

# JSXGraph Reference Card

## Include JSXGraph in HTML

Three parts are needed: Include files containing the software, an HTML element, and JavaScript code.

### Include files:

Three files have to be included: `jsxgraph.css`, `jsxgraphcore.js` and either `prototype.js` or `jquery.js`.

```
- <script type="text/javascript"
    src="domain/prototype.js"></script>
or - <script type="text/javascript"
    src="domain/jquery.min.js"></script>
- <link rel="stylesheet" type="text/css"
    href="domain/jsxgraph.css"/>
- <script type="text/javascript"
    src="domain/jsxgraphcore.js"></script>
```

domain is the location of the files. This can be a local directory or `http://jsxgraph.uni-bayreuth.de/distrib/`

### HTML element containing the construction:

```
<div id="box" class="jxgbox"
    style="width:600px; height:600px;"></div>
```

### JavaScript code:

```
<script type="text/javascript">
    var brd = JXG.JSXGraph.initBoard('box',{axis:true});
</script>
```

## Initializing the board

```
var brd = JXG.JSXGraph.initBoard('box',{attributes});
```

– *Attributes of the board*

`unitX`, `unitY`: number of pixels of one unit  
in *x/y*-axis direction

`originX`, `originY`: the position of the origin  
in pixel coordinates

`boundingbox`: [ $x_1, y_1, x_2, y_2$ ] user coordinates of the  
upper left and bottom right corner

`zoomX`, `zoomY`: zoom factor in *x/y*-axis direction

`zoomfactor`: overall zoom factor in both directions

`axis:true/false`: show axes

`grid:true/false`: show grid

*Properties and methods of the board:*

`brd.snapToGrid:true/false`: grid mode

`brd.suspendUpdate()` stop updating (if speed is needed)

`brd.unsuspendUpdate()` restart updating

## Basic commands

```
var el = brd.createElement('type',[parents],[attributes]);
el.setProperty({key1:value1,key2:value2,...});
```

## Point

```
brd.createElement('point',[parents],[attributes]);
```

### Parent elements:

[*x*,*y*] Euclidean coordinates

[*z*,*x*,*y*] Homogeneous coordinates (*z* in first place)

[`function()`{`return` *p*1.*X()*;}],

`function()`{`return` *p*2.*Y()*;}] Functions for *x*,*y*, (and *z*)

### Methods

*p*.*X()*, *p*.*Y()* *x*-coordinate, *y*-coordinate  
*p*.*Z()* (Homogeneous) *z*-coordinate  
*p*.*Dist*(*q*) Distance from *p* to point *q*

## Glider

Point on circle, line, curve, or turtle.

```
brd.createElement('glider',[parents],[attributes]);
```

### Parent elements:

[*x*,*y*,*c*] Initial coordinates and object to glide on  
[*c*] Object to glide on (initially at origin)

Coordinates may also be defined by functions, see Point.

## Line

```
brd.createElement('line',[parents],[attributes]);
```

### Parent elements:

[*p*1,*p*2] line through 2 points  
[*c*,*a*,*b*] line defined by 3 coordinates (can also be functions)  
[[*x*1,*y*1],[*x*2,*y*2]] line by 2 coordinate pairs

In case of coordinates as parents, the line is the set of solutions of the equation  $a \cdot x + b \cdot y + c \cdot z = 0$ .

## Circle

```
brd.createElement('circle',[parents],[attributes]);
```

### Parent elements:

[*p*1,*p*2] 2 points: center and point on circle line  
[*p*,*r*] center, radius (constant or function)  
[*p*,*c*],[*c*,*p*] center, circle from which the radius is taken  
[*p*,*l*],[*l*,*p*] center, line segment for the radius  
[*p*1,*p*2,*p*3] circle through 3 points  
Points may also be specified as array of coordinates.

