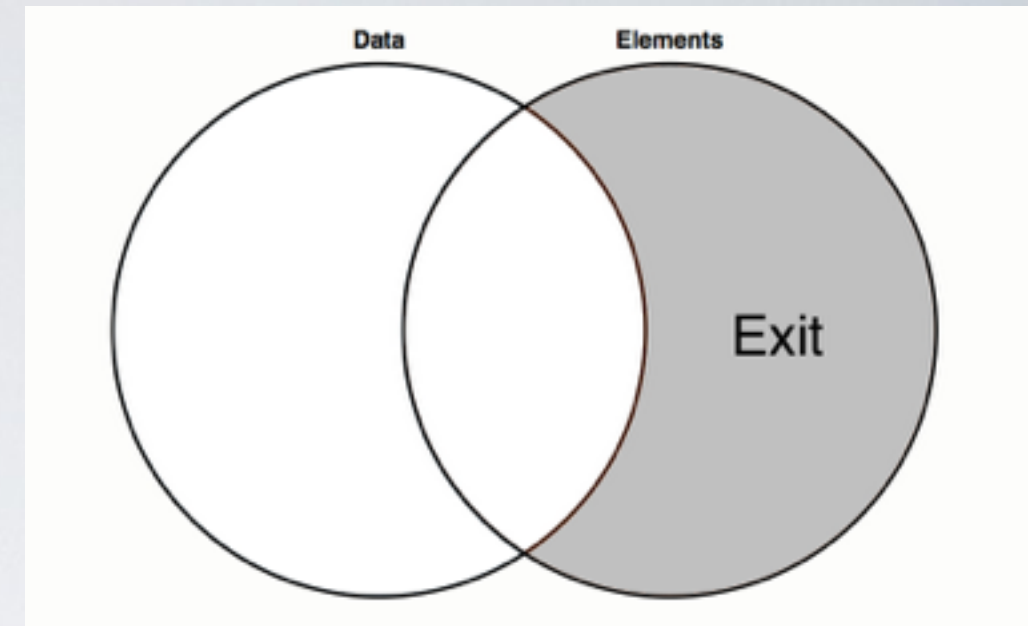
Enter - Update - **Exit**



```
data = [10, 20, 30];  
d3.select('body').selectAll('div')  
  .data( data )  
  .exit()  
  .remove();
```



Enter - Update - **Exit**



```
data = [10, 20, 30];  
d3.select('body').selectAll('div')  
  .data( data )  
  .exit()  
  .remove();
```

?

1

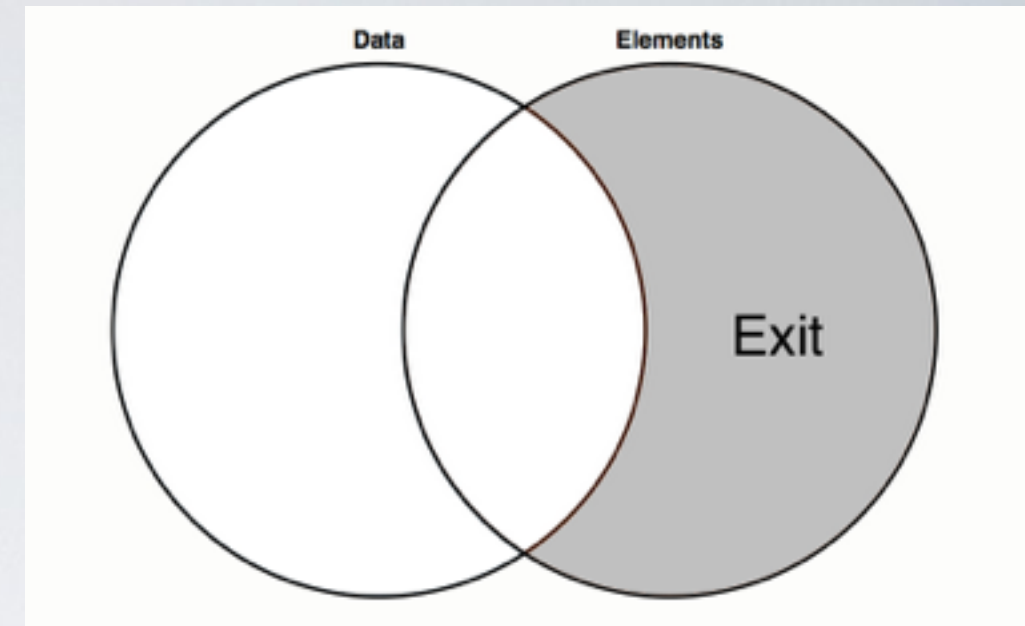
3

5

7

9

Enter - Update - **Exit**



```
data = [10, 20, 30];  
d3.select('body').selectAll('div')  
  .data( data )  
  .text(function(d, i){ return d; }) // update text  
  .exit()  
  .remove();
```

10

20

30

7

9

SELECTION

Data

Data

Data

Data

Data

Enter & Update

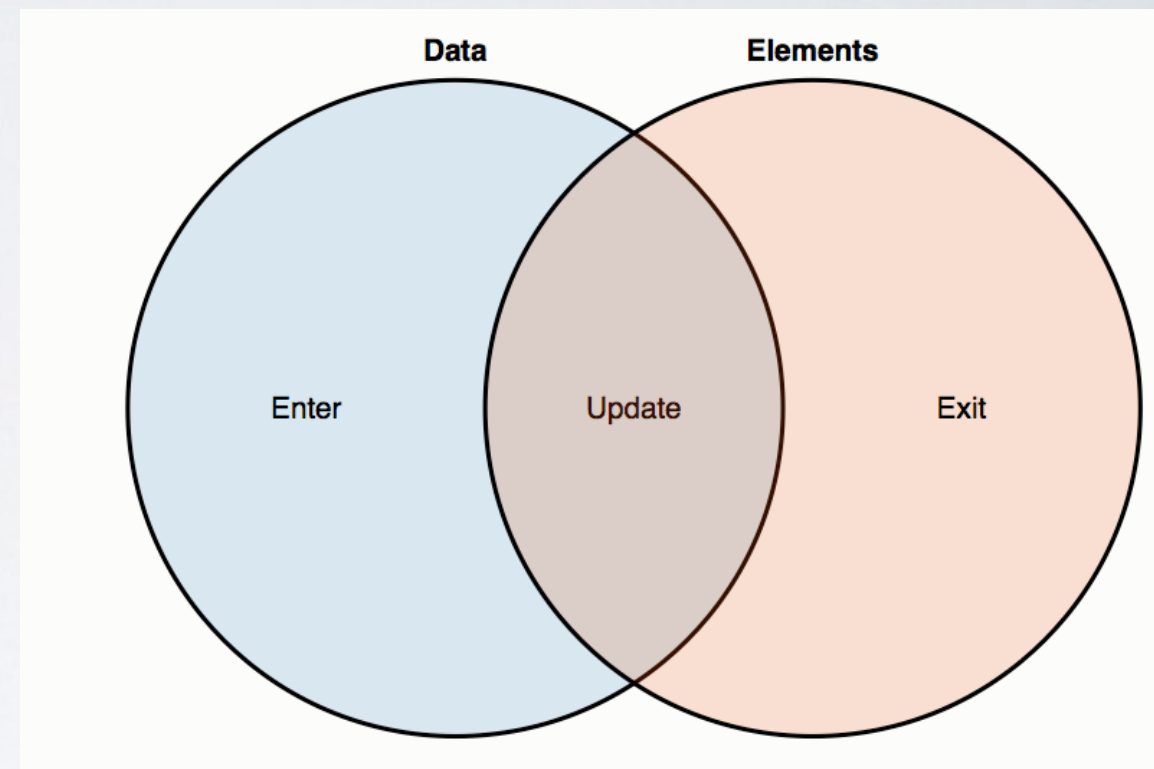
Exit

SELECTION



Enter - Update - Exit

- ◆ **Enter:** $\text{Data} > \text{Elements}$.
- ◆ **Update:** $\text{Data} = \text{Elements}$.
- ◆ **Exit:** $\text{Data} < \text{Elements}$.



