# The canvas element

interface **HTMLCanvasElement** : [HTMLElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlelement) {

attribute unsigned long [width](http://www.whatwg.org/specs/web-apps/current-work/#width1);

attribute unsigned long [height](http://www.whatwg.org/specs/web-apps/current-work/#height1);

DOMString [toDataURL](http://www.whatwg.org/specs/web-apps/current-work/#todataurl)();

DOMString [toDataURL](http://www.whatwg.org/specs/web-apps/current-work/#todataurl0)(in DOMString type, [Variadic] in any args);

DOMObject [getContext](http://www.whatwg.org/specs/web-apps/current-work/#getcontext)(in DOMString contextId);

};

The [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element represents a resolution-dependent bitmap canvas, which can be used for rendering graphs, game graphics, or other visual images on the fly.

Authors should not use the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element in a document when a more suitable element is available. For example, it is inappropriate to use a [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element to render a page heading: if the desired presentation of the heading is graphically intense, it should be marked up using appropriate elements (typically [h1](http://www.whatwg.org/specs/web-apps/current-work/#h1)) and then styled using CSS and supporting technologies such as XBL.

When authors use the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element, they should also provide content that, when presented to the user, conveys essentially the same function or purpose as the bitmap canvas. This content may be placed as content of the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element. The contents of the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element, if any, are the element's [fallback content](http://www.whatwg.org/specs/web-apps/current-work/#fallback).

In interactive visual media, if the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element is [with script](http://www.whatwg.org/specs/web-apps/current-work/#with-script), the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element represents an embedded element with a dynamically created image.

In non-interactive, static, visual media, if the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element has been previously painted on (e.g. if the page was viewed in an interactive visual medium and is now being printed, or if some script that ran during the page layout process painted on the element), then the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element represents [embedded content](http://www.whatwg.org/specs/web-apps/current-work/#embedded1) with the current image and size. Otherwise, the element represents its [fallback content](http://www.whatwg.org/specs/web-apps/current-work/#fallback) instead.

In non-visual media, and in visual media if the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element is [without script](http://www.whatwg.org/specs/web-apps/current-work/#without), the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element represents its [fallback content](http://www.whatwg.org/specs/web-apps/current-work/#fallback) instead.

The [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element has two attributes to control the size of the coordinate space: **width** and **height**. These attributes, when specified, must have values that are [valid non-negative integers](http://www.whatwg.org/specs/web-apps/current-work/#valid). The [rules for parsing non-negative integers](http://www.whatwg.org/specs/web-apps/current-work/#rules) must be used to obtain their numeric values. If an attribute is missing, or if parsing its value returns an error, then the default value must be used instead. The [width](http://www.whatwg.org/specs/web-apps/current-work/#width0) attribute defaults to 300, and the [height](http://www.whatwg.org/specs/web-apps/current-work/#height0) attribute defaults to 150.

The intrinsic dimensions of the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element equal the size of the coordinate space, with the numbers interpreted in CSS pixels. However, the element can be sized arbitrarily by a style sheet. During rendering, the image is scaled to fit this layout size.

The size of the coordinate space does not necessarily represent the size of the actual bitmap that the user agent will use internally or during rendering. On high-definition displays, for instance, the user agent may internally use a bitmap with two device pixels per unit in the coordinate space, so that the rendering remains at high quality throughout.

Whenever the [width](http://www.whatwg.org/specs/web-apps/current-work/#width0) and [height](http://www.whatwg.org/specs/web-apps/current-work/#height0) attributes are set (whether to a new value or to the previous value), the bitmap and any associated contexts must be cleared back to their initial state and reinitialized with the newly specified coordinate space dimensions.

The **width** and **height** DOM attributes must [reflect](http://www.whatwg.org/specs/web-apps/current-work/#reflect) the content attributes of the same name.

Only one square appears to be drawn in the following example:

// canvas is a reference to a <canvas> element

var context = canvas.getContext('2d');

context.fillRect(0,0,50,50);

canvas.setAttribute('width', '300'); // clears the canvas

context.fillRect(0,100,50,50);

canvas.width = canvas.width; // clears the canvas

context.fillRect(100,0,50,50); // only this square remains

When the canvas is initialized it must be set to fully transparent black.

To draw on the canvas, authors must first obtain a reference to a **context** using the **getContext(*contextId*)** method of the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element.

This specification only defines one context, with the name "[2d](http://www.whatwg.org/specs/web-apps/current-work/#d)". If [getContext()](http://www.whatwg.org/specs/web-apps/current-work/#getcontext) is called with that exact string for its *contextId* argument, then the UA must return a reference to an object implementing [CanvasRenderingContext2D](http://www.whatwg.org/specs/web-apps/current-work/#canvasrenderingcontext2d). Other specifications may define their own contexts, which would return different objects.

Vendors may also define experimental contexts using the syntax *vendorname*-*context*, for example, moz-3d.

When the UA is passed an empty string or a string specifying a context that it does not support, then it must return null. String comparisons must be [case-sensitive](http://www.whatwg.org/specs/web-apps/current-work/#case-sensitive).

Arguments other than the *contextId* must be ignored.

***A future version of this specification will probably define a 3d context (probably based on the OpenGL ES API).***

The **toDataURL()** method must, when called with no arguments, return a data: URL containing a representation of the image as a PNG file. [[PNG]](http://www.whatwg.org/specs/web-apps/current-work/#refsPNG).

If the canvas has no pixels (i.e. either its horizontal dimension or its vertical dimension is zero) then the method must return the string "data:,". (This is the shortest data: URL; it represents the empty string in a text/plain resource.)

The **toDataURL(*type*)** method (when called with one *or more* arguments) must return a data: URL containing a representation of the image in the format given by *type*. The possible values are MIME types with no parameters, for example image/png, image/jpeg, or even maybe image/svg+xml if the implementation actually keeps enough information to reliably render an SVG image from the canvas.

For image types that do not support an alpha channel, the image must be composited onto a solid black background using the source-over operator, and the resulting image must be the one used to create the data: URL.

Only support for image/png is required. User agents may support other types. If the user agent does not support the requested type, it must return the image using the PNG format.

User agents must convert the provided type to lower case before establishing if they support that type and before creating the data: URL.

***When trying to use types other than image/png, authors can check if the image was really returned in the requested format by checking to see if the returned string starts with one the exact strings "data:image/png," or "data:image/png;". If it does, the image is PNG, and thus the requested type was not supported. (The one exception to this is if the canvas has either no height or no width, in which case the result might simply be "data:,".)***

If the method is invoked with the first argument giving a type corresponding to one of the types given in the first column of the following table, and the user agent supports that type, then the subsequent arguments, if any, must be treated as described in the second cell of that row.

| **Type** | **Other arguments** |
| --- | --- |
| image/jpeg | The second argument, if it is a number between 0.0 and 1.0, must be treated as the desired quality level. If it is not a number or is outside that range, the user agent must use its default value, as if the argument had been omitted. |

Other arguments must be ignored and must not cause the user agent to raise an exception. A future version of this specification will probably define other parameters to be passed to [toDataURL()](http://www.whatwg.org/specs/web-apps/current-work/#todataurl) to allow authors to more carefully control compression settings, image metadata, etc.

## The 2D context

When the [getContext()](http://www.whatwg.org/specs/web-apps/current-work/#getcontext) method of a [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element is invoked with **2d** as the argument, a [CanvasRenderingContext2D](http://www.whatwg.org/specs/web-apps/current-work/#canvasrenderingcontext2d) object is returned.

There is only one [CanvasRenderingContext2D](http://www.whatwg.org/specs/web-apps/current-work/#canvasrenderingcontext2d) object per canvas, so calling the [getContext()](http://www.whatwg.org/specs/web-apps/current-work/#getcontext) method with the [2d](http://www.whatwg.org/specs/web-apps/current-work/#d) argument a second time must return the same object.

The 2D context represents a flat Cartesian surface whose origin (0,0) is at the top left corner, with the coordinate space having *x* values increasing when going right, and *y* values increasing when going down.

interface **CanvasRenderingContext2D** {

// back-reference to the canvas

readonly attribute [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas0);

// state

void [save](http://www.whatwg.org/specs/web-apps/current-work/#save)(); // push state on state stack

void [restore](http://www.whatwg.org/specs/web-apps/current-work/#restore)(); // pop state stack and restore state

// transformations (default transform is the identity matrix)

void [scale](http://www.whatwg.org/specs/web-apps/current-work/#scale)(in float x, in float y);

void [rotate](http://www.whatwg.org/specs/web-apps/current-work/#rotate)(in float angle);

void [translate](http://www.whatwg.org/specs/web-apps/current-work/#translate)(in float x, in float y);

void [transform](http://www.whatwg.org/specs/web-apps/current-work/#transform)(in float m11, in float m12, in float m21, in float m22, in float dx, in float dy);

void [setTransform](http://www.whatwg.org/specs/web-apps/current-work/#settransform)(in float m11, in float m12, in float m21, in float m22, in float dx, in float dy);

// compositing

attribute float [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha); // (default 1.0)

attribute DOMString [globalCompositeOperation](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation); // (default source-over)

// colors and styles

attribute DOMObject [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle); // (default black)

attribute DOMObject [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle); // (default black)

[CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) [createLinearGradient](http://www.whatwg.org/specs/web-apps/current-work/#createlineargradient)(in float x0, in float y0, in float x1, in float y1);

[CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) [createRadialGradient](http://www.whatwg.org/specs/web-apps/current-work/#createradialgradient)(in float x0, in float y0, in float r0, in float x1, in float y1, in float r1);

[CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) [createPattern](http://www.whatwg.org/specs/web-apps/current-work/#createpattern)(in [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) image, in DOMString repetition);

[CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) [createPattern](http://www.whatwg.org/specs/web-apps/current-work/#createpattern)(in [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) image, in DOMString repetition);

// line caps/joins

attribute float [lineWidth](http://www.whatwg.org/specs/web-apps/current-work/#linewidth); // (default 1)

attribute DOMString [lineCap](http://www.whatwg.org/specs/web-apps/current-work/#linecap); // "butt", "round", "square" (default "butt")

attribute DOMString [lineJoin](http://www.whatwg.org/specs/web-apps/current-work/#linejoin); // "round", "bevel", "miter" (default "miter")

attribute float [miterLimit](http://www.whatwg.org/specs/web-apps/current-work/#miterlimit); // (default 10)

// shadows

attribute float [shadowOffsetX](http://www.whatwg.org/specs/web-apps/current-work/#shadowoffsetx); // (default 0)

attribute float [shadowOffsetY](http://www.whatwg.org/specs/web-apps/current-work/#shadowoffsety); // (default 0)

attribute float [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur); // (default 0)

attribute DOMString [shadowColor](http://www.whatwg.org/specs/web-apps/current-work/#shadowcolor); // (default transparent black)

// rects

void [clearRect](http://www.whatwg.org/specs/web-apps/current-work/#clearrect)(in float x, in float y, in float w, in float h);

void [fillRect](http://www.whatwg.org/specs/web-apps/current-work/#fillrect)(in float x, in float y, in float w, in float h);

void [strokeRect](http://www.whatwg.org/specs/web-apps/current-work/#strokerect)(in float x, in float y, in float w, in float h);

// path API

void [beginPath](http://www.whatwg.org/specs/web-apps/current-work/#beginpath)();

void [closePath](http://www.whatwg.org/specs/web-apps/current-work/#closepath)();

void [moveTo](http://www.whatwg.org/specs/web-apps/current-work/#moveto)(in float x, in float y);

void [lineTo](http://www.whatwg.org/specs/web-apps/current-work/#lineto)(in float x, in float y);

void [quadraticCurveTo](http://www.whatwg.org/specs/web-apps/current-work/#quadraticcurveto)(in float cpx, in float cpy, in float x, in float y);

void [bezierCurveTo](http://www.whatwg.org/specs/web-apps/current-work/#beziercurveto)(in float cp1x, in float cp1y, in float cp2x, in float cp2y, in float x, in float y);

void [arcTo](http://www.whatwg.org/specs/web-apps/current-work/#arcto)(in float x1, in float y1, in float x2, in float y2, in float radius);

void [rect](http://www.whatwg.org/specs/web-apps/current-work/#rectx)(in float x, in float y, in float w, in float h);

void [arc](http://www.whatwg.org/specs/web-apps/current-work/#arcx-)(in float x, in float y, in float radius, in float startAngle, in float endAngle, in boolean anticlockwise);

void [fill](http://www.whatwg.org/specs/web-apps/current-work/#fill)();

void [stroke](http://www.whatwg.org/specs/web-apps/current-work/#stroke)();

void [clip](http://www.whatwg.org/specs/web-apps/current-work/#clip)();

boolean [isPointInPath](http://www.whatwg.org/specs/web-apps/current-work/#ispointinpath)(in float x, in float y);

// text

attribute DOMString [font](http://www.whatwg.org/specs/web-apps/current-work/#font); // (default 10px sans-serif)

attribute DOMString [textAlign](http://www.whatwg.org/specs/web-apps/current-work/#textalign); // "start", "end", "left", "right", "center" (default: "start")

attribute DOMString [textBaseline](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline); // "top", "hanging", "middle", "alphabetic", "ideographic", "bottom" (default: "alphabetic")

void [fillText](http://www.whatwg.org/specs/web-apps/current-work/#filltext)(in DOMString text, in float x, in float y);

void [fillText](http://www.whatwg.org/specs/web-apps/current-work/#filltext)(in DOMString text, in float x, in float y, in float maxWidth);

void [strokeText](http://www.whatwg.org/specs/web-apps/current-work/#stroketext)(in DOMString text, in float x, in float y);

void [strokeText](http://www.whatwg.org/specs/web-apps/current-work/#stroketext)(in DOMString text, in float x, in float y, in float maxWidth);

[TextMetrics](http://www.whatwg.org/specs/web-apps/current-work/#textmetrics) [measureText](http://www.whatwg.org/specs/web-apps/current-work/#measuretext)(in DOMString text);

// drawing images

void [drawImage](http://www.whatwg.org/specs/web-apps/current-work/#drawimage)(in [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) image, in float dx, in float dy);

void [drawImage](http://www.whatwg.org/specs/web-apps/current-work/#drawimage)(in [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) image, in float dx, in float dy, in float dw, in float dh);

void [drawImage](http://www.whatwg.org/specs/web-apps/current-work/#drawimage)(in [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) image, in float sx, in float sy, in float sw, in float sh, in float dx, in float dy, in float dw, in float dh);

void [drawImage](http://www.whatwg.org/specs/web-apps/current-work/#drawimage)(in [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) image, in float dx, in float dy);

void [drawImage](http://www.whatwg.org/specs/web-apps/current-work/#drawimage)(in [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) image, in float dx, in float dy, in float dw, in float dh);

void [drawImage](http://www.whatwg.org/specs/web-apps/current-work/#drawimage)(in [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) image, in float sx, in float sy, in float sw, in float sh, in float dx, in float dy, in float dw, in float dh);

// pixel manipulation

[ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) [createImageData](http://www.whatwg.org/specs/web-apps/current-work/#createimagedata)(in float sw, in float sh);

[ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) [getImageData](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata)(in float sx, in float sy, in float sw, in float sh);

void [putImageData](http://www.whatwg.org/specs/web-apps/current-work/#putimagedata)(in [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) imagedata, in float dx, in float dy);

void [putImageData](http://www.whatwg.org/specs/web-apps/current-work/#putimagedata0)(in [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) imagedata, in float dx, in float dy, in float dirtyX, in float dirtyY, in float dirtyWidth, in float dirtyHeight);

};

interface **CanvasGradient** {

// opaque object

void [addColorStop](http://www.whatwg.org/specs/web-apps/current-work/#addcolorstop)(in float offset, in DOMString color);

};

interface **CanvasPattern** {

// opaque object

};

interface **TextMetrics** {

readonly attribute float [width](http://www.whatwg.org/specs/web-apps/current-work/#width2);

};

interface **ImageData** {

readonly attribute unsigned long int [width](http://www.whatwg.org/specs/web-apps/current-work/#width3);

readonly attribute unsigned long int [height](http://www.whatwg.org/specs/web-apps/current-work/#height2);

readonly attribute [CanvasPixelArray](http://www.whatwg.org/specs/web-apps/current-work/#canvaspixelarray) [data](http://www.whatwg.org/specs/web-apps/current-work/#data1);

};

interface **CanvasPixelArray** {

readonly attribute unsigned long [length](http://www.whatwg.org/specs/web-apps/current-work/#length5);

[IndexGetter] octet [XXX5](http://www.whatwg.org/specs/web-apps/current-work/#xxx5index)(in unsigned long index);

[IndexSetter] void [XXX6](http://www.whatwg.org/specs/web-apps/current-work/#xxx6index)(in unsigned long index, in octet value);

};

The **canvas** attribute must return the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element that the context paints on.

Unless otherwise stated, for the 2D context interface, any method call with a numeric argument whose value is infinite or a NaN value must be ignored.

Whenever the CSS value currentColor is used as a color in this API, the "computed value of the 'color' property" for the purposes of determining the computed value of the currentColor keyword is the computed value of the 'color' property on the element in question at the time that the color is specified (e.g. when the appropriate attribute is set, or when the method is called; not when the color is rendered or otherwise used). If the computed value of the 'color' property is undefined for a particular case (e.g. because the element is not in a document), then the "computed value of the 'color' property" for the purposes of determining the computed value of the currentColor keyword is fully opaque black.

### The canvas state

Each context maintains a stack of drawing states. **Drawing states** consist of:

The current [transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0).

The current [clipping region](http://www.whatwg.org/specs/web-apps/current-work/#clipping).

The current values of the following attributes: [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle), [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle), [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha), [lineWidth](http://www.whatwg.org/specs/web-apps/current-work/#linewidth), [lineCap](http://www.whatwg.org/specs/web-apps/current-work/#linecap), [lineJoin](http://www.whatwg.org/specs/web-apps/current-work/#linejoin), [miterLimit](http://www.whatwg.org/specs/web-apps/current-work/#miterlimit), [shadowOffsetX](http://www.whatwg.org/specs/web-apps/current-work/#shadowoffsetx), [shadowOffsetY](http://www.whatwg.org/specs/web-apps/current-work/#shadowoffsety), [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur), [shadowColor](http://www.whatwg.org/specs/web-apps/current-work/#shadowcolor), [globalCompositeOperation](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation), [font](http://www.whatwg.org/specs/web-apps/current-work/#font), [textAlign](http://www.whatwg.org/specs/web-apps/current-work/#textalign), [textBaseline](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline).

