JSXGraph Reference Card

Include JSXGraph in HTML

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

Include files:

Two files have to be included: `jsxgraph.css`, and `jsxgraph-core.js`.

```
- <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

boundingbox:	$[x_1, y_1, x_2, y_2]$ user coordinates of the upper left and bottom right corner
keepaspectratio:true/false	default: false
zoomX,zoomY:	zoom factor in x/y-axis direction
zoomfactor:	overall zoom factor in both directions
axis,grid,showNavigation,showCopyright:	true/false

show axis, grid, zoom/navigation buttons, display copyright

Properties and methods of the board:

brd.snapToGrid:true/false:	grid mode
brd.suspendUpdate()	stop updating (if speed is needed)
brd.unsuspendUpdate()	restart updating
brd.addChild(brd2)	Connect board brd2 to board brd

Basic commands

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

Point

```
brd.create('point',[parents],{attributes});
```

Parent elements:

[x,y]	Euclidean coordinates
[z,x,y]	Homogeneous coordinates (z in first place)
[function(){return p1.X();}, function(){return p2.Y();}]	Functions for x, y, (and z)
[function(){return [a,b];}]	Function returning array
[function(){return new JXG.Coords(...);}]	Function returning Coords object

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.create('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.create('line',[parents],{attributes});
```

Parent elements:

[p1,p2]	line through 2 points
[c,a,b]	line defined by 3 coordinates (can also be functions)
[[x1,y1],[x2,y2]]	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.create('circle',[parents],{attributes});
```

Parent elements:

[p1,p2]	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
[p1,p2,p3]	circle through 3 points

Points may also be specified as array of coordinates.

Polygon

```
brd.create('polygon',[p1,p2,...],{attributes});
```

[p1,p2,...]	The array of points

is connected by line segments and the inner area is filled.

```
brd.create('regularpolygon',[p1,p2,n],{attributes});
```

Slider

```
var s = brd.create('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
snapWidth:num	minimum distance between 2 values
s.Value():	returns the position of the slider $\in [e, g]$

Group

```
brd.create('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.create('functiongraph',[parents],{atts});
```

Function graph, $x \mapsto f(x)$

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

```
– brd.create('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.create('spline',[p1,p2,...],{attributes});
```

[p1,p2,...]	*Cubic spline:* array of points

```
– brd.create('riemannsum',[f,n,type],{atts});
```

Riemann sum of type 'left', 'right', 'middle', 'trapezodial', 'upper', or 'lower'

Tangent, normal

```
var el = brd.create('tangent',[g],{attributes});
var el = brd.create('normal',[g],{attributes});
```

g	glider on circle, line, polygon, curve, or turtle

Turtle

```
var t = brd.create('turtle',[parents],{atts});
```

t.X(), t.Y(), t.dir	position, direction (degrees).

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.create('angle',[A,B,C],{attributes});
```
– *arc:* circular arc defined by 3 points
```
el = brd.create('arc',[A,B,C],{attributes});
```
– *arrow:* line through 2 points with arrow head
```
el = brd.create('arrow',[A,B],{attributes});
```
– *arrowparallel:* arrow parallel to arrow a starting at point P
```
el = brd.create('arrowparallel',[a,P],{atts}); or [P,a]
```
– *bisector:* angular bisector defined by 3 points, returns line
```
el = brd.create('bisector',[A,B,C],{atts});
```
angular bisector defined by 2 lines, returns 2 lines
```
el = brd.create('bisectorlines',[l1,l2],{atts});
```
– *circumcircle:* circle through 3 points (deprecated)
```
el = brd.create('circumcircle',[A,B,C],{atts});
```
– *circumcirclemidpoint:* center of circle through 3 points
```
el = brd.create('circumcirclemidpoint',[A,B,C]);
```
– *midpoint:* midpoint between 2 points or the 2 points defined by a line
```
el = brd.create('midpoint',[A,B],{atts}); or [line]
```
– *mirrorpoint:* rotate point B around point A by 180°
```
el = brd.create('mirrorpoint',[A,B],{atts});
```
– *parallel:* line parallel to line l through point P
```
el = brd.create('parallel',[l,P],{atts}); or [P,l]
```
– *parallelpoint:* point D such that $ABCD$ from a parallelogram
```
el = brd.create('parallelpoint',[A,B,C],{atts});
```
– *perpendicular:* line perpendicular to line l through point P
```
el = brd.create('perpendicular',[l,P],{atts}); or [P,l]
```
– *perpendicularpoint:* point defining a perpendicular line to line l through point P
```
el = brd.create('perpendicularpoint',[l,P],{}); or [P,l]
```
– *reflection:* reflection of point P over the line l. Superseded by transformations
```
el = brd.create('reflection',[l,P],{atts}); or [P,l]
```
– *sector:* circle sector defined by 3 points ???
```
el = brd.create('sector',[A,B,C],{atts});
```
– *semi circle:* defined by 2 points p_1 and p_2.
```
brd.create('semicircle',[p1,p2],{atts});
```
– *intersection:* of 2 objects (lines or circles).
Returns array of length 2 with first and second intersection point (also for line/line intersection).
```
brd.create('intersection',[o1,o2,n],{atts});
```

Text

Display static or dynamic texts.
```
el = brd.create('text',[x,y,"Hello"]);
el = brd.create('text',[x,y,f]);     where
f = function(){ return p.X(); }
```
Example for a dynamic text: f returns the x coordinate of the point p.

Image

Display bitmap image (also as data uri).
```
el = brd.create('image',[uri-string,[x,y],[w,h]]);
   [x,y]: position of lower left corner, [w,h]: width, height
```

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:
```
face:    possible point faces: '[]', 'o', 'x', '+', '<', '>', 'A', 'v'
size:                                 number
fixed:                                true, false
```
Attributes for line elements:
```
straightFirst,straightLast,withTicks:true, false
```
Attributes for line, arc and curve elements:
```
firstArrow,lastArrow:                 true, false
```
Attributes for polygon elements:
```
withLines:                            true, false
```
Attributes for text elements:
```
display:                         'html', 'internal'
```
Color string:

HTML color definition or HSV color scheme:
```
JXG.hsv2rgb(h,s,v)        0 ≤ h ≤ 360, 0 ≤ s,v ≤ 1
                         returns RGB color string.
```

Transform

Affine transformation of objects.
```
t = brd.create('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]` 3×3 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 · s
p2 = brd.create('point',[p1,t],{fixed:true});
```
Point p_2: apply t on point p_1

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

`c = JXG.Math.Numerics.bezier([p1,p2,...])`   Bezier curve
$p_2, p_3, p_5, p_6, \ldots$ are control points. `brd.create('curve',c);`

`f = JXG.Math.Numerics.regressionPolynomial(n,xArr,yArr)`
Regression pol. of deg. n: `brd.create('functiongraph',f);`

`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', 'integral', 'ticks'.

Chart

To do . . .

Links

Help pages are available at `http://jsxgraph.org`