Notes on Philip Taylor's `canvas` tests

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Abstract

This document presents some notes about Philip Taylor's conformance tests [1] for the HTML specification, [2] related to the Porter–Duff operators. [3]

1 Introductory definitions

Definition 1.1 (Color) *A color A is defined as*

$$A := (r, g, b, a) \qquad r, g, b, a \in [0, 255]$$

Definition 1.2 (Post-multiplied color) *The post-multiplied representation of a color A is*

$$C_A := (r, g, b, \alpha) \qquad \alpha := \frac{a}{255}$$

Definition 1.3 (Pre-multiplied color) *The pre-multiplied representation of a post-multiplied color C_A is*

$$c_A := (\alpha \cdot r, \alpha \cdot g, \alpha \cdot b)$$

Given a value for F_A and F_B, we define the result of compositing colors A and B as follows:

Definition 1.4 (Composited colors)

$$c_O := (r_O, g_O, b_O) := c_A F_A + c_B F_B$$

$$\alpha_O := \alpha_A F_A + \alpha_B F_B$$

$$C_O := \left(\frac{r_O}{\alpha_O}, \frac{g_O}{\alpha_O}, \frac{b_O}{\alpha_O}, \alpha_O \right)$$

$$O := C_O \cdot \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 255 \end{pmatrix}$$

2 Tests

We use the terminology in the HTML specification: [2] A is the image being rendered and B is the state of the bitmap.

These are the results for the `2d.composite.transparent.*` tests.

2.1 `source-over`

The associated Porter–Duff operator is

$$A \text{ over } B.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1, F_B = 1 - \alpha_A = \frac{1}{4}.$$

We find

$$\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= 1 \cdot c_A + \frac{1}{4} \cdot c_B = \left(0, \frac{1}{8} \cdot 255, \frac{3}{4} \cdot 255\right) \\
\alpha_O &= 1 \cdot \frac{3}{4} + \frac{1}{2} \cdot \frac{1}{4} = \frac{7}{8} \\
C_O &= \left(0, \frac{8}{7}\frac{1}{8}255, \frac{8}{7}\frac{3}{4}255, \frac{7}{8}\right) \\
O &= \left(0, \frac{8}{7}\frac{1}{8}255, \frac{8}{7}\frac{3}{4}255, \frac{7}{8}255\right) \\
&\approx (0, 36.43, 218.57, 223.13) \\
&\approx (0, 36, 219, 223)
\end{aligned}$$

The test has $(0, 36, 218, 223) \pm 5$: approved with `s/218/219/`.

2.2 `destination-over`

The associated Porter–Duff operator is

$$B \text{ over } A.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1 - \alpha_B = \frac{1}{2}, F_B = 1.$$

We find

$$
\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= \frac{1}{2} \cdot c_A + 1 \cdot c_B = \left(0, \frac{1}{2} \cdot 255, \frac{3}{8} \cdot 255\right) \\
\alpha_O &= \frac{1}{2} \cdot \frac{3}{4} + 1 \cdot \frac{1}{2} = \frac{7}{8} \\
C_O &= \left(0, \frac{8}{7}\frac{1}{2}255, \frac{8}{7}\frac{3}{8}255, \frac{7}{8}\right) \\
O &= \left(0, \frac{8}{7}\frac{1}{2}255, \frac{8}{7}\frac{3}{8}255, \frac{7}{8}255\right) \\
&\approx (0, 145.71, 109.29, 223.13) \\
&\approx (0, 146, 109, 223)
\end{aligned}
$$

The test has $(0, 145, 109, 223) \pm 5$: approved with `s/145/146/`.

2.3 `source-in`

The associated Porter–Duff operator is

$$A \text{ in } B.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = \alpha_B = \frac{1}{2}, F_B = 0.$$

We find

$$
\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= \frac{1}{2} \cdot c_A + 0 \cdot c_B = \left(0, 0, \frac{3}{8} \cdot 255\right) \\
\alpha_O &= \frac{1}{2} \cdot \frac{3}{4} + 0 \cdot \frac{1}{2} = \frac{3}{8} \\
C_O &= \left(0, 0, \frac{8}{3}\frac{3}{8}255, \frac{3}{8}\right) \\
O &= \left(0, 0, 255, \frac{3}{8}255\right) \\
&\approx (0, 0, 255.00, 95.63) \\
&\approx (0, 0, 255, 96)
\end{aligned}
$$

The test has $(0, 0, 255, 95) \pm 5$: approved with `s/95/96/`.