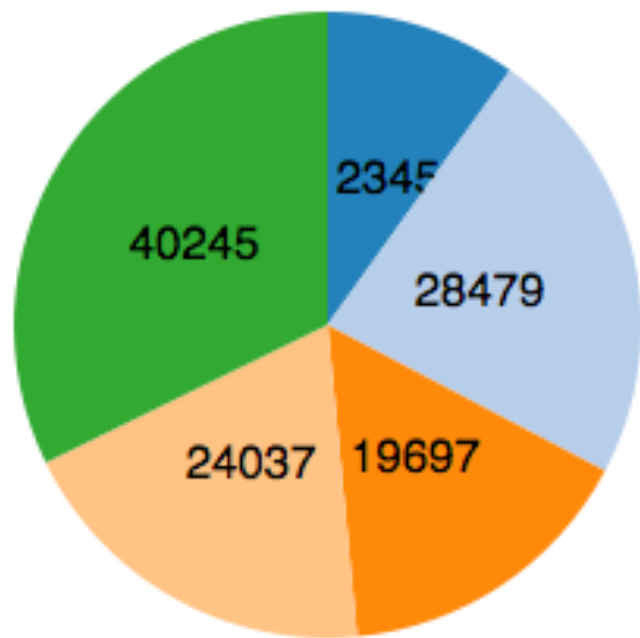
D3.JS V.S JQUERY

	jQuery	D3.js
Selector	<code>\$("#id001");</code>	<code>d3.selectAll("#id001");</code>
Attribute	<code>SELECTION.attr("key", "val")</code>	<code>SELECTION.attr("key", "val")</code>
class	<code>SELECTION.addClass("...")</code> <code>SELECTION.removeClass("...")</code>	<code>SELECTION.classed("...", true)</code> <code>SELECTION.classed("...", false)</code>
DOM append	<code>SELECTION.append("<div></div>")</code>	<code>SELECTION.append("div")</code>

注意： D3.append 與 jQuery.append 回傳的元素不同。

D3 LAYOUT

Pie Layout



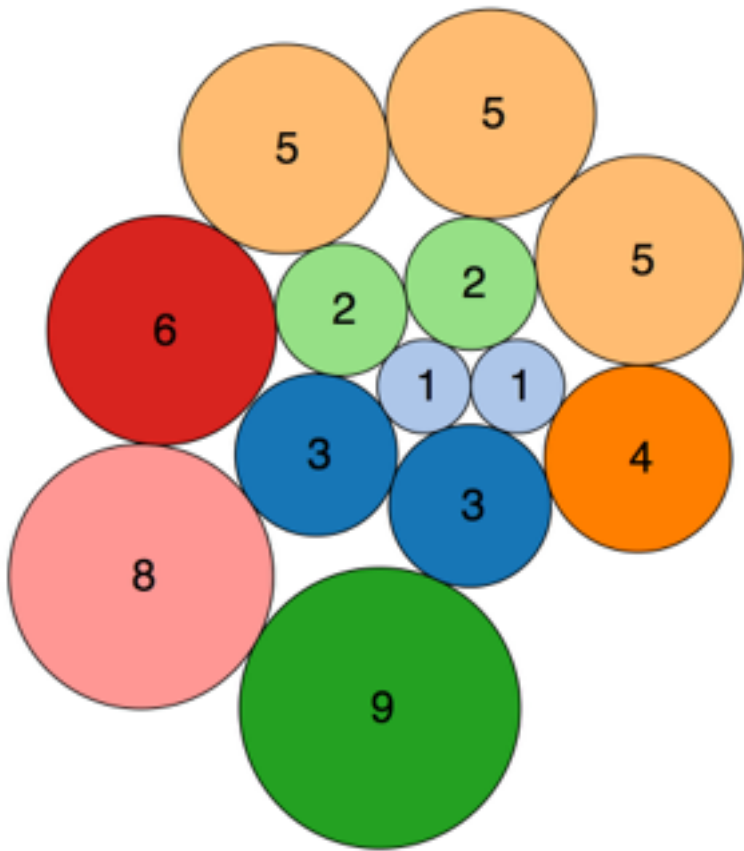
```
// 建立資料
```

```
var data = [12345, 28479, 19697, 24037, 40245];
```

```
// 透過 layout.pie() 與 data 生成圖樣
```

```
var g = svg.selectAll("g path")  
    .data(d3.layout.pie(data))  
    .enter()  
    .append("g");
```

Pack Layout



// 原始資料

```
var data = [3,1,4,1,5,9,2,6,5,3,5,8,2];
```

// 將資料透過 map 轉換成規定的格式

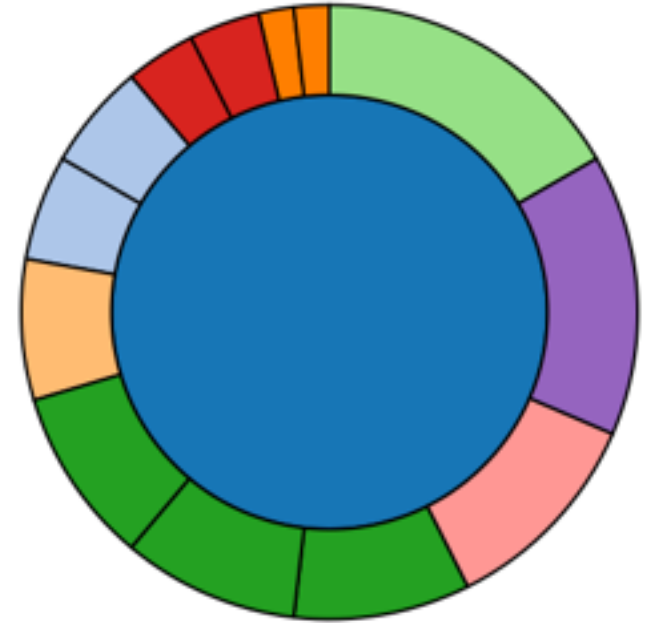
```
var root = { children: data.map(function (d)
{ return {value: d}; }) };
```

// d3.layout.pack()

// size 指定圖案大小，利用 .nodes 帶入資料

```
var nodes = d3.layout.pack().size([500,
500]).nodes(root);
```


Partition Layout



```
// d3.layout.pack()  
// size 指定圖案大小，利用 .nodes 帶入資料  
var nodes = d3.layout.partition()  
              .size([2 * Math.PI, 10000]).nodes(data);  
  
// d3.svg.arc 製作弧形  
var arc = d3.svg.arc()  
            .startAngle(function (d) { return d.x; })  
            .endAngle(function (d) { return d.x + d.dx; })  
            .innerRadius(function (d) { return Math.sqrt(d.y); })  
            .outerRadius(function (d) { return Math.sqrt(d.y + d.dy); });
```

