

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.Distance(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', 'trapezoidal', 'upper', or 'lower'

– `brd.create('integral',[[a,b],f],[atts]);`

Display the area $\int_a^b f(x)dx$.

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

Conic sections

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

`brd.create('ellipse',[p1,p2,p3],[attributes]);`
`brd.create('ellipse',[p1,p2,a],[attributes]);`
`brd.create('hyperbola',[p1,p2,p3],[attributes]);`
`brd.create('hyperbola',[p1,p2,a],[attributes]);`

– *parabola:* defined by the focus and the directrix (line).
`brd.create('parabola',[p1,line],[attributes]);`

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

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

`brd.create('conic',[p1,...,p5],[atts]);`
`brd.create('conic',[a00,a11,a22,a01,a02,a12],[atts]);`

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);` or `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.

`e1 = brd.create('text', [x,y,"Hello"]);`
`e1 = 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).

`e1 = brd.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
`e1 = brd.create('angle', [M,B,C], {attributes});`
– *arc*: circular arc defined by 3 points
`e1 = brd.create('arc', [A,B,C], {attributes});`
– *arrow*: line through 2 points with arrow head
`e1 = brd.create('arrow', [A,B], {attributes});`
– *arrowparallel*: arrow parallel to arrow a starting at point P
`e1 = brd.create('arrowparallel', [a,P], {atts});` or `[P,a]`
– *bisector*: angular bisector defined by 3 points, returns line
`e1 = brd.create('bisector', [A,B,C], {atts});`
angular bisector defined by 2 lines, returns 2 lines
`e1 = brd.create('bisectorlines', [l1,l2], {atts});`
– *circumcircle*: circle through 3 points (deprecated)
`e1 = brd.create('circumcircle', [A,B,C], {atts});`
– *circumcirclemidpoint*: center of circle through 3 points
`e1 = brd.create('circumcirclemidpoint', [A,B,C]);`
– *circumcircle arc*: circular arc defined by 3 points
`e1 = brd.create('circumcirclearc', [A,B,C], {attributes});`
– *midpoint*: midpoint between 2 points or the 2 points defined by a line
– *circumcircle sector*: circular sector defined by 3 points
`e1 = brd.create('circumcirclesector', [A,B,C], {attributes});`
`e1 = brd.create('midpoint', [A,B], {atts});` or `[line]`
– *mirrorpoint*: rotate point B around point A by 180°
`e1 = brd.create('mirrorpoint', [A,B], {atts});`
– *parallel*: line parallel to line l through point P
`e1 = brd.create('parallel', [l,P], {atts});` or `[P,l]`
– *parallelpoin*t: point D such that $ABCD$ from a parallelogram
`e1 = brd.create('parallelpoin', [A,B,C], {atts});`
– *perpendicular*: line perpendicular to line l through point P
`e1 = brd.create('perpendicular', [l,P], {atts});` or `[P,l]`
– *perpendicularpoint*: point defining a perpendicular line to line l through point P
`e1 = brd.create('perpendicularpoint', [l,P], {});` or `[P,l]`
– *reflection*: reflection of point P over the line l . Superseded by transformations
`e1 = brd.create('reflection', [l,P], {atts});` or `[P,l]`
– *sector*: circle sector defined by 3 points ???
`e1 = 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});`

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: $t := t \cdot s$
`p2 = brd.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,...,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`.

`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

$p_2, p_3, p_5, p_6, \dots$ are control points. `brd.create('curve',c);`

`c = JXG.Math.Numerics.bspline([p1,p2,...],depth)` B-spline curve

`f = JXG.Math.Numerics.regressionPolynomial(n,xArr,yArr)`

Regression pol. of deg. n : `brd.create('functiongraph',f);`

`brd.riemannsum(f,n,type,start,end)` Area 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', 'ticks'.

Chart

To do ...

Links

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