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 `jsxgraphcore.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 b = JXG.JSXGraph.initBoard('box',{axis:true});
<script>
```

Initializing the board

`var b = 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:

`b.snapToGrid:true/false:`	grid mode
`b.suspendUpdate()`	stop updating (if speed is needed)
`b.unsuspendUpdate()`	restart updating
`b.addChild(b2)`	Connect board `b2` to board `b`

Basic commands

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

Point

`b.create('point',[parents],{atts});`

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.

`b.create('glider',[parents],{atts});`

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

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

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

`b.create('circle',[parents],{atts});`

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

`b.create('polygon',[p1,p2,...],{atts});`

`[p1,p2,...]` The array of points is connected by line segments and the inner area is filled.

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

Slider

`var s = b.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

`b.create('group',[p1,p2,...],{atts});`

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

Invisible grouping of points. If one point is moved, the others are transformed accordingly.

Curve

– `b.create('functiongraph',[parents],{atts});`
Function graph, $x \mapsto f(x)$

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

– `b.create('curve',[parents],{atts});`

· *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

– `b.create('spline',[p1,p2,...],{atts});`
`[p1,p2,...]` *Cubic spline:* array of points

– `b.create('riemannsum',[f,n,type],{atts});`
Riemann sum of type 'left', 'right', 'middle', 'trapezodial', 'upper', or 'lower'

– `b.create('integral',[[a,b],f],{atts});`
Display the area $\int_a^b f(x)dx$.

Tangent, normal

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

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

Conic sections

– *ellipse, hyperbola:* defined by the two foci points and a point on the conic section or the length of the major axis.

```
b.create('ellipse',[p1,p2,p3],{atts});
b.create('ellipse',[p1,p2,a],{atts});
b.create('hyperbola',[p1,p2,p3],{atts});
b.create('hyperbola',[p1,p2,a],{atts});
```

– *parabola:* defined by the focus and the directrix (line).

`b.create('parabola',[p1,line],{atts});`

– *conic section:* defined by 5 points or by the (symmetric) quadratic form

$$(x,y,z)\begin{pmatrix} a_{00} & a_{01} & a_{02} \\ a_{01} & a_{11} & a_{12} \\ a_{02} & a_{12} & a_{22} \end{pmatrix}(x,y,z)^\top$$

`b.create('conic',[p1,...,p5],{atts});`
`b.create('conic',[`a_{00}`,`a_{11}`,`a_{22}`,`a_{01}`,`a_{02}`,`a_{12}`],{atts});`

Turtle

`var t = b.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();`

Text

Display static or dynamic texts.

```
el = b.create('text',[x,y,"Hello"]);
el = b.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 = b.create('image',[uri-string,[x,y],[w,h]]);`
`[x,y]`: position of lower left corner, `[w,h]`: width, height

Other geometric elements

– *angle:* filled area defined by 3 points
`el = b.create('angle',[M,B,C],{atts});`

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

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

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

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

angular bisector defined by 2 lines, returns 2 lines
`el = b.create('bisectorlines',[l1,l2],{atts});`

– *incircle:* incircle of triangle defined by 3 points
`el = b.create('incircle',[A,B,C],{atts});`

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

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

– *circumcircle arc:* circular arc defined by 3 points
`el = b.create('circumcirclearc',[A,B,C],{atts});`

– *midpoint:* midpoint between 2 points or the 2 points defined by a line

– *circumcircle sector:* circular sector defined by 3 points
`el = b.create('circumcirclesector',[A,B,C],{atts});`

`el = b.create('midpoint',[A,B],{atts}); or [line]`

– *mirrorpoint:* rotate point B around point A by 180°
`el = b.create('mirrorpoint',[A,B],{atts});`

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

– *parallelpoint:* point D such that $ABCD$ from a parallelogram
`el = b.create('parallelpoint',[A,B,C],{atts});`

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

– *perpendicularpoint:* orthogonal projection of P onto l
`el = b.create('orthogonalprojection',[l,P],{}); or [P,l]`

– *reflection:* reflection of point P over the line l. Superseded by transformations

`el = b.create('reflection',[l,P],{atts}); or [P,l]`

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

– *semi circle:* defined by 2 points p_1 and p_2.
`b.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).

`b.create('intersection',[o1,o2,n],{atts});`

Transform

Affine transformation of points, images and texts.

`t = b.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: $t := t \cdot s$
`p2 = b.create('point',[p1,t],{fixed:true});`
Point p_2: apply t on point p_1

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: $0, 1, \ldots, 6$
`infoboxtext:`	string

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)` $0 \leq h \leq 360$, $0 \leq s, v \leq 1$
returns RGB color string.

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`.

`b.angle(A,B,C)` angle ABC
`b.cosh(x), board.sinh(x)`
`b.pow(a,b)` a^b
`b.D(f,x)` compute $\frac{d}{dx}f$ numerically
`b.I([a,b],f)` compute $\int_a^b f(x)dx$ numerically
`b.root(f,x)` root of the function f.
Uses Newton method with start value x
`b.factorial(n)` computes $n! = 1 \cdot 2 \cdot 3 \cdots n$
`b.binomial(n,k)` computes $\binom{n}{k}$
`b.distance(arr1,arr2)` Euclidean distance
`b.lagrangePolynomial([p1,p2,...])`
returns a polynomial through the given points
`b.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. `b.create('curve',c);`
`c = JXG.Math.Numerics.bspline([p1,p2,...],order)` B-spline curve
`f = JXG.Math.Numerics.regressionPolynomial(n,xArr,yArr)`
Regression pol. of deg. n: `b.create('functiongraph',f);`
`b.riemannsum(f,n,type,start,end)` Area of Riemann sum, see *Curves*

– Intersection of objects:

`b.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', 'ticks'.

Chart

To do . . .

Links

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