D3.JS LAYOUT

More: <https://github.com/mbostock/d3/wiki/Layouts>

效能與優化

過多的 SVG 元素

- 移除非必要的元素，如 <g>

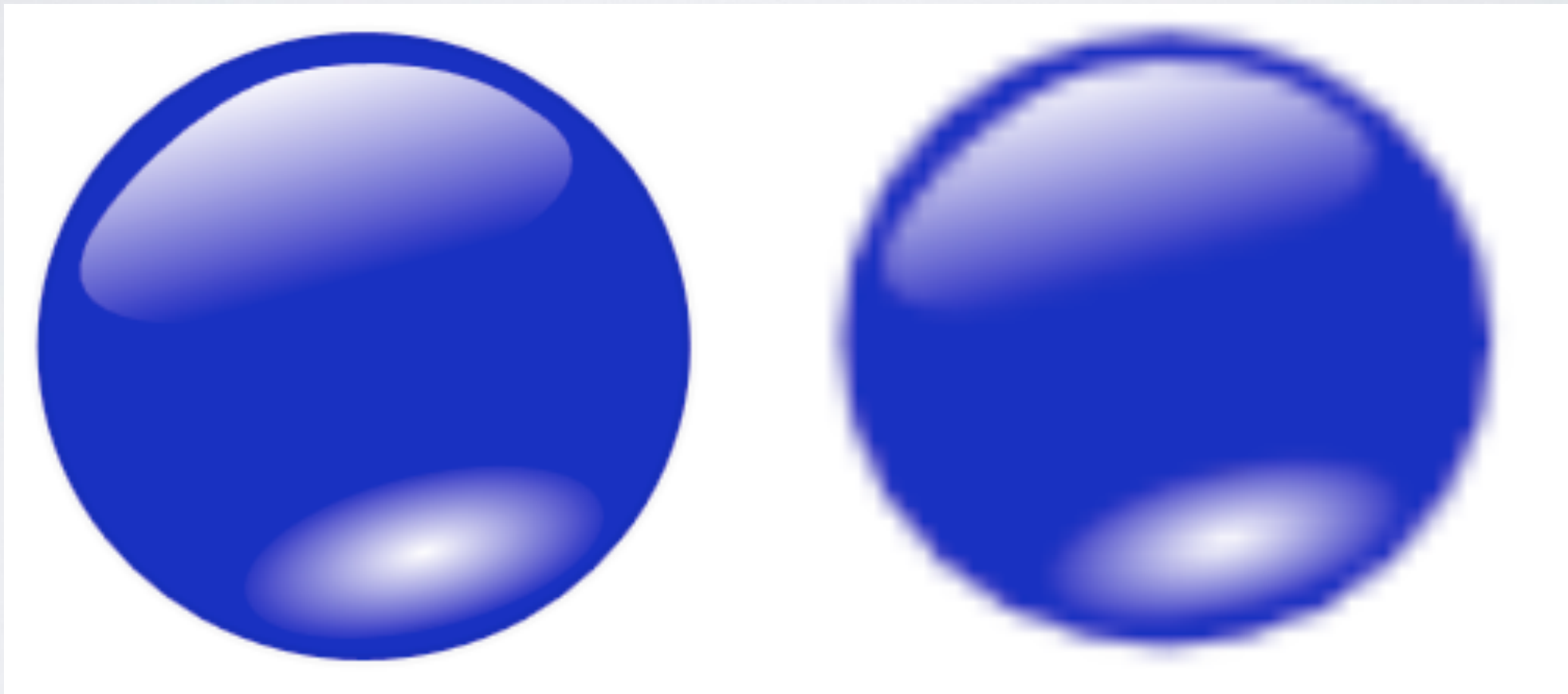
```
points = svg.selectAll("g")
    .data(data)
    .enter()
    .append("g")
    .attr("transform", function(d) {
        return "translate(" + d[0] + "," + d[1] + ")";
    });
```

```
points.append("circle").attr("r", 5);
points.append("text").text("label");
```

```
svg.selectAll("circle").data(data).enter()  
  .append("circle")  
  .attr({  
    "cx": function(d) { return d[0]; },  
    "cy", function(d) { return d[1]; },  
    "r", 5  
  });
```

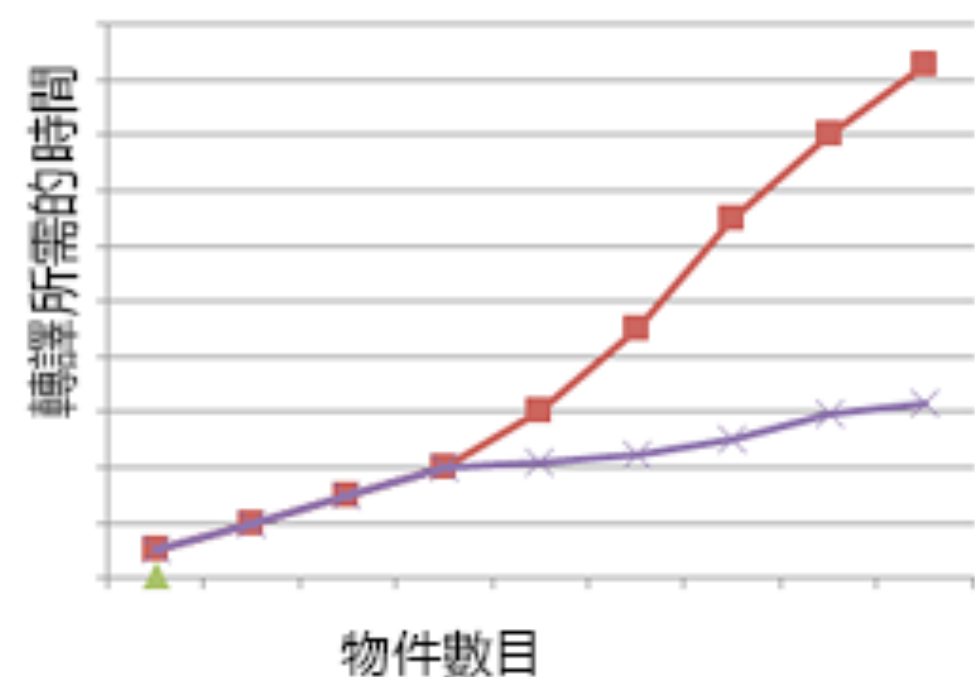
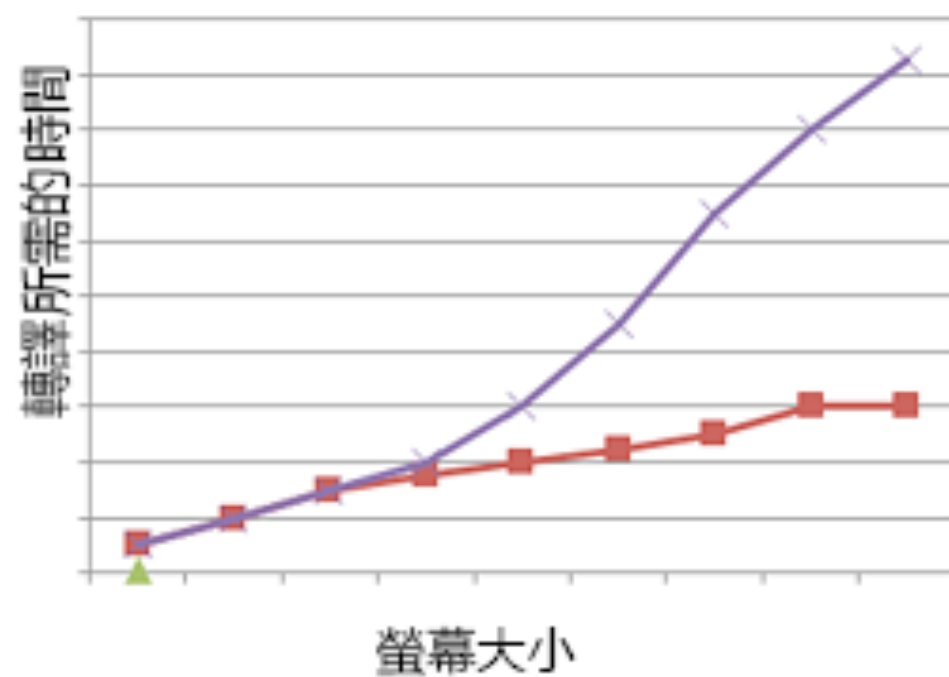
```
svg.selectAll("text").data(data).enter()  
  .append("text")  
  .attr({  
    "x", function(d) { return d[0]; },  
    "y", function(d) { return d[1]; }  
  })  
  .text("label");
```