***The current path and the current bitmap are not part of the drawing state. The current path is persistent, and can only be reset using the*** [***beginPath()***](http://www.whatwg.org/specs/web-apps/current-work/#beginpath) ***method. The current bitmap is a property of the canvas, not the context.***

The **save()** method must push a copy of the current drawing state onto the drawing state stack.

The **restore()** method must pop the top entry in the drawing state stack, and reset the drawing state it describes. If there is no saved state, the method must do nothing.

### Transformations

The transformation matrix is applied to coordinates when creating shapes and paths.

When the context is created, the transformation matrix must initially be the identity transform. It may then be adjusted using the transformation methods.

The transformations must be performed in reverse order. For instance, if a scale transformation that doubles the width is applied, followed by a rotation transformation that rotates drawing operations by a quarter turn, and a rectangle twice as wide as it is tall is then drawn on the canvas, the actual result will be a square.

The **scale(*x*, *y*)** method must add the scaling transformation described by the arguments to the transformation matrix. The *x* argument represents the scale factor in the horizontal direction and the *y* argument represents the scale factor in the vertical direction. The factors are multiples.

The **rotate(*angle*)** method must add the rotation transformation described by the argument to the transformation matrix. The *angle* argument represents a clockwise rotation angle expressed in radians.

The **translate(*x*, *y*)** method must add the translation transformation described by the arguments to the transformation matrix. The *x* argument represents the translation distance in the horizontal direction and the *y* argument represents the translation distance in the vertical direction. The arguments are in coordinate space units.

The **transform(*m11*, *m12*, *m21*, *m22*, *dx*, *dy*)** method must multiply the current transformation matrix with the matrix described by:

|  |  |  |
| --- | --- | --- |
| *m11* | *m21* | *dx* |
| *m12* | *m22* | *dy* |
| 0 | 0 | 1 |

The **setTransform(*m11*, *m12*, *m21*, *m22*, *dx*, *dy*)** method must reset the current transform to the identity matrix, and then invoke the [transform](http://www.whatwg.org/specs/web-apps/current-work/#transform)(*m11*, *m12*, *m21*, *m22*, *dx*, *dy*) method with the same arguments.

### Compositing

All drawing operations are affected by the global compositing attributes, [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha) and [globalCompositeOperation](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation).

The **globalAlpha** attribute gives an alpha value that is applied to shapes and images before they are composited onto the canvas. The value must be in the range from 0.0 (fully transparent) to 1.0 (no additional transparency). If an attempt is made to set the attribute to a value outside this range, the attribute must retain its previous value. When the context is created, the [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha) attribute must initially have the value 1.0.

The **globalCompositeOperation** attribute sets how shapes and images are drawn onto the existing bitmap, once they have had [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha) and the current transformation matrix applied. It must be set to a value from the following list. In the descriptions below, the source image, *A*, is the shape or image being rendered, and the destination image, *B*, is the current state of the bitmap.

***source-atop***

*A* atop *B*. Display the source image wherever both images are opaque. Display the destination image wherever the destination image is opaque but the source image is transparent. Display transparency elsewhere.

***source-in***

*A* in *B*. Display the source image wherever both the source image and destination image are opaque. Display transparency elsewhere.

***source-out***

*A* out *B*. Display the source image wherever the source image is opaque and the destination image is transparent. Display transparency elsewhere.

***source-over* (default)**

*A* over *B*. Display the source image wherever the source image is opaque. Display the destination image elsewhere.

***destination-atop***

*B* atop *A*. Same as [source-atop](http://www.whatwg.org/specs/web-apps/current-work/#source-atop) but using the destination image instead of the source image and vice versa.

***destination-in***

*B* in *A*. Same as [source-in](http://www.whatwg.org/specs/web-apps/current-work/#source-in) but using the destination image instead of the source image and vice versa.

***destination-out***

*B* out *A*. Same as [source-out](http://www.whatwg.org/specs/web-apps/current-work/#source-out) but using the destination image instead of the source image and vice versa.

***destination-over***

*B* over *A*. Same as [source-over](http://www.whatwg.org/specs/web-apps/current-work/#source-over) but using the destination image instead of the source image and vice versa.

***lighter***

*A* plus *B*. Display the sum of the source image and destination image, with color values approaching 1 as a limit.

***copy***

*A* (*B* is ignored). Display the source image instead of the destination image.

***xor***

*A* xor *B*. Exclusive OR of the source image and destination image.

***vendorName*-*operationName***

Vendor-specific extensions to the list of composition operators should use this syntax.

These values are all case-sensitive — they must be used exactly as shown. User agents must not recognize values that are not a [case-sensitive](http://www.whatwg.org/specs/web-apps/current-work/#case-sensitive) match for one of the values given above.

The operators in the above list must be treated as described by the Porter-Duff operator given at the start of their description (e.g. *A* over *B*). [[PORTERDUFF]](http://www.whatwg.org/specs/web-apps/current-work/#refsPORTERDUFF)

On setting, if the user agent does not recognize the specified value, it must be ignored, leaving the value of [globalCompositeOperation](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation) unaffected.

When the context is created, the [globalCompositeOperation](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation) attribute must initially have the value source-over.

### Colors and styles

The **strokeStyle** attribute represents the color or style to use for the lines around shapes, and the **fillStyle** attribute represents the color or style to use inside the shapes.

Both attributes can be either strings, [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient)s, or [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern)s. On setting, strings must be parsed as CSS <color> values and the color assigned, and [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) and [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) objects must be assigned themselves. If the value is a string but is not a valid color, or is neither a string, a [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient), nor a [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern), then it must be ignored, and the attribute must retain its previous value.

On getting, if the value is a color, then the [serialization of the color](http://www.whatwg.org/specs/web-apps/current-work/#serialization) must be returned. Otherwise, if it is not a color but a [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) or [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern), then the respective object must be returned. (Such objects are opaque and therefore only useful for assigning to other attributes or for comparison to other gradients or patterns.)

The **serialization of a color** for a color value is a string, computed as follows: if it has alpha equal to 1.0, then the string is a lowercase six-digit hex value, prefixed with a "#" character (U+0023 NUMBER SIGN), with the first two digits representing the red component, the next two digits representing the green component, and the last two digits representing the blue component, the digits being in the range 0-9 a-f (U+0030 to U+0039 and U+0061 to U+0066). Otherwise, the color value has alpha less than 1.0, and the string is the color value in the CSS rgba() functional-notation format: the literal string rgba (U+0072 U+0067 U+0062 U+0061) followed by a U+0028 LEFT PARENTHESIS, a base-ten integer in the range 0-255 representing the red component (using digits 0-9, U+0030 to U+0039, in the shortest form possible), a literal U+002C COMMA and U+0020 SPACE, an integer for the green component, a comma and a space, an integer for the blue component, another comma and space, a U+0030 DIGIT ZERO, a U+002E FULL STOP (representing the decimal point), one or more digits in the range 0-9 (U+0030 to U+0039) representing the fractional part of the alpha value, and finally a U+0029 RIGHT PARENTHESIS.

When the context is created, the [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle) and [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle) attributes must initially have the string value #000000.

There are two types of gradients, linear gradients and radial gradients, both represented by objects implementing the opaque [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) interface.

Once a gradient has been created (see below), stops are placed along it to define how the colors are distributed along the gradient. The color of the gradient at each stop is the color specified for that stop. Between each such stop, the colors and the alpha component must be linearly interpolated over the RGBA space without premultiplying the alpha value to find the color to use at that offset. Before the first stop, the color must be the color of the first stop. After the last stop, the color must be the color of the last stop. When there are no stops, the gradient is transparent black.

The **addColorStop(*offset*, *color*)** method on the [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) interface adds a new stop to a gradient. If the *offset* is less than 0, greater than 1, infinite, or NaN, then an INDEX\_SIZE\_ERR exception must be raised. If the *color* cannot be parsed as a CSS color, then a SYNTAX\_ERR exception must be raised. Otherwise, the gradient must have a new stop placed, at offset *offset* relative to the whole gradient, and with the color obtained by parsing *color* as a CSS <color> value. If multiple stops are added at the same offset on a gradient, they must be placed in the order added, with the first one closest to the start of the gradient, and each subsequent one infinitesimally further along towards the end point (in effect causing all but the first and last stop added at each point to be ignored).

The **createLinearGradient(*x0*, *y0*, *x1*, *y1*)** method takes four arguments that represent the start point (*x0*, *y0*) and end point (*x1*, *y1*) of the gradient. If any of the arguments to [createLinearGradient()](http://www.whatwg.org/specs/web-apps/current-work/#createlineargradient) are infinite or NaN, the method must raise a NOT\_SUPPORTED\_ERR exception. Otherwise, the method must return a linear [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) initialized with the specified line.

Linear gradients must be rendered such that all points on a line perpendicular to the line that crosses the start and end points have the color at the point where those two lines cross (with the colors coming from the [interpolation and extrapolation](http://www.whatwg.org/specs/web-apps/current-work/#interpolation) described above). The points in the linear gradient must be transformed as described by the [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0) when rendering.

If *x0* = *x1* and *y0* = *y1*, then the linear gradient must paint nothing.