## Polygon

```
brd.createElement('polygon',[p1,p2,...],[attributes]);
[p1,p2,...] The array of points
is connected by line segments and the inner area is filled.
```

## Slider

```
var s = brd.createElement('slider',
    [[a,b],[c,d],[e,f,g]],{atts});
[a,b],[c,d]: visual start and end position of the slider
[e,f,g]: the slider returns values between e and g,
the initial position is at value f
s.Value(): returns the position of the slider  $\in [e,g]$ 
```

## Group

```
brd.createElement('group',[p1,p2,...],[attributes]);
[p1,p2,...] array of points
Invisible grouping of points. If one point is moved, the others
are transformed accordingly.
```

## Curve

```
- brd.createElement('functiongraph',[parents],[atts]);
Function graph,  $x \mapsto f(x)$ 
```

```
[function(x){return x*x;},-1,1] function term
optional: start, end
```

```
- brd.createElement('curve',[parents],[attributes]);
· Parameter curve,  $t \mapsto (f(t), g(t))$ :
```

```
[function(t){return 5*t;},function(t){return t*t;},0,2]
x function, y function, optional: start, end
```

· *Polar curve*: Defined by the equation  $r = f(\phi)$ .

```
[function(phi){return 5*phi;},[1,2],0,Math.PI]
Defining function, optional: center, start, end
```

· *Data plot*:

```
[[1,2,3],[4,-2,3]] array of x- and y-coordinates, or
[[1,2,3],function(x){return x*x;}]
array of x-coordinates, function term
```

```
- brd.createElement('spline',[p1,p2,...],[attributes]);
[p1,p2,...] Cubic spline: array of points
```

```
- brd.createElement('riemannsum',[f,n,type],[atts]);
Riemann sum of type 'left', 'right', 'middle', 'trapezodial', 'upper', or 'lower'
```

## Tangent, normal

```
var el = brd.createElement('tangent',[g],[attributes]);
var el = brd.createElement('normal',[g],[attributes]);
g circle, line, polygon, curve, or turtle to glide on
```

## Turtle

```
var t = brd.createElement('turtle',[parents],[atts]);
t.pos[], t.dir position, direction (in degrees) of the turtle.
```

### Parent elements:

[*x*,*y*,*angle*] Optional start values for *x*, *y*, and direction

### Methods:

```
t.back(len); or t.bk(len);
t.clean(); erase the turtle lines without resetting the turtle
t.clearScreen(); or t.cs(); call t.home() and t.clean()
t.forward(len); t.fd(len);
t.hideTurtle(); or t.ht();
t.home(); Set the turtle to [0,0] and direction to 90.
t.left(angle); or t.lt(angle);
t.lookTo(t2.pos); Turtle looks to the turtle t2
t.lookTo([x,y]); Turtle looks to a coordinate pair
t.moveTo([x,y]); Move the turtle with drawing
t.penDown(); or t.pd();
t.penUp(); or t.pu();
t.popTurtle(); pop turtle status from stack
t.pushTurtle(); push turtle status on stack
t.right(angle); or t.rt(angle);
t.setPos(x,y); Move the turtle without drawing
t.setPenColor(col); col: colorString, e.g. 'red' or '#ff0000'
t.setPenSize(size); size: number
t.showTurtle(); or t.st();
```

## Other geometric elements

– *angle*: filled area defined by 3 points  
`el = brd.createElement('angle', [A,B,C], {attributes});`

– *arc*: circular arc defined by 3 points  
`el = brd.createElement('arc', [A,B,C], {attributes});`

– *arrow*: line through 2 points with arrow head  
`el = brd.createElement('arrow', [A,B], {attributes});`

– *arrowparallel*: arrow parallel to arrow  $a$  starting at point  $P$   
`el = brd.createElement('arrowparallel', [a,P], {atts});`  
`el = brd.createElement('arrowparallel', [P,a], {atts});`

– *bisector*: angular bisector defined by 3 points, returns line  
`el = brd.createElement('bisector', [A,B,C], {atts});`

– *circumcircle*: circle through 3 points (deprecated)  
`el = brd.createElement('circumcircle', [A,B,C], {atts});`

– *circumcirclemidpoint*: center of circle through 3 points  
`el = brd.createElement('circumcirclemidpoint', [A,B,C]);`

– *midpoint*: midpoint between 2 points or the 2 points defined by a line  
`el = brd.createElement('midpoint', [A,B], {atts});`  
`el = brd.createElement('midpoint', [line], {atts});`

– *mirrorpoint*: rotate point  $B$  around point  $A$  by  $180^\circ$   
`el = brd.createElement('mirrorpoint', [A,B], {atts});`

– *parallel*: line parallel to line  $l$  through point  $P$   
`el = brd.createElement('parallel', [l,P], {atts});`  
`el = brd.createElement('parallel', [P,l], {atts});`

– *parallelpoin*t: point  $D$  such that  $ABCD$  from a parallelogram  
`el = brd.createElement('parallelpoin', [A,B,C], {atts});`