SVG v.s Canvas



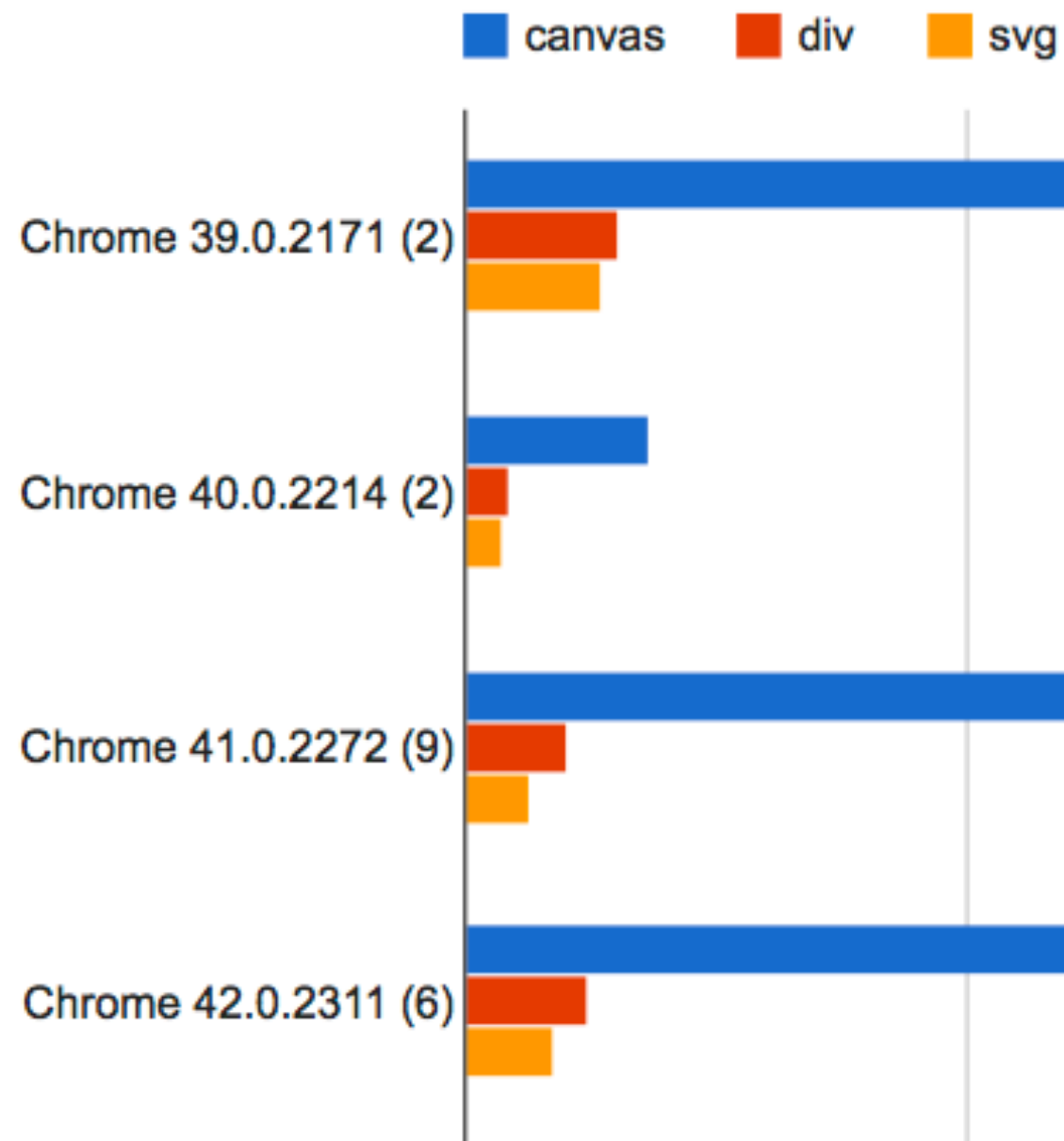
SVG v.s Canvas

效能比較



— Canvas
— SVG

SVG v.s Canvas



source: <http://jsperf.com/html-vs-svg-vs-canvas/30>

聽起來很優，是否可以用 D3 畫 Canvas 圖像？

```
// CANVAS 畫布
```

```
var chart = body.append("canvas")  
                .attr({"width": 400, "height": 300});  
var context = chart.node().getContext("2d");
```

```
// 只存在於記憶體的 element SELECTION
```

```
var detachedContainer = document.createElement("custom");  
var dataContainer = d3.select(detachedContainer);
```

// 將外部資料綁定至 custom 元素

```
function drawCustom(data) {
```

```
  var dataBinding = dataContainer
```

```
    .selectAll("custom.rect")
```

```
    .data(data, function(d) { return d; });
```

// Data Binding - ENTER, UPDATE, EXIT

```
dataBinding.attr({ ... });
```

// update

```
dataBinding.enter().append().attr({ ... });
```

// enter

```
dataBinding.exit().attr({ ... });
```

// exit

```
drawCanvas();
```

```
}
```

```
function drawCanvas() {  
    // 將處理好的 dataContainer SELECTION 轉換成實體 rect  
    var elements = dataContainer.selectAll("custom.rect");  
  
    // 針對每一筆資料畫 rect 至 canvas 上  
    elements.each(function(d) {  
        var node = d3.select(this);  
        context.beginPath();  
        context.fillStyle = node.attr("fillStyle");  
        context.rect(node.attr("x"), node.attr("y"), node.attr("size"),  
                     node.attr("size"));  
        context.fill();  
        context.closePath();  
    });  
}
```




所以我說那個好用的 d3.Layout 呢

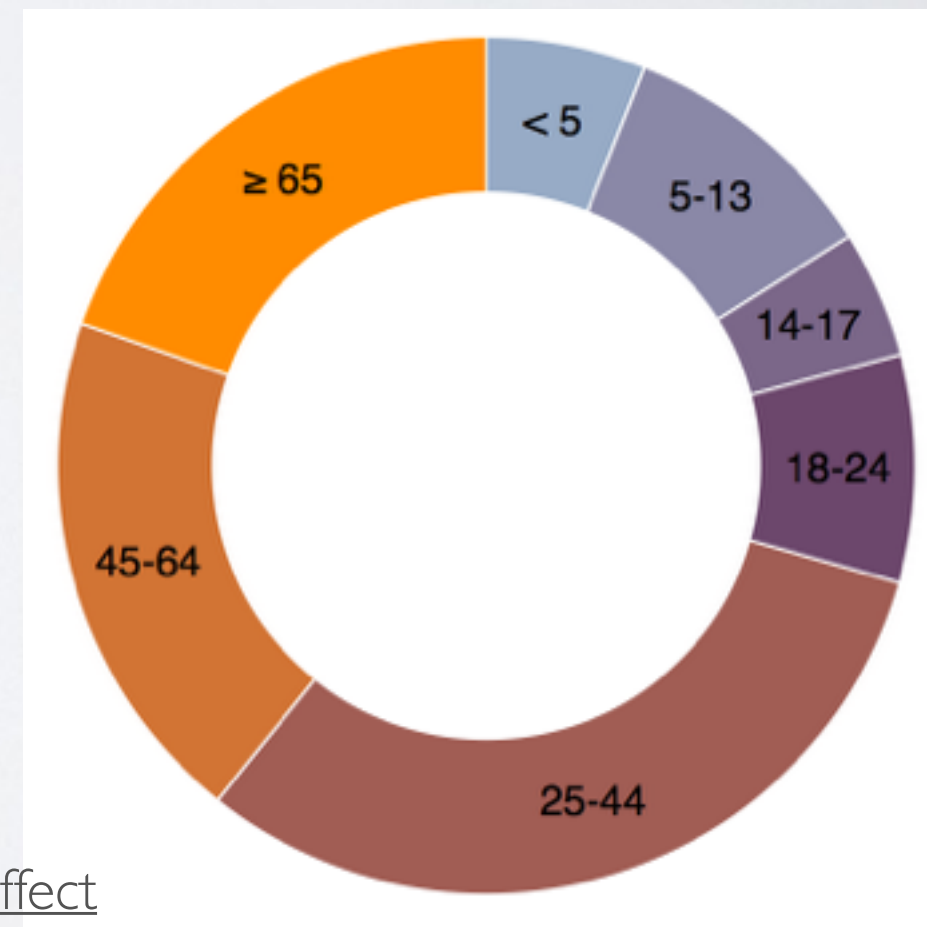
- 過多的資料 (元素) 是導致效能變差的元凶。
 - 分次載入資料
 - 善用 **enter - update - exit Pattern** 可將元素維持在一定數量
- D3 雖然可搭配 CANVAS，視時機使用
 - 必須放棄 D3 提供的繪圖功能 (純 DOM 操作)
- 比起 CANVAS，SVG 更具有 SEO 優勢

事件綁定

```
SELECTION.on('click', function(){  
    alert('Hello D3!');  
});
```

事件綁定

- mouse events:
 - mousedown, mouseup, mouseover, mouseout, mouseenter, mouseleave, click, dblclick
- 當元素重疊導致事件失效
 - 由上層元素指定事件
 - CSS: `pointer-events: none;`



過場動畫

- Transitions have a four-phase life cycle:
 - The transition is scheduled.
 - The transition starts.
 - The transition runs.
 - The transition ends.