The **createRadialGradient(*x0*, *y0*, *r0*, *x1*, *y1*, *r1*)** method takes six arguments, the first three representing the start circle with origin (*x0*, *y0*) and radius *r0*, and the last three representing the end circle with origin (*x1*, *y1*) and radius *r1*. The values are in coordinate space units. If any of the arguments are infinite or NaN, a NOT\_SUPPORTED\_ERR exception must be raised. If either of *r0* or *r1* are negative, an INDEX\_SIZE\_ERR exception must be raised. Otherwise, the method must return a radial [CanvasGradient](http://www.whatwg.org/specs/web-apps/current-work/#canvasgradient) initialized with the two specified circles.

Radial gradients must be rendered by following these steps:

If *x0* = *x1* and *y0* = *y1* and *r0* = *r1*, then the radial gradient must paint nothing. Abort these steps.

Let x(*ω*) = (*x1*-*x0*)*ω* + *x0*

Let y(*ω*) = (*y1*-*y0*)*ω* + *y0*

Let r(*ω*) = (*r1*-*r0*)*ω* + *r0*

Let the color at *ω* be the color at that position on the gradient (with the colors coming from the [interpolation and extrapolation](http://www.whatwg.org/specs/web-apps/current-work/#interpolation) described above).

For all values of *ω* where r(*ω*) > 0, starting with the value of *ω* nearest to positive infinity and ending with the value of *ω* nearest to negative infinity, draw the circumference of the circle with radius r(*ω*) at position (x(*ω*), y(*ω*)), with the color at *ω*, but only painting on the parts of the canvas that have not yet been painted on by earlier circles in this step for this rendering of the gradient.

***This effectively creates a cone, touched by the two circles defined in the creation of the gradient, with the part of the cone before the start circle (0.0) using the color of the first offset, the part of the cone after the end circle (1.0) using the color of the last offset, and areas outside the cone untouched by the gradient (transparent black).***

Gradients must be painted only where the relevant stroking or filling effects requires that they be drawn.

The points in the radial gradient must be transformed as described by the [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0) when rendering.

Patterns are represented by objects implementing the opaque [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) interface.

To create objects of this type, the **createPattern(*image*, *repetition*)** method is used. The first argument gives the image to use as the pattern (either an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) or an [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement)). Modifying this image after calling the [createPattern()](http://www.whatwg.org/specs/web-apps/current-work/#createpattern) method must not affect the pattern. The second argument must be a string with one of the following values: repeat, repeat-x, repeat-y, no-repeat. If the empty string or null is specified, repeat must be assumed. If an unrecognized value is given, then the user agent must raise a SYNTAX\_ERR exception. User agents must recognize the four values described above exactly (e.g. they must not do case folding). The method must return a [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) object suitably initialized.

The *image* argument must be an instance of an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) or [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement). If the *image* is of the wrong type or null, the implementation must raise a TYPE\_MISMATCH\_ERR exception.

If the *image* argument is an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) object whose [complete](http://www.whatwg.org/specs/web-apps/current-work/#complete) attribute is false, then the implementation must raise an INVALID\_STATE\_ERR exception.

If the *image* argument is an [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) object with either a horizontal dimension or a vertical dimension equal to zero, then the implementation must raise an INVALID\_STATE\_ERR exception.

Patterns must be painted so that the top left of the first image is anchored at the origin of the coordinate space, and images are then repeated horizontally to the left and right (if the repeat-x string was specified) or vertically up and down (if the repeat-y string was specified) or in all four directions all over the canvas (if the repeat string was specified). The images are not scaled by this process; one CSS pixel of the image must be painted on one coordinate space unit. Of course, patterns must actually be painted only where the stroking or filling effect requires that they be drawn, and are affected by the current transformation matrix.

When the [createPattern()](http://www.whatwg.org/specs/web-apps/current-work/#createpattern) method is passed, as its *image* argument, an animated image, the poster frame of the animation, or the first frame of the animation if there is no poster frame, must be used.

### Line styles

The **lineWidth** attribute gives the width of lines, in coordinate space units. On setting, zero, negative, infinite, and NaN values must be ignored, leaving the value unchanged.

When the context is created, the [lineWidth](http://www.whatwg.org/specs/web-apps/current-work/#linewidth) attribute must initially have the value 1.0.

The **lineCap** attribute defines the type of endings that UAs will place on the end of lines. The three valid values are butt, round, and square. The butt value means that the end of each line has a flat edge perpendicular to the direction of the line (and that no additional line cap is added). The round value means that a semi-circle with the diameter equal to the width of the line must then be added on to the end of the line. The square value means that a rectangle with the length of the line width and the width of half the line width, placed flat against the edge perpendicular to the direction of the line, must be added at the end of each line. On setting, any other value than the literal strings butt, round, and square must be ignored, leaving the value unchanged.

When the context is created, the [lineCap](http://www.whatwg.org/specs/web-apps/current-work/#linecap) attribute must initially have the value butt.

The **lineJoin** attribute defines the type of corners that UAs will place where two lines meet. The three valid values are bevel, round, and miter.

On setting, any other value than the literal strings bevel, round, and miter must be ignored, leaving the value unchanged.

When the context is created, the [lineJoin](http://www.whatwg.org/specs/web-apps/current-work/#linejoin) attribute must initially have the value miter.

A join exists at any point in a subpath shared by two consecutive lines. When a subpath is closed, then a join also exists at its first point (equivalent to its last point) connecting the first and last lines in the subpath.

In addition to the point where the join occurs, two additional points are relevant to each join, one for each line: the two corners found half the line width away from the join point, one perpendicular to each line, each on the side furthest from the other line.

A filled triangle connecting these two opposite corners with a straight line, with the third point of the triangle being the join point, must be rendered at all joins. The [lineJoin](http://www.whatwg.org/specs/web-apps/current-work/#linejoin) attribute controls whether anything else is rendered. The three aforementioned values have the following meanings:

The bevel value means that this is all that is rendered at joins.

The round value means that a filled arc connecting the two aforementioned corners of the join, abutting (and not overlapping) the aforementioned triangle, with the diameter equal to the line width and the origin at the point of the join, must be rendered at joins.

The miter value means that a second filled triangle must (if it can given the miter length) be rendered at the join, with one line being the line between the two aforementioned corners, abutting the first triangle, and the other two being continuations of the outside edges of the two joining lines, as long as required to intersect without going over the miter length.

The miter length is the distance from the point where the lines touch on the inside of the join to the intersection of the line edges on the outside of the join. The miter limit ratio is the maximum allowed ratio of the miter length to half the line width. If the miter length would cause the miter limit ratio to be exceeded, this second triangle must not be rendered.

The miter limit ratio can be explicitly set using the **miterLimit** attribute. On setting, zero, negative, infinite, and NaN values must be ignored, leaving the value unchanged.

When the context is created, the [miterLimit](http://www.whatwg.org/specs/web-apps/current-work/#miterlimit) attribute must initially have the value 10.0.

### Shadows

All drawing operations are affected by the four global shadow attributes.

The **shadowColor** attribute sets the color of the shadow.

When the context is created, the [shadowColor](http://www.whatwg.org/specs/web-apps/current-work/#shadowcolor) attribute initially must be fully-transparent black.

On getting, the [serialization of the color](http://www.whatwg.org/specs/web-apps/current-work/#serialization) must be returned.

On setting, the new value must be parsed as a CSS <color> value and the color assigned. If the value is not a valid color, then it must be ignored, and the attribute must retain its previous value.

The **shadowOffsetX** and **shadowOffsetY** attributes specify the distance that the shadow will be offset in the positive horizontal and positive vertical distance respectively. Their values are in coordinate space units. They are not affected by the current transformation matrix.

When the context is created, the shadow offset attributes must initially have the value 0.

On getting, they must return their current value. On setting, the attribute being set must be set to the new value, except if the value is infinite or NaN, in which case the new value must be ignored.

The **shadowBlur** attribute specifies the size of the blurring effect. (The units do not map to coordinate space units, and are not affected by the current transformation matrix.)

When the context is created, the [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur) attribute must initially have the value 0.

On getting, the attribute must return its current value. On setting the attribute must be set to the new value, except if the value is negative, infinite or NaN, in which case the new value must be ignored.

When shadows are drawn, they must be rendered as follows:

Let *A* be the source image for which a shadow is being created.

Let *B* be an infinite transparent black bitmap, with a coordinate space and an origin identical to *A*.

Copy the alpha channel of *A* to *B*, offset by [shadowOffsetX](http://www.whatwg.org/specs/web-apps/current-work/#shadowoffsetx) in the positive *x* direction, and [shadowOffsetY](http://www.whatwg.org/specs/web-apps/current-work/#shadowoffsety) in the positive *y* direction.

If [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur) is greater than 0:

If [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur) is less than 8, let *σ* be half the value of [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur); otherwise, let *σ* be the square root of multiplying the value of [shadowBlur](http://www.whatwg.org/specs/web-apps/current-work/#shadowblur) by 2.

Perform a 2D Gaussian Blur on *B*, using *σ* as the standard deviation.

User agents may limit values of *σ* to an implementation-specific maximum value to avoid exceeding hardware limitations during the Gaussian blur operation.

Set the red, green, and blue components of every pixel in *B* to the red, green, and blue components (respectively) of the color of [shadowColor](http://www.whatwg.org/specs/web-apps/current-work/#shadowcolor).

Multiply the alpha component of every pixel in *B* by the alpha component of the color of [shadowColor](http://www.whatwg.org/specs/web-apps/current-work/#shadowcolor).