– *perpendicular*: line perpendicular to line  $l$  through point  $P$   
`el = brd.createElement('perpendicular', [l,P], {atts});`  
`el = brd.createElement('perpendicular', [P,l], {atts});`

– *perpendicularpoint*: point defining a perpendicular line to line  $l$  through point  $P$   
`el = brd.createElement('perpendicularpoint', [l,P], {});`  
`el = brd.createElement('perpendicularpoint', [P,l], {});`

– *reflection*: reflection of point  $P$  over the line  $l$ . Superseded by transformations  
`el = brd.createElement('reflection', [l,P], {atts});`  
`el = brd.createElement('reflection', [P,l], {atts});`

– *sector*: circle sector defined by 3 points ???  
`el = brd.createElement('sector', [A,B,C], {atts});`

## Text

Display static or dynamic texts.

```
el = brd.createElement('text', [x,y,"Hello"]);
el = brd.createElement('text', [x,y,f]);
```

Example for a dynamic text: return the  $x$  coordinate of the point  $p$ .

```
f = function(){ return p.X(); }
```

## Attributes of geometric elements

Generic attributes:

`strokeWidth`: number  
`strokeColor,fillColor,highlightFillColor,`  
`highlightStrokeColor,labelColor`: color string  
`strokeOpacity,fillOpacity,highlightFillOpacity,`  
`highlightStrokeOpacity`: value between 0 and 1  
`visible,trace,draft`: true, false  
`dash`: dash style for lines: 0,1,...,6

Attributes for point elements:

`style`: point style: 0,1,...,12  
`fixed`: true, false

Attributes for line elements:

`straightFirst,straightLast,withTicks`: true, false

Attributes for line and arc elements:

`firstArrow,lastArrow`: true, false

Attributes for polygons elements:

`withLines`: true, false

## Transform

Affine transformation of objects.

`t = brd.createElement('transform', [data,base], {type:'type'});`  
`base`: the transformation is applied to the coordinates of this object.

Possible types:

– translate: `data=[x,y]`

– scale: `data=[x,y]`

– reflect: `data=[line]` or `[x1,y1,x2,y2]`

– rotate: `data=[angle,point]` or `[angle,x,y]`

– shear: `data=[angle]`

– generic: `data=[v11,v12,v13,v21,...,v33]`  $3 \times 3$  matrix

Methods:

`t.bindTo(p)` the coordinates of  $p$  are defined by  $t$   
`t.applyOnce(p)` apply the transformation once  
`t.melt(s)` combine two transformations to one:  $t := t \cdot s$

## Mathematical functions

Functions of the intrinsic JavaScript object *Math*:

`Math.abs,Math.acos,Math.asin,Math.atan,Math.ceil,`  
`Math.cos,Math.exp,Math.floor,Math.log,Math.max,`  
`Math.min,Math.random,Math.sin,Math.sqrt,Math.tan`

`(number).toFixed(3)`: Rounding a number to fixed precision

Additional mathematical functions are methods of `JXG.Board`.

`brd.angle(A,B,C)` angle  $ABC$

`brd.cosh(x), board.sinh(x)`

`brd.pow(a,b)`  $a^b$

`brd.D(f,x)` compute  $\frac{d}{dx}f$  numerically

`brd.I([a,b],f)` compute  $\int_a^b f(x)dx$  numerically

`brd.root(f,x)` root of the function  $f$ .

Uses Newton method with start value  $x$

`brd.factorial(n)` computes  $n! = 1 \cdot 2 \cdot 3 \cdots n$

`brd.binomial(n,k)` computes  $\binom{n}{k}$

`brd.distance(arr1,arr2)` Euclidean distance

`brd.lagrangePolynomial([p1,p2,...])`

returns a polynomial through the given points

`brd.neville([p1,p2,...])` polynomial curve interpolation

`brd.riemannsum(f,n,type,start,end)` Volume of Riemann

sum, see *Curves*

– Intersection of objects:

`brd.intersection(el1,el2,i,j)` intersection of the elements

$el_1$  and  $el_2$  which can be lines, circles or curves

In case of circle and line intersection,  $i \in \{0,1\}$  denotes the first or second intersection. In case of an intersection with a curve,  $i$  and  $j$  are floats which are the start values for the path positions in the Newton method for  $el_1$  and  $el_2$ , resp.

## Todo list

'axis', 'image', 'integral', 'ticks'.

## Chart

To do ...

## Links

Help pages are available at <http://jsxgraph.org>