<http://bost.ocks.org/mike/transition/>

過場動畫

```
SELECTION.transition()  
    .duration(1000)      // 動畫執行時間  
    .delay(1000)         // 延遲  
    .ease( ... )         // Easing 函數  
    .attr({  
        'transform': function(d){ ..... }  
    });
```

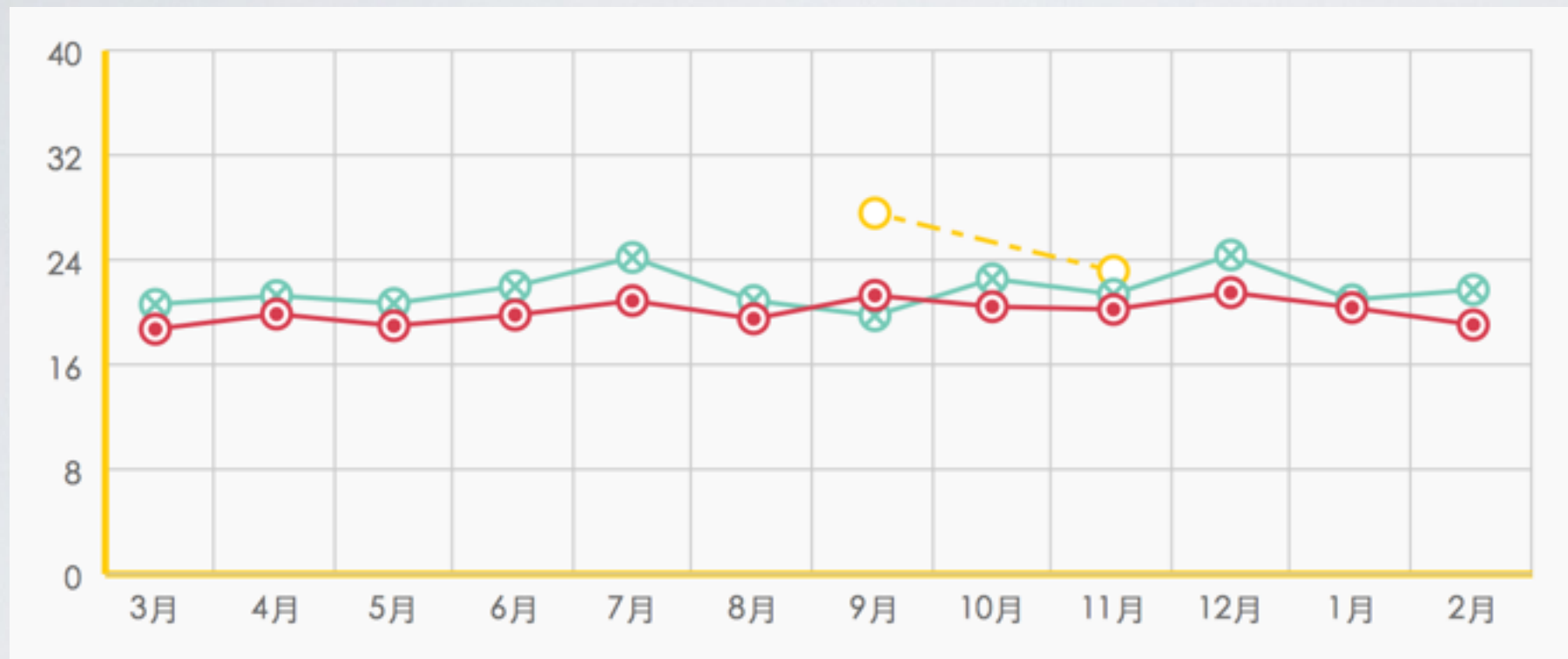
- D3.js Easing Checker - <http://blocks.org/hunzy/9929724>

```
SELECTION.transition()  
    .duration(1000)  
    .each('start', function(){  
        // 動畫開始前執行  
    })  
    .attr({  
        // ..... (略)  
    })  
    .each('end', function(){  
        // 動畫結束後執行  
    });
```

螢幕閃動？

- 除了 `setInterval` / `setTimeout` 以外
 - `requestAnimationFrame`
 - **`d3.timer()`** 會自動選擇最佳方式
 - `d3.timer(function(){ ... }, 1000);`

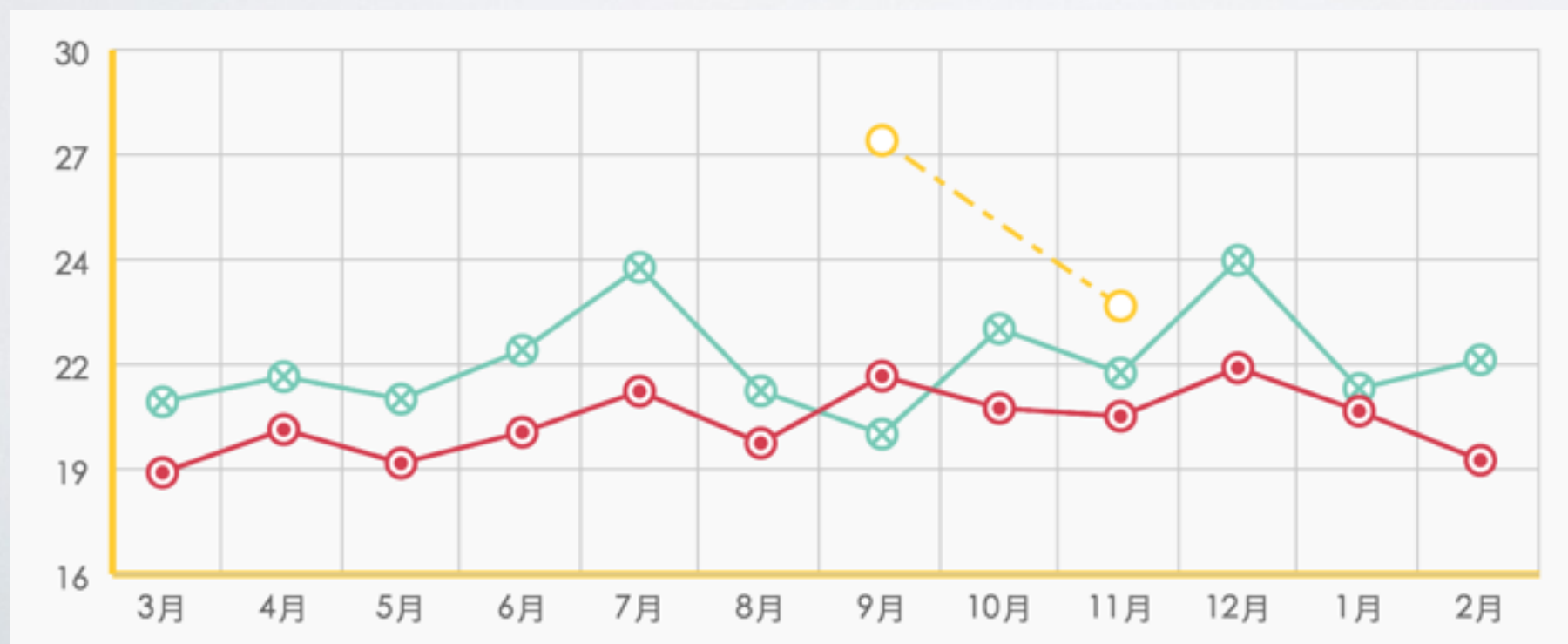
TICKS



善用

d3.min()

d3.max()



D3.js on Mobile

Responsive with D3



source: <https://blog.safaribooksonline.com/2014/02/17/building-responsive-visualizations-d3-js/>

// 取得寬高，依寬高畫出最適圖

```
var width = parseInt(d3.select("#graph").style("width")) - margin * 2,  
    height = parseInt(d3.select("#graph").style("height")) - margin * 2;
```