The shadow is in the bitmap *B*, and is rendered as part of the drawing model described below.

### Simple shapes (rectangles)

There are three methods that immediately draw rectangles to the bitmap. They each take four arguments; the first two give the *x* and *y* coordinates of the top left of the rectangle, and the second two give the width *w* and height *h* of the rectangle, respectively.

The [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0) must be applied to the following four coordinates, which form the path that must then be closed to get the specified rectangle: (*x*, *y*), (*x*+*w*, *y*), (*x*+*w*, *y*+*h*), (*x*, *y*+*h*).

Shapes are painted without affecting the current path, and are subject to the [clipping region](http://www.whatwg.org/specs/web-apps/current-work/#clipping), and, with the exception of [clearRect()](http://www.whatwg.org/specs/web-apps/current-work/#clearrect), also [shadow effects](http://www.whatwg.org/specs/web-apps/current-work/#shadows0), [global alpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha), and [global composition operators](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation).

The **clearRect(*x*, *y*, *w*, *h*)** method must clear the pixels in the specified rectangle that also intersect the current clipping region to a fully transparent black, erasing any previous image. If either height or width are zero, this method has no effect.

The **fillRect(*x*, *y*, *w*, *h*)** method must paint the specified rectangular area using the [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle). If either height or width are zero, this method has no effect.

The **strokeRect(*x*, *y*, *w*, *h*)** method must stroke the specified rectangle's path using the [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle), [lineWidth](http://www.whatwg.org/specs/web-apps/current-work/#linewidth), [lineJoin](http://www.whatwg.org/specs/web-apps/current-work/#linejoin), and (if appropriate) [miterLimit](http://www.whatwg.org/specs/web-apps/current-work/#miterlimit) attributes. If both height and width are zero, this method has no effect, since there is no path to stroke (it's a point). If only one of the two is zero, then the method will draw a line instead (the path for the outline is just a straight line along the non-zero dimension).

### Complex shapes (paths)

The context always has a current path. There is only one current path, it is not part of the drawing state.

A **path** has a list of zero or more subpaths. Each subpath consists of a list of one or more points, connected by straight or curved lines, and a flag indicating whether the subpath is closed or not. A closed subpath is one where the last point of the subpath is connected to the first point of the subpath by a straight line. Subpaths with fewer than two points are ignored when painting the path.

Initially, the context's path must have zero subpaths.

The points and lines added to the path by these methods must be transformed according to the [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0) as they are added.

The **beginPath()** method must empty the list of subpaths so that the context once again has zero subpaths.

The **moveTo(*x*, *y*)** method must create a new subpath with the specified point as its first (and only) point.

The **closePath()** method must do nothing if the context has no subpaths. Otherwise, it must mark the last subpath as closed, create a new subpath whose first point is the same as the previous subpath's first point, and finally add this new subpath to the path. (If the last subpath had more than one point in its list of points, then this is equivalent to adding a straight line connecting the last point back to the first point, thus "closing" the shape, and then repeating the last [moveTo()](http://www.whatwg.org/specs/web-apps/current-work/#moveto) call.)

New points and the lines connecting them are added to subpaths using the methods described below. In all cases, the methods only modify the last subpath in the context's paths.

The **lineTo(*x*, *y*)** method must do nothing if the context has no subpaths. Otherwise, it must connect the last point in the subpath to the given point (*x*, *y*) using a straight line, and must then add the given point (*x*, *y*) to the subpath.

The **quadraticCurveTo(*cpx*, *cpy*, *x*, *y*)** method must do nothing if the context has no subpaths. Otherwise it must connect the last point in the subpath to the given point (*x*, *y*) using a quadratic Bézier curve with control point (*cpx*, *cpy*), and must then add the given point (*x*, *y*) to the subpath. [[BEZIER]](http://www.whatwg.org/specs/web-apps/current-work/#refsBEZIER)

The **bezierCurveTo(*cp1x*, *cp1y*, *cp2x*, *cp2y*, *x*, *y*)** method must do nothing if the context has no subpaths. Otherwise, it must connect the last point in the subpath to the given point (*x*, *y*) using a cubic Bézier curve with control points (*cp1x*, *cp1y*) and (*cp2x*, *cp2y*). Then, it must add the point (*x*, *y*) to the subpath. [[BEZIER]](http://www.whatwg.org/specs/web-apps/current-work/#refsBEZIER)

The **arcTo(*x1*, *y1*, *x2*, *y2*, *radius*)** method must do nothing if the context has no subpaths. If the context *does* have a subpath, then the behavior depends on the arguments and the last point in the subpath.

Negative values for *radius* must cause the implementation to raise an INDEX\_SIZE\_ERR exception.

Let the point (*x0*, *y0*) be the last point in the subpath.

If the point (*x0*, *y0*) is equal to the point (*x1*, *y1*), or if the point (*x1*, *y1*) is equal to the point (*x2*, *y2*), or if the radius *radius* is zero, then the method must add the point (*x1*, *y1*) to the subpath, and connect that point to the previous point (*x0*, *y0*) by a straight line.

Otherwise, if the points (*x0*, *y0*), (*x1*, *y1*), and (*x2*, *y2*) all lie on a single straight line, then: if the direction from (*x0*, *y0*) to (*x1*, *y1*) is the same as the direction from (*x1*, *y1*) to (*x2*, *y2*), then the method must add the point (*x1*, *y1*) to the subpath, and connect that point to the previous point (*x0*, *y0*) by a straight line; otherwise, the direction from (*x0*, *y0*) to (*x1*, *y1*) is the opposite of the direction from (*x1*, *y1*) to (*x2*, *y2*), and the method must add a point (*x∞*, *y∞*) to the subpath, and connect that point to the previous point (*x0*, *y0*) by a straight line, where (*x∞*, *y∞*) is the point that is infinitely far away from (*x1*, *y1*), that lies on the same line as (*x0*, *y0*), (*x1*, *y1*), and (*x2*, *y2*), and that is on the same side of (*x1*, *y1*) on that line as (*x2*, *y2*).

Otherwise, let *The Arc* be the shortest arc given by circumference of the circle that has radius *radius*, and that has one point tangent to the half-infinite line that crosses the point (*x0*, *y0*) and ends at the point (*x1*, *y1*), and that has a different point tangent to the half-infinite line that ends at the point (*x1*, *y1*) and crosses the point (*x2*, *y2*). The points at which this circle touches these two lines are called the start and end tangent points respectively.

The method must connect the point (*x0*, *y0*) to the start tangent point by a straight line, adding the start tangent point to the subpath, and then must connect the start tangent point to the end tangent point by *The Arc*, adding the end tangent point to the subpath.

The **arc(*x*, *y*, *radius*, *startAngle*, *endAngle*, *anticlockwise*)** method draws an arc. If the context has any subpaths, then the method must add a straight line from the last point in the subpath to the start point of the arc. In any case, it must draw the arc between the start point of the arc and the end point of the arc, and add the start and end points of the arc to the subpath. The arc and its start and end points are defined as follows:

Consider a circle that has its origin at (*x*, *y*) and that has radius *radius*. The points at *startAngle* and *endAngle* along this circle's circumference, measured in radians clockwise from the positive x-axis, are the start and end points respectively.

If the *anticlockwise* argument is false and *endAngle*-*startAngle* is equal to or greater than 2π, or, if the *anticlockwise* argument is *true* and *startAngle*-*endAngle* is equal to or greater than 2π, then the arc is the whole circumference of this circle.

Otherwise, the arc is the path along the circumference of this circle from the start point to the end point, going anti-clockwise if the *anticlockwise* argument is true, and clockwise otherwise. Since the points are on the circle, as opposed to being simply angles from zero, the arc can never cover an angle greater than 2π radians. If the two points are the same, or if the radius is zero, then the arc is defined as being of zero length in both directions.

Negative values for *radius* must cause the implementation to raise an INDEX\_SIZE\_ERR exception.

The **rect(*x*, *y*, *w*, *h*)** method must create a new subpath containing just the four points (*x*, *y*), (*x*+*w*, *y*), (*x*+*w*, *y*+*h*), (*x*, *y*+*h*), with those four points connected by straight lines, and must then mark the subpath as closed. It must then create a new subpath with the point (*x*, *y*) as the only point in the subpath.

The **fill()** method must fill all the subpaths of the current path, using [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle), and using the non-zero winding number rule. Open subpaths must be implicitly closed when being filled (without affecting the actual subpaths).

***Thus, if two overlapping but otherwise independent subpaths have opposite windings, they cancel out and result in no fill. If they have the same winding, that area just gets painted once.***

The **stroke()** method must calculate the strokes of all the subpaths of the current path, using the [lineWidth](http://www.whatwg.org/specs/web-apps/current-work/#linewidth), [lineCap](http://www.whatwg.org/specs/web-apps/current-work/#linecap), [lineJoin](http://www.whatwg.org/specs/web-apps/current-work/#linejoin), and (if appropriate) [miterLimit](http://www.whatwg.org/specs/web-apps/current-work/#miterlimit) attributes, and then fill the combined stroke area using the [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle) attribute.