// 依寬高更新比例尺

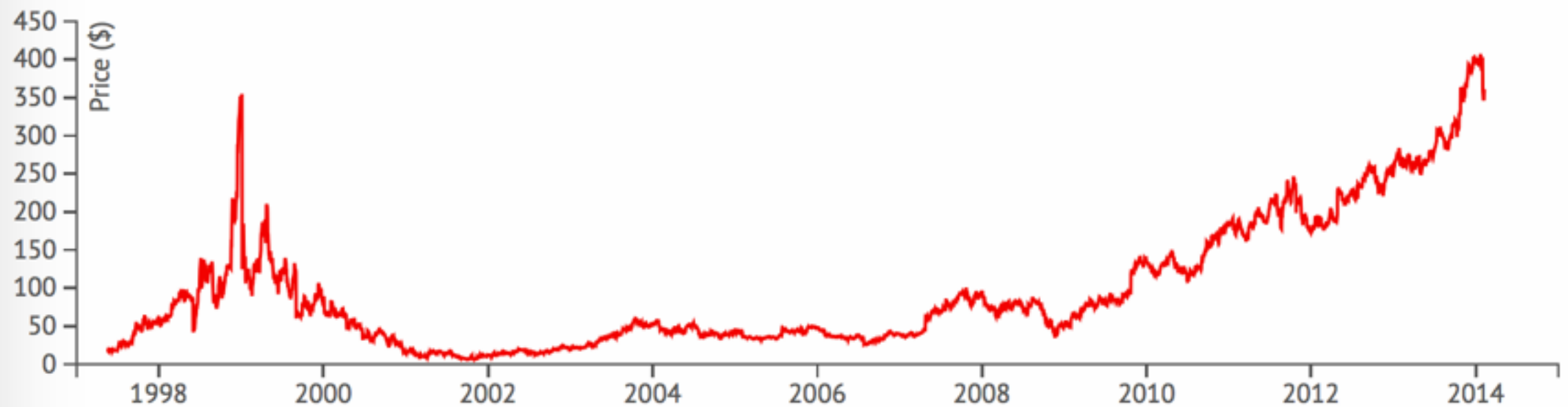
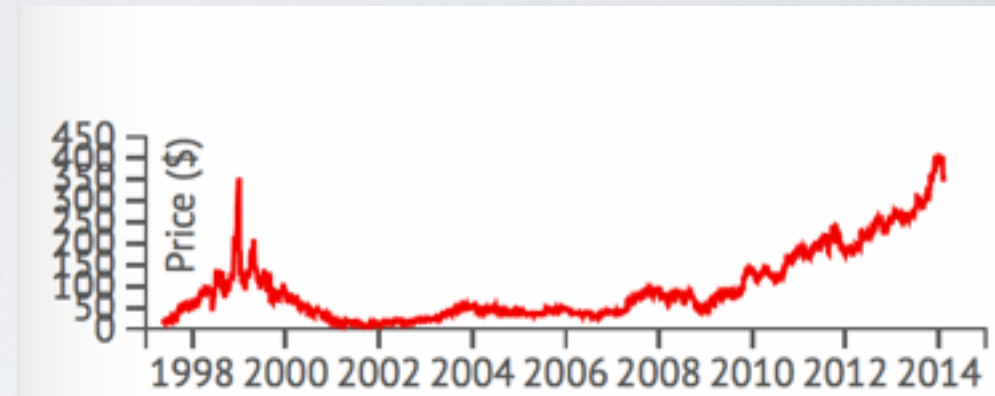
```
xScale.range([0, width]).nice(d3.time.year);  
yScale.range([height, 0]).nice();
```

// x, y 軸

```
graph.select('.x.axis')  
    .attr("transform", "translate(0," + height + ")").call(xAxis);  
graph.select('.y.axis').call(yAxis);
```

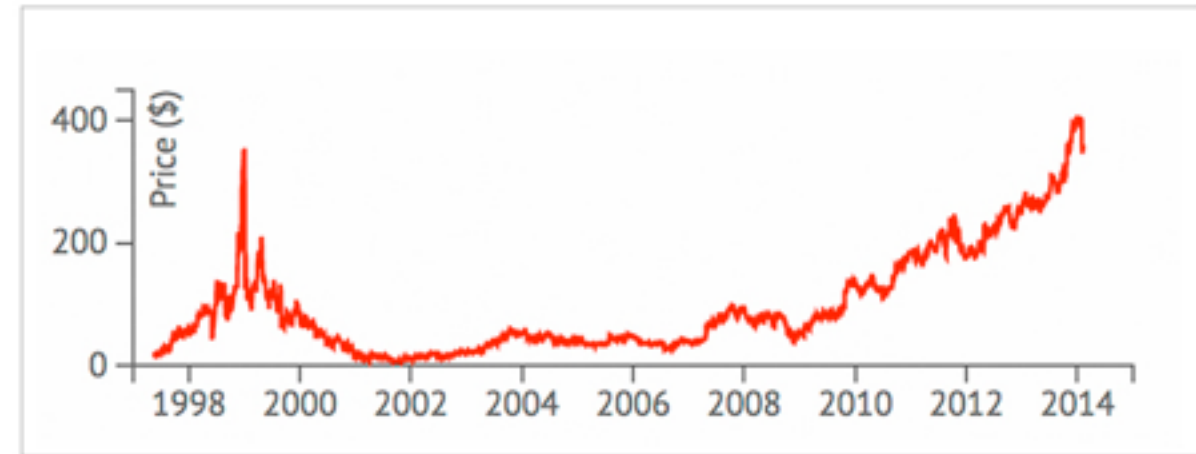
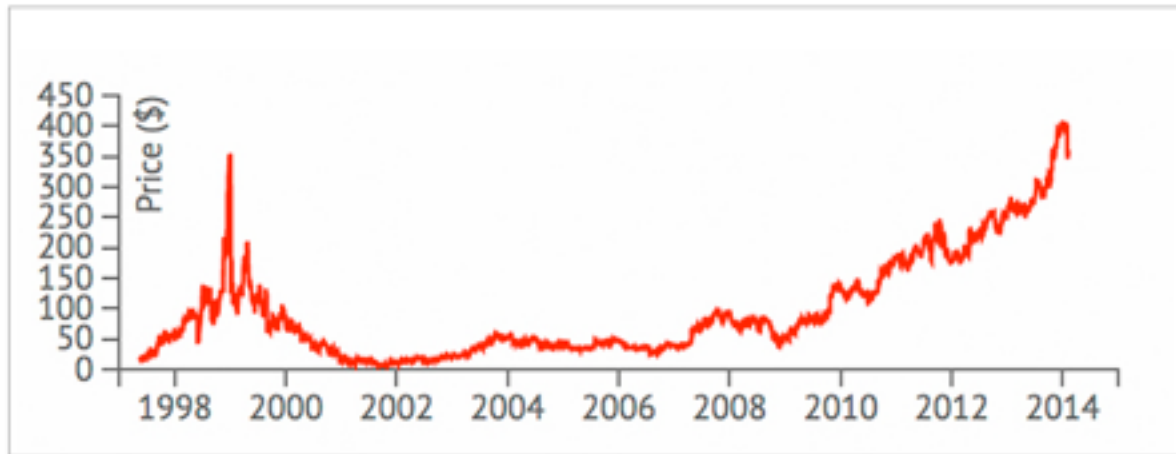
// 產生線圖

```
graph.selectAll('.line').attr("d", line);
```