***Since the subpaths are all stroked as one, overlapping parts of the paths in one stroke operation are treated as if their union was what was painted.***

Paths, when filled or stroked, must be painted without affecting the current path, and must be subject to [shadow effects](http://www.whatwg.org/specs/web-apps/current-work/#shadows0), [global alpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha), the [clipping region](http://www.whatwg.org/specs/web-apps/current-work/#clipping), and [global composition operators](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation). (Transformations affect the path when the path is created, not when it is painted, though the stroke [*style*](http://www.whatwg.org/specs/web-apps/current-work/#style1) is still affected by the transformation during painting.)

Zero-length line segments must be pruned before stroking a path. Empty subpaths must be ignored.

The **clip()** method must create a new **clipping region** by calculating the intersection of the current clipping region and the area described by the current path, using the non-zero winding number rule. Open subpaths must be implicitly closed when computing the clipping region, without affecting the actual subpaths. The new clipping region replaces the current clipping region.

When the context is initialized, the clipping region must be set to the rectangle with the top left corner at (0,0) and the width and height of the coordinate space.

The **isPointInPath(*x*, *y*)** method must return true if the point given by the *x* and *y* coordinates passed to the method, when treated as coordinates in the canvas coordinate space unaffected by the current transformation, is inside the current path as determined by the non-zero winding number rule; and must return false otherwise. Points on the path itself are considered to be inside the path. If either of the arguments is infinite or NaN, then the method must return false.

### Text

The **font** DOM attribute, on setting, must be parsed the same way as the 'font' property of CSS (but without supporting property-independent stylesheet syntax like 'inherit'), and the resulting font must be assigned to the context, with the 'line-height' component forced to 'normal'. If the new value is syntactically incorrect, then it must be ignored, without assigning a new font value. [[CSS]](http://www.whatwg.org/specs/web-apps/current-work/#refsCSS)

Font names must be interpreted in the context of the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element's stylesheets; any fonts embedded using @font-face must therefore be available. [[CSSWEBFONTS]](http://www.whatwg.org/specs/web-apps/current-work/#refsCSSWEBFONTS)

Only vector fonts should be used by the user agent; if a user agent were to use bitmap fonts then transformations would likely make the font look very ugly.

On getting, the [font](http://www.whatwg.org/specs/web-apps/current-work/#font) attribute must return the serialized form of the current font of the context. [[CSSOM]](http://www.whatwg.org/specs/web-apps/current-work/#refsCSSOM)

When the context is created, the font of the context must be set to 10px sans-serif. When the 'font-size' component is set to lengths using percentages, 'em' or 'ex' units, or the 'larger' or 'smaller' keywords, these must be interpreted relative to the computed value of the 'font-size' property of the corresponding [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element at the time that the attribute is set. When the 'font-weight' component is set to the relative values 'bolder' and 'lighter', these must be interpreted relative to the computed value of the 'font-weight' property of the corresponding [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element at the time that the attribute is set. If the computed values are undefined for a particular case (e.g. because the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element is not in a document), then the relative keywords must be interpreted relative to the normal-weight 10px sans-serif default.

The **textAlign** DOM attribute, on getting, must return the current value. On setting, if the value is one of start, end, left, right, or center, then the value must be changed to the new value. Otherwise, the new value must be ignored. When the context is created, the [textAlign](http://www.whatwg.org/specs/web-apps/current-work/#textalign) attribute must initially have the value start.

The **textBaseline** DOM attribute, on getting, must return the current value. On setting, if the value is one of [top](http://www.whatwg.org/specs/web-apps/current-work/#top), [hanging](http://www.whatwg.org/specs/web-apps/current-work/#hanging), [middle](http://www.whatwg.org/specs/web-apps/current-work/#middle), [alphabetic](http://www.whatwg.org/specs/web-apps/current-work/#alphabetic), [ideographic](http://www.whatwg.org/specs/web-apps/current-work/#ideographic), or [bottom](http://www.whatwg.org/specs/web-apps/current-work/#bottom), then the value must be changed to the new value. Otherwise, the new value must be ignored. When the context is created, the [textBaseline](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) attribute must initially have the value alphabetic.

The [textBaseline](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) attribute's allowed keywords correspond to alignment points in the font:

The top of the em square is roughly at the top of the glyphs
   in a font, the hanging baseline is where some glyphs like आ are
   anchored, the middle is half-way between the top of the em square and the
   bottom of the em square, the alphabetic baseline is where characters like
   Á, ÿ, f, and Ω are anchored, the ideographic
   baseline is where glyphs like 私 and 達 are anchored, and the
   bottom of the em square is roughly at the bottom of the glyphs in a font.
   The top and bottom of the bounding box can be far from these baselines,
   due to glyphs extending far outside the em square.

The keywords map to these alignment points as follows:

***top***

The top of the em square

***hanging***

The hanging baseline

***middle***

The middle of the em square

***alphabetic***

The alphabetic baseline

***ideographic***

The ideographic baseline

***bottom***

The bottom of the em square

The **fillText()** and **strokeText()** methods take three or four arguments, *text*, *x*, *y*, and optionally *maxWidth*, and render the given *text* at the given (*x*, *y*) coordinates ensuring that the text isn't wider than *maxWidth* if specified, using the current [font](http://www.whatwg.org/specs/web-apps/current-work/#font), [textAlign](http://www.whatwg.org/specs/web-apps/current-work/#textalign), and [textBaseline](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) values. Specifically, when the methods are called, the user agent must run the following steps:

Let *font* be the current font of the browsing context, as given by the [font](http://www.whatwg.org/specs/web-apps/current-work/#font) attribute.

Replace all the [space characters](http://www.whatwg.org/specs/web-apps/current-work/#space) in *text* with U+0020 SPACE characters.

Form a hypothetical infinitely wide CSS line box containing a single inline box containing the text *text*, with all the properties at their initial values except the 'font' property of the inline box set to *font* and the 'direction' property of the inline box set to [the directionality](http://www.whatwg.org/specs/web-apps/current-work/#the-directionality) of the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element. [[CSS]](http://www.whatwg.org/specs/web-apps/current-work/#refsCSS)

If the *maxWidth* argument was specified and the hypothetical width of the inline box in the hypothetical line box is greater than *maxWidth* CSS pixels, then change *font* to have a more condensed font (if one is available or if a reasonably readable one can be synthesized by applying a horizontal scale factor to the font) or a smaller font, and return to the previous step.

Let the *anchor point* be a point on the inline box, determined by the [textAlign](http://www.whatwg.org/specs/web-apps/current-work/#textalign) and [textBaseline](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) values, as follows:

Horizontal position:

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is left**

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is start and** [**the directionality**](http://www.whatwg.org/specs/web-apps/current-work/#the-directionality) **of the** [**canvas**](http://www.whatwg.org/specs/web-apps/current-work/#canvas) **element is 'ltr'**

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is end and** [**the directionality**](http://www.whatwg.org/specs/web-apps/current-work/#the-directionality) **of the** [**canvas**](http://www.whatwg.org/specs/web-apps/current-work/#canvas) **element is 'rtl'**

Let the *anchor point*'s horizontal position be the left edge of the inline box.

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is right**

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is end and** [**the directionality**](http://www.whatwg.org/specs/web-apps/current-work/#the-directionality) **of the** [**canvas**](http://www.whatwg.org/specs/web-apps/current-work/#canvas) **element is 'ltr'**

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is start and** [**the directionality**](http://www.whatwg.org/specs/web-apps/current-work/#the-directionality) **of the** [**canvas**](http://www.whatwg.org/specs/web-apps/current-work/#canvas) **element is 'rtl'**

Let the *anchor point*'s horizontal position be the right edge of the inline box.

**If** [**textAlign**](http://www.whatwg.org/specs/web-apps/current-work/#textalign) **is center**

Let the *anchor point*'s horizontal position be half way between the left and right edges of the inline box.

Vertical position:

**If** [**textBaseline**](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) **is** [**top**](http://www.whatwg.org/specs/web-apps/current-work/#top)

Let the *anchor point*'s vertical position be the top of the em box of the first available font of the inline box.

**If** [**textBaseline**](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) **is** [**hanging**](http://www.whatwg.org/specs/web-apps/current-work/#hanging)

Let the *anchor point*'s vertical position be the hanging baseline of the first available font of the inline box.

**If** [**textBaseline**](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) **is** [**middle**](http://www.whatwg.org/specs/web-apps/current-work/#middle)

Let the *anchor point*'s vertical position be half way between the bottom and the top of the em box of the first available font of the inline box.

**If** [**textBaseline**](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) **is** [**alphabetic**](http://www.whatwg.org/specs/web-apps/current-work/#alphabetic)

Let the *anchor point*'s vertical position be the alphabetic baseline of the first available font of the inline box.

**If** [**textBaseline**](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) **is** [**ideographic**](http://www.whatwg.org/specs/web-apps/current-work/#ideographic)

Let the *anchor point*'s vertical position be the ideographic baseline of the first available font of the inline box.

**If** [**textBaseline**](http://www.whatwg.org/specs/web-apps/current-work/#textbaseline) **is** [**bottom**](http://www.whatwg.org/specs/web-apps/current-work/#bottom)

Let the *anchor point*'s vertical position be the bottom of the em box of the first available font of the inline box.

Paint the hypothetical inline box as the shape given by the text's glyphs, as transformed by the [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0), and anchored and sized so that before applying the [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0), the *anchor point* is at (*x*, *y*) and each CSS pixel is mapped to one coordinate space unit.