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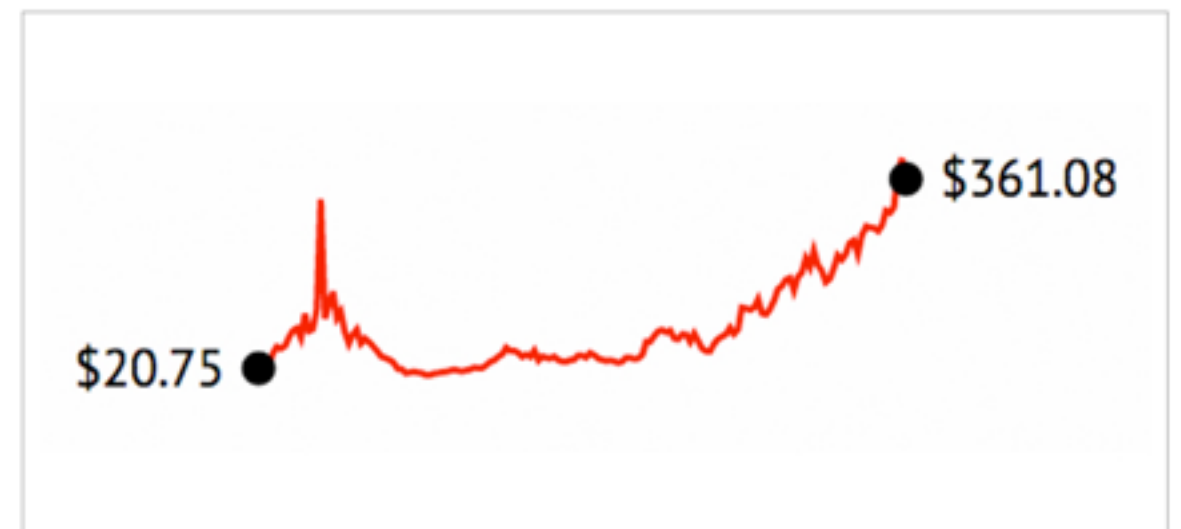
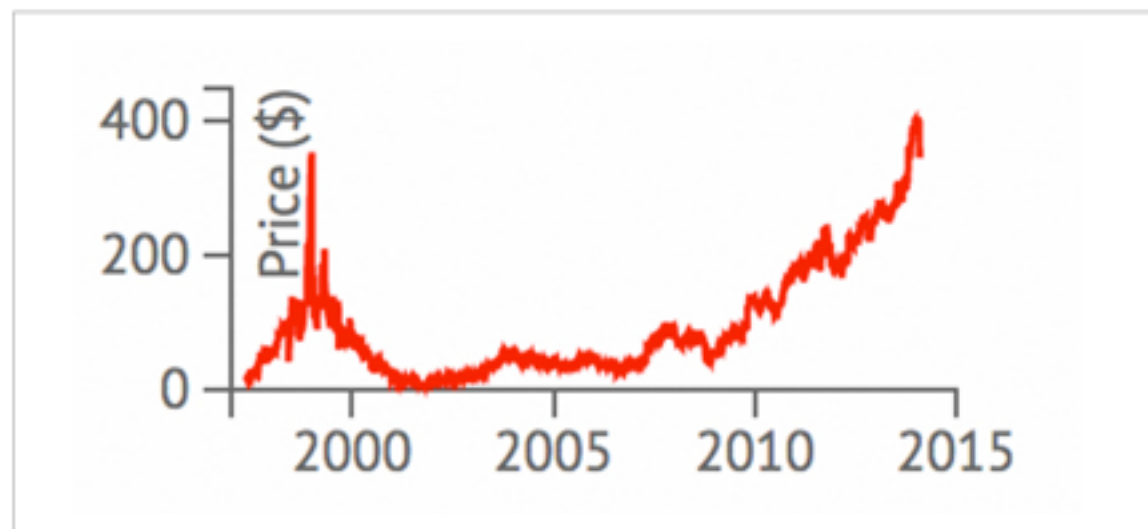
Responsive with D3



// **resize** 時，動態更新 **x, y** 軸刻度，更適合閱讀

```
function resize() {  
    ...  
    xAxis.ticks(Math.max(width/50, 2));  
    yAxis.ticks(Math.max(height/50, 2));  
    ...  
}
```

Responsive with D3



Responsive with D3

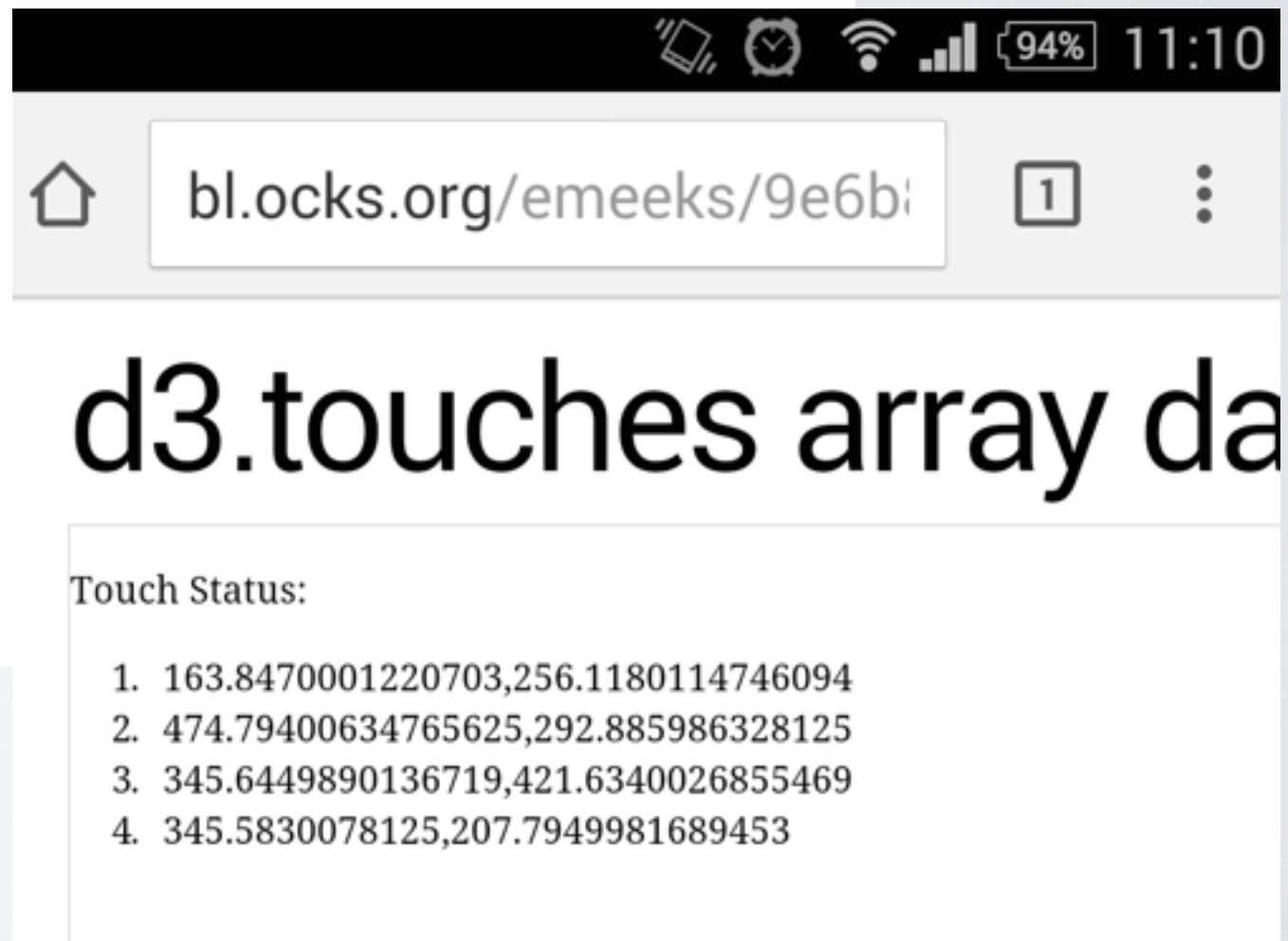
- 大部份智慧型裝置對 SVG 支援良好
- 向量圖形，縮放不失真
- 動畫 / 元素過多時易有效能問題
- 不是每一種圖形都適合做 Responsive

Touch Events

- click, dblclick 仍然可以用
 - 一樣沒有 hover (mouseenter / mouseleave)
 - touchstart, touchend, touchmove
- 多點觸控 - d3.touches
 - https://github.com/mbostock/d3/wiki/Selections#d3_touches

```
d3.select("svg").on("touchstart", touchStatus);  
d3.select("svg").on("touchmove", touchStatus);
```

```
function touchStatus() {  
  d3.event.preventDefault();  
  d3.event.stopPropagation();  
  
  // will return an array  
  var d = d3.touches(this);  
}
```



try this: <http://bl.ocks.org/emeeks/9e6b87735d2da05813e3>

ZOOM IN / OUT

```
var zoom = d3.behavior.zoom()  
    .scaleExtent([1, 10])  
    .on("zoom", zoomed);  
  
function zoomed() {  
    container.attr("transform",  
        "translate(" + d3.event.translate + ") " +  
        "scale(" + d3.event.scale + ")");  
}
```