For [fillText()](http://www.whatwg.org/specs/web-apps/current-work/#filltext) [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle) must be applied to the glyphs and [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle) must be ignored. For [strokeText()](http://www.whatwg.org/specs/web-apps/current-work/#stroketext) the reverse holds and [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle) must be applied to the glyph outlines and [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle) must be ignored.

Text is painted without affecting the current path, and is subject to [shadow effects](http://www.whatwg.org/specs/web-apps/current-work/#shadows0), [global alpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha), the [clipping region](http://www.whatwg.org/specs/web-apps/current-work/#clipping), and [global composition operators](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation).

The **measureText()** method takes one argument, *text*. When the method is invoked, the user agent must replace all the [space characters](http://www.whatwg.org/specs/web-apps/current-work/#space) in *text* with U+0020 SPACE characters, and then must form a hypothetical infinitely wide CSS line box containing a single inline box containing the text *text*, with all the properties at their initial values except the 'font' property of the inline element set to the current font of the browsing context, as given by the [font](http://www.whatwg.org/specs/web-apps/current-work/#font) attribute, and must then return a new [TextMetrics](http://www.whatwg.org/specs/web-apps/current-work/#textmetrics) object with its [width](http://www.whatwg.org/specs/web-apps/current-work/#width2) attribute set to the width of that inline box, in CSS pixels. [[CSS]](http://www.whatwg.org/specs/web-apps/current-work/#refsCSS)

The [TextMetrics](http://www.whatwg.org/specs/web-apps/current-work/#textmetrics) interface is used for the objects returned from [measureText()](http://www.whatwg.org/specs/web-apps/current-work/#measuretext). It has one attribute, **width**, which is set by the [measureText()](http://www.whatwg.org/specs/web-apps/current-work/#measuretext) method.

***Glyphs rendered using*** [***fillText()***](http://www.whatwg.org/specs/web-apps/current-work/#filltext) ***and*** [***strokeText()***](http://www.whatwg.org/specs/web-apps/current-work/#stroketext) ***can spill out of the box given by the font size (the em square size) and the width returned by*** [***measureText()***](http://www.whatwg.org/specs/web-apps/current-work/#measuretext) ***(the text width). This version of the specification does not provide a way to obtain the bounding box dimensions of the text. If the text is to be rendered and removed, care needs to be taken to replace the entire area of the canvas that the clipping region covers, not just the box given by the em square height and measured text width.***

***A future version of the 2D context API may provide a way to render fragments of documents, rendered using CSS, straight to the canvas. This would be provided in preference to a dedicated way of doing multiline layout.***

### Images

To draw images onto the canvas, the **drawImage** method can be used.

This method is overloaded with three variants: drawImage(*image*, *dx*, *dy*), drawImage(*image*, *dx*, *dy*, *dw*, *dh*), and drawImage(*image*, *sx*, *sy*, *sw*, *sh*, *dx*, *dy*, *dw*, *dh*). (Actually it is overloaded with six; each of those three can take either an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) or an [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) for the *image* argument.) If not specified, the *dw* and *dh* arguments must default to the values of *sw* and *sh*, interpreted such that one CSS pixel in the image is treated as one unit in the canvas coordinate space. If the *sx*, *sy*, *sw*, and *sh* arguments are omitted, they must default to 0, 0, the image's intrinsic width in image pixels, and the image's intrinsic height in image pixels, respectively.

The *image* argument must be an instance of an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) or [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement). If the *image* is of the wrong type or null, the implementation must raise a TYPE\_MISMATCH\_ERR exception.

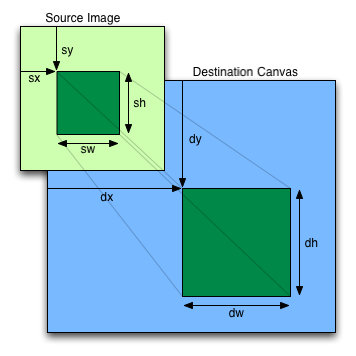
If the *image* argument is an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) object whose [complete](http://www.whatwg.org/specs/web-apps/current-work/#complete) attribute is false, then the implementation must raise an INVALID\_STATE\_ERR exception.

The source rectangle is the rectangle whose corners are the four points (*sx*, *sy*), (*sx*+*sw*, *sy*), (*sx*+*sw*, *sy*+*sh*), (*sx*, *sy*+*sh*).

If the source rectangle is not entirely within the source image, or if one of the *sw* or *sh* arguments is zero, the implementation must raise an INDEX\_SIZE\_ERR exception.

The destination rectangle is the rectangle whose corners are the four points (*dx*, *dy*), (*dx*+*dw*, *dy*), (*dx*+*dw*, *dy*+*dh*), (*dx*, *dy*+*dh*).

When [drawImage()](http://www.whatwg.org/specs/web-apps/current-work/#drawimage) is invoked, the region of the image specified by the source rectangle must be painted on the region of the canvas specified by the destination rectangle, after applying the [current transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0) to the points of the destination rectangle.



***When a canvas is drawn onto itself, the drawing model requires the source to be copied before the image is drawn back onto the canvas, so it is possible to copy parts of a canvas onto overlapping parts of itself.***

When the [drawImage()](http://www.whatwg.org/specs/web-apps/current-work/#drawimage) method is passed, as its *image* argument, an animated image, the poster frame of the animation, or the first frame of the animation if there is no poster frame, must be used.

Images are painted without affecting the current path, and are subject to [shadow effects](http://www.whatwg.org/specs/web-apps/current-work/#shadows0), [global alpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha), the [clipping region](http://www.whatwg.org/specs/web-apps/current-work/#clipping), and [global composition operators](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation).

### Pixel manipulation

The **createImageData(*sw*, *sh*)** method must return an [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) object representing a rectangle with a width in CSS pixels equal to the absolute magnitude of *sw* and a height in CSS pixels equal to the absolute magnitude of *sh*, filled with transparent black.

The **getImageData(*sx*, *sy*, *sw*, *sh*)** method must return an [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) object representing the underlying pixel data for the area of the canvas denoted by the rectangle whose corners are the four points (*sx*, *sy*), (*sx*+*sw*, *sy*), (*sx*+*sw*, *sy*+*sh*), (*sx*, *sy*+*sh*), in canvas coordinate space units. Pixels outside the canvas must be returned as transparent black. Pixels must be returned as non-premultiplied alpha values.

If any of the arguments to [createImageData()](http://www.whatwg.org/specs/web-apps/current-work/#createimagedata) or [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) are infinite or NaN, the method must instead raise a NOT\_SUPPORTED\_ERR exception. If either the *sw* or *sh* arguments are zero, the method must instead raise an INDEX\_SIZE\_ERR exception.

[ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) objects must be initialized so that their **width** attribute is set to *w*, the number of physical device pixels per row in the image data, their **height** attribute is set to *h*, the number of rows in the image data, and their **data** attribute is initialized to a [CanvasPixelArray](http://www.whatwg.org/specs/web-apps/current-work/#canvaspixelarray) object holding the image data. At least one pixel's worth of image data must be returned.

The [CanvasPixelArray](http://www.whatwg.org/specs/web-apps/current-work/#canvaspixelarray) object provides ordered, indexed access to the color components of each pixel of the image data. The data must be represented in left-to-right order, row by row top to bottom, starting with the top left, with each pixel's red, green, blue, and alpha components being given in that order for each pixel. Each component of each device pixel represented in this array must be in the range 0..255, representing the 8 bit value for that component. The components must be assigned consecutive indices starting with 0 for the top left pixel's red component.

The [CanvasPixelArray](http://www.whatwg.org/specs/web-apps/current-work/#canvaspixelarray) object thus represents *h*×*w*×4 integers. The **length** attribute of a [CanvasPixelArray](http://www.whatwg.org/specs/web-apps/current-work/#canvaspixelarray) object must return this number.

The **XXX5(*index*)** method must return the value of the *index*th component in the array.

The **XXX6(*index*, *value*)** method must set the value of the *index*th component in the array to *value*. JS undefined values must be converted to zero. Other values must first be converted to numbers using JavaScript's ToNumber algorithm, and if the result is a NaN value, then the value be must converted to zero. If the result is less than 0, it must be clamped to zero. If the result is more than 255, it must be clamped to 255. If the number is not an integer, it should be rounded to the nearest integer using the IEEE 754r *convertToIntegerTiesToEven* rounding mode. [[ECMA262]](http://www.whatwg.org/specs/web-apps/current-work/#refsECMA262) [[IEEE754R]](http://www.whatwg.org/specs/web-apps/current-work/#refsIEEE754r)

The above is not intended to cause these methods to get any unusual behaviour, it's just supposed to be the normal behaviour for passing values to a method expecting an octet type.

***The width and height (w and h) might be different from the sw and sh arguments to the above methods, e.g. if the canvas is backed by a high-resolution bitmap, or if the sw and sh arguments are negative.***

The **putImageData(*imagedata*, *dx*, *dy*)** and **putImageData(*imagedata*, *dx*, *dy*, *dirtyX*, *dirtyY*, *dirtyWidth*, *dirtyHeight*)** methods write data from [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) structures back to the canvas.

If any of the arguments to the method are infinite or NaN, the method must raise a NOT\_SUPPORTED\_ERR exception.

If the first argument to the method is null or not an [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) object then the [putImageData()](http://www.whatwg.org/specs/web-apps/current-work/#putimagedata) method must raise a TYPE\_MISMATCH\_ERR exception.

When the last four arguments are omitted, they must be assumed to have the values 0, 0, the [width](http://www.whatwg.org/specs/web-apps/current-work/#width3) member of the *imagedata* structure, and the [height](http://www.whatwg.org/specs/web-apps/current-work/#height2) member of the *imagedata* structure, respectively.

When invoked with arguments that do not, per the last few paragraphs, cause an exception to be raised, the [putImageData()](http://www.whatwg.org/specs/web-apps/current-work/#putimagedata) method must act as follows:

Let *dxdevice* be the x-coordinate of the device pixel in the underlying pixel data of the canvas corresponding to the *dx* coordinate in the canvas coordinate space.

Let *dydevice* be the y-coordinate of the device pixel in the underlying pixel data of the canvas corresponding to the *dy* coordinate in the canvas coordinate space.

If *dirtyWidth* is negative, let *dirtyX* be *dirtyX*+*dirtyWidth*, and let *dirtyWidth* be equal to the absolute magnitude of *dirtyWidth*.

If *dirtyHeight* is negative, let *dirtyY* be *dirtyY*+*dirtyHeight*, and let *dirtyHeight* be equal to the absolute magnitude of *dirtyHeight*.

If *dirtyX* is negative, let *dirtyWidth* be *dirtyWidth*+*dirtyX*, and let *dirtyX* be zero.

If *dirtyY* is negative, let *dirtyHeight* be *dirtyHeight*+*dirtyY*, and let *dirtyY* be zero.

If *dirtyX*+*dirtyWidth* is greater than the [width](http://www.whatwg.org/specs/web-apps/current-work/#width3) attribute of the *imagedata* argument, let *dirtyWidth* be the value of that [width](http://www.whatwg.org/specs/web-apps/current-work/#width3) attribute, minus the value of *dirtyX*.

If *dirtyY*+*dirtyHeight* is greater than the [height](http://www.whatwg.org/specs/web-apps/current-work/#height2) attribute of the *imagedata* argument, let *dirtyHeight* be the value of that [height](http://www.whatwg.org/specs/web-apps/current-work/#height2) attribute, minus the value of *dirtyY*.

If, after those changes, either *dirtyWidth* or *dirtyHeight* is negative or zero, stop these steps without affecting the canvas.

Otherwise, for all integer values of *x* and *y* where *dirtyX* ≤ *x* < *dirtyX*+*dirtyWidth* and *dirtyY* ≤ *y* < *dirtyY*+*dirtyHeight*, copy the four channels of the pixel with coordinate (*x*, *y*) in the *imagedata* data structure to the pixel with coordinate (*dxdevice*+*x*, *dydevice*+*y*) in the underlying pixel data of the canvas.

The handling of pixel rounding when the specified coordinates do not exactly map to the device coordinate space is not defined by this specification, except that the following must result in no visible changes to the rendering:

context.putImageData(context.getImageData(x, y, w, h), x, y);

...for any value of *x*, *y*, *w*, and *h*, and the following two calls:

context.createImageData(w, h);

context.getImageData(0, 0, w, h);

...must return [ImageData](http://www.whatwg.org/specs/web-apps/current-work/#imagedata) objects with the same dimensions, for any value of *w* and *h*. In other words, while user agents may round the arguments of these methods so that they map to device pixel boundaries, any rounding performed must be performed consistently for all of the [createImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata), [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) and [putImageData()](http://www.whatwg.org/specs/web-apps/current-work/#putimagedata) operations.

The current path, [transformation matrix](http://www.whatwg.org/specs/web-apps/current-work/#transformations0), [shadow attributes](http://www.whatwg.org/specs/web-apps/current-work/#shadows0), [global alpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha), the [clipping region](http://www.whatwg.org/specs/web-apps/current-work/#clipping), and [global composition operator](http://www.whatwg.org/specs/web-apps/current-work/#globalcompositeoperation) must not affect the [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) and [putImageData()](http://www.whatwg.org/specs/web-apps/current-work/#putimagedata) methods.

The data returned by [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) is at the resolution of the canvas backing store, which is likely to not be one device pixel to each CSS pixel if the display used is a high resolution display.

## Drawing model

When a shape or image is painted, user agents must follow these steps, in the order given (or act as if they do):

Render the shape or image, creating image A, as described in the previous sections. For shapes, the current fill, stroke, and line styles must be honored, and the stroke must itself also be subjected to the current transformation matrix.

Render the shadow from image A, using the current shadow styles, creating image B.

Multiply the alpha component of every pixel in B by [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha).

Within the clipping region, composite B over the current canvas bitmap using the current composition operator.

Multiply the alpha component of every pixel in A by [globalAlpha](http://www.whatwg.org/specs/web-apps/current-work/#globalalpha).

Within the clipping region, composite A over the current canvas bitmap using the current composition operator.

## Color spaces and color correction

The [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) APIs must perform color correction at only two points: when rendering images with their own gamma correction and color space information onto the canvas, to convert the image to the color space used by the canvas (e.g. using the [drawImage()](http://www.whatwg.org/specs/web-apps/current-work/#drawimage) method with an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) object), and when rendering the actual canvas bitmap to the output device.

Thus, in the 2D context, colors used to draw shapes onto the canvas will exactly match colors obtained through the [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) method.

The [toDataURL()](http://www.whatwg.org/specs/web-apps/current-work/#todataurl) method must not include color space information in the resource returned. Where the output format allows it, the color of pixels in resources created by [toDataURL()](http://www.whatwg.org/specs/web-apps/current-work/#todataurl) must match those returned by the [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) method.

In user agents that support CSS, the color space used by a [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element must match the color space used for processing any colors for that element in CSS.

The gamma correction and color space information of images must be handled in such a way that an image rendered directly using an [img](http://www.whatwg.org/specs/web-apps/current-work/#img) element would use the same colors as one painted on a [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element that is then itself rendered. Furthermore, the rendering of images that have no color correction information (such as those returned by the [toDataURL()](http://www.whatwg.org/specs/web-apps/current-work/#todataurl) method) must be rendered with no color correction.

Thus, in the 2D context, calling the [drawImage()](http://www.whatwg.org/specs/web-apps/current-work/#drawimage) method to render the output of the [toDataURL()](http://www.whatwg.org/specs/web-apps/current-work/#todataurl) method to the canvas, given the appropriate dimensions, has no visible effect.

## Security with [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) elements

Information leakage can occur if scripts from one [origin](http://www.whatwg.org/specs/web-apps/current-work/#origin0) can access information (e.g. read pixels) from images from another origin (one that isn't the [same](http://www.whatwg.org/specs/web-apps/current-work/#same-origin)).

To mitigate this, [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) elements are defined to have a flag indicating whether they are origin-clean. All [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) elements must start with their origin-clean set to true. The flag must be set to false if any of the following actions occur:

The element's 2D context's [drawImage()](http://www.whatwg.org/specs/web-apps/current-work/#drawimage) method is called with an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) whose [origin](http://www.whatwg.org/specs/web-apps/current-work/#origin0) is not the [same](http://www.whatwg.org/specs/web-apps/current-work/#same-origin) as that of the Document object that owns the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element.

The element's 2D context's [drawImage()](http://www.whatwg.org/specs/web-apps/current-work/#drawimage) method is called with an [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) whose origin-clean flag is false.

The element's 2D context's [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle) attribute is set to a [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) object that was created from an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) whose [origin](http://www.whatwg.org/specs/web-apps/current-work/#origin0) was not the [same](http://www.whatwg.org/specs/web-apps/current-work/#same-origin) as that of the Document object that owns the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element when the pattern was created.

The element's 2D context's [fillStyle](http://www.whatwg.org/specs/web-apps/current-work/#fillstyle) attribute is set to a [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) object that was created from an [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) whose origin-clean flag was false when the pattern was created.

The element's 2D context's [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle) attribute is set to a [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) object that was created from an [HTMLImageElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlimageelement) whose [origin](http://www.whatwg.org/specs/web-apps/current-work/#origin0) was not the [same](http://www.whatwg.org/specs/web-apps/current-work/#same-origin) as that of the Document object that owns the [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element when the pattern was created.

The element's 2D context's [strokeStyle](http://www.whatwg.org/specs/web-apps/current-work/#strokestyle) attribute is set to a [CanvasPattern](http://www.whatwg.org/specs/web-apps/current-work/#canvaspattern) object that was created from an [HTMLCanvasElement](http://www.whatwg.org/specs/web-apps/current-work/#htmlcanvaselement) whose origin-clean flag was false when the pattern was created.

Whenever the [toDataURL()](http://www.whatwg.org/specs/web-apps/current-work/#todataurl) method of a [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element whose origin-clean flag is set to false is called, the method must raise a [security exception](http://www.whatwg.org/specs/web-apps/current-work/#security10).

Whenever the [getImageData()](http://www.whatwg.org/specs/web-apps/current-work/#getimagedata) method of the 2D context of a [canvas](http://www.whatwg.org/specs/web-apps/current-work/#canvas) element whose origin-clean flag is set to false is called with otherwise correct arguments, the method must raise a [security exception](http://www.whatwg.org/specs/web-apps/current-work/#security10).

Even resetting the canvas state by changing its [width](http://www.whatwg.org/specs/web-apps/current-work/#width0) or [height](http://www.whatwg.org/specs/web-apps/current-work/#height0) attributes doesn't reset the origin-clean flag.