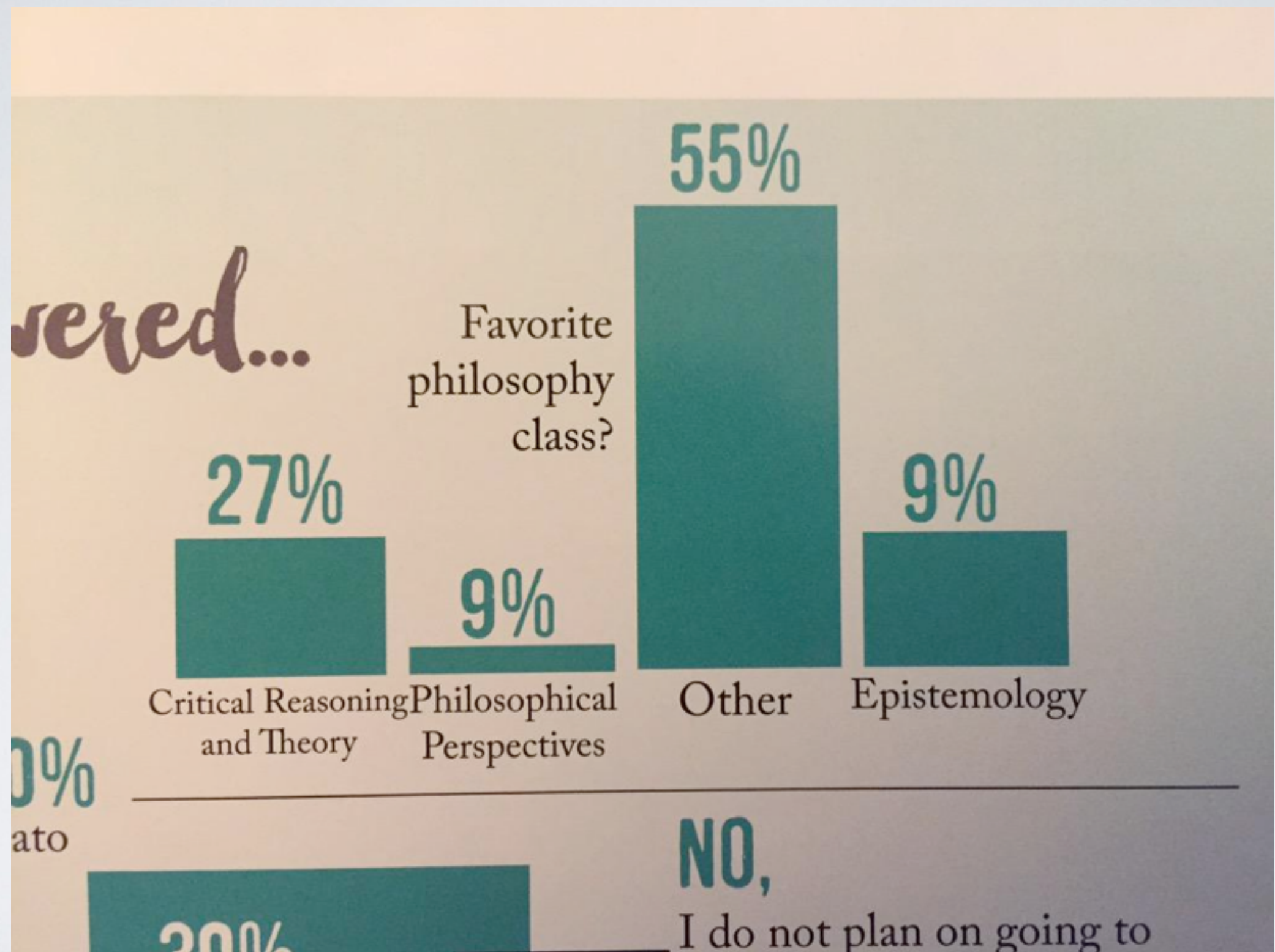
DRAG

```
var drag = d3.behavior.drag()  
  .origin(function(d) { return d; })  
  .on("dragstart", dragstarted)  
  .on("drag", dragged)  
  .on("dragend", dragended);
```

```
function dragstarted(d) { ... }
```

```
function dragged(d) { ... }
```

```
function dragended(d) { ... }
```

source: <http://viz.wtf/>

角度差異-一點透視

羊25000

羊75000

PS3

WII

以圖表來說其實是沒有差異
又或者可以說 WII 比較昂貴

1 呃
3 ∴
9
∴

這就是武天
師父的戰鬥
力了！

●●●●●



PPH-0-00 00000000000000000000
00-00-0000-00-0000000000000000
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00-000000

中尾 隆聖

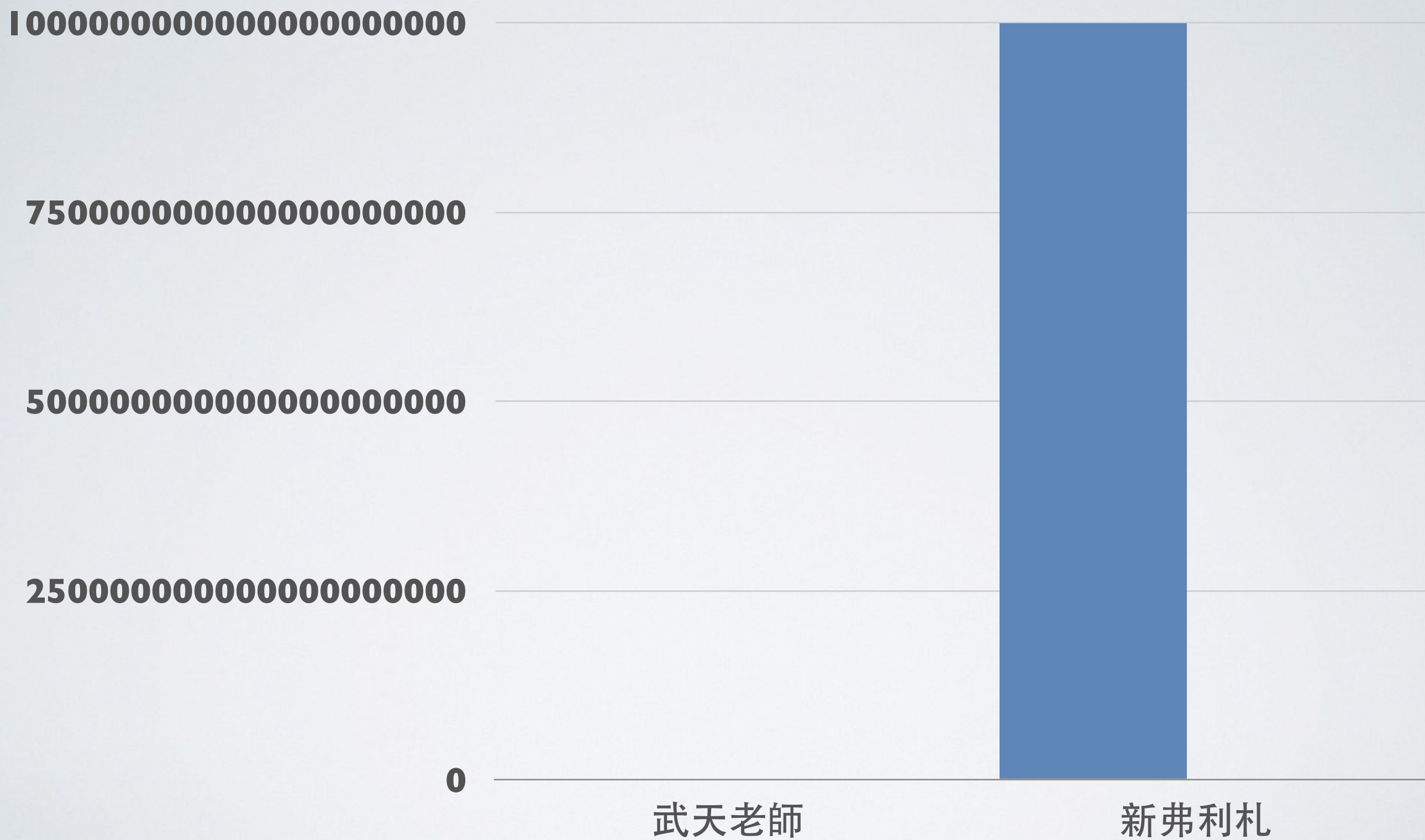
最恐フリーザ 戦闘力は

100,000,000,000,000,000,000



とてつもなく強く、おが底まで届いている……

フリーザは、そなたが非常にいいですね。



最重要的不全然是技術

- 圖表務求精準，著重訊息關鍵
- 選擇對的圖表
- 慎選主題 - 把一個故事講好
- 圖表優使性 (usability)



「看到，就懂了。」

– Randy Krum, Author of Cool Infographics.

THANKS!

- **Kuro Hsu**
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- <http://kuro.tw>
- <http://facebook.com/kurotanshi>