2.4 `destination-in`

The associated Porter–Duff operator is

$$B \text{ in } A.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 0, F_B = \alpha_A = \frac{3}{4}.$$

We find

$$\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= 0 \cdot c_A + \frac{3}{4} \cdot c_B = \left(0, \frac{3}{8} \cdot 255, 0\right) \\
\alpha_O &= 0 \cdot \frac{3}{4} + \frac{3}{4} \cdot \frac{1}{2} = \frac{3}{8} \\
C_O &= \left(0, \frac{8}{3}\frac{3}{8}255, 0, \frac{3}{8}\right) \\
O &= \left(0, 255, 0, \frac{3}{8}255\right) \\
&\approx (0, 255.00, 0, 95.63) \\
&\approx (0, 255, 0, 96)
\end{aligned}$$

The test has $(0, 255, 0, 95) \pm 5$: approved with `s/95/96/`.

2.5 `source-out`

The associated Porter–Duff operator is

$$A \text{ out } B.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1 - \alpha_B = \frac{1}{2}, F_B = 0.$$

We find

$$\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= \frac{1}{2} \cdot c_A + 0 \cdot c_B = \left(0, 0, \frac{3}{8} \cdot 255\right) \\
\alpha_O &= \frac{1}{2} \cdot \frac{3}{4} + 0 \cdot \frac{1}{2} = \frac{3}{8} \\
C_O &= \left(0, 0, \frac{8}{3}\frac{3}{8}255, \frac{3}{8}\right) \\
O &= \left(0, 0, 255, \frac{3}{8}255\right) \\
&\approx (0, 0, 255.00, 95.63) \\
&\approx (0, 0, 255, 96)
\end{aligned}$$

The test has $(0, 255, 0, 95) \pm 5$: approved with `s/95/96/`.

2.6 `destination-out`

The associated Porter–Duff operator is

$$B \text{ out } A.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 0, F_B = 1 - \alpha_A = \frac{1}{4}.$$

We find

$$\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= 0 \cdot c_A + \frac{1}{4} \cdot c_B = \left(0, \frac{1}{8} \cdot 255, 0\right) \\
\alpha_O &= 0 \cdot \frac{3}{4} + \frac{1}{4} \cdot \frac{1}{2} = \frac{1}{8} \\
C_O &= \left(0, 8\frac{1}{8}255, 0, \frac{1}{8}\right) \\
O &= \left(0, 255, 0, \frac{1}{8}255\right) \\
&\approx (0, 255.00, 0, 31.88) \\
&\approx (0, 255, 0, 32)
\end{aligned}$$

The test has $(0, 255, 0, 31) \pm 5$: approved with `s/31/32/`.

2.7 `source-atop`

The associated Porter–Duff operator is

$$A \text{ atop } B.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = \alpha_B = \frac{1}{2}, F_B = 1 - \alpha_A = \frac{1}{4}.$$

We find

$$\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= \frac{1}{2} \cdot c_A + \frac{1}{4} \cdot c_B = \left(0, \frac{1}{8} \cdot 255, \frac{3}{8} \cdot 255\right) \\
\alpha_O &= \frac{1}{2} \cdot \frac{3}{4} + \frac{1}{4} \cdot \frac{1}{2} = \frac{1}{2} \\
C_O &= \left(0, 2\frac{1}{8}255, 2\frac{3}{8}255, \frac{1}{2}\right) \\
O &= \left(0, \frac{1}{4}255, \frac{3}{4}255, \frac{1}{2}255\right) \\
&= (0, 63.75, 191.25, 127.50) \\
&\approx (0, 64, 191, 128)
\end{aligned}$$

The test has $(0, 63, 191, 127) \pm 5$: approved with `s/63/64/` and `s/127/128/`.

2.8 `destination-atop`

The associated Porter–Duff operator is

$$B \text{ atop } A.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1 - \alpha_B = \frac{1}{2}, F_B = \alpha_A = \frac{3}{4}.$$

We find

$$
\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= \frac{1}{2} \cdot c_A + \frac{3}{4} \cdot c_B = \left(0, \frac{3}{8} \cdot 255, \frac{3}{8} \cdot 255\right) \\
\alpha_O &= \frac{1}{2} \cdot \frac{3}{4} + \frac{3}{4} \cdot \frac{1}{2} = \frac{3}{4} \\
C_O &= \left(0, \frac{4}{3}\frac{3}{8}255, \frac{4}{3}\frac{3}{8}255, \frac{3}{4}\right) \\
O &= \left(0, \frac{1}{2}255, \frac{1}{2}255, \frac{3}{4}255\right) \\
&= (0, 127.50, 127.50, 191.25) \\
&\approx (0, 128, 128, 191)
\end{aligned}
$$

The test has $(0, 127, 127, 191) \pm 5$: approved with `s/127/128/g`.

2.9 `xor`

The associated Porter–Duff operator is

$$A \text{ xor } B.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1 - \alpha_B = \frac{1}{2}, F_B = 1 - \alpha_A = \frac{1}{4}.$$

We find

$$
\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= \frac{1}{2} \cdot c_A + \frac{1}{4} \cdot c_B = \left(0, \frac{1}{8} \cdot 255, \frac{3}{8} \cdot 255\right) \\
\alpha_O &= \frac{1}{2} \cdot \frac{3}{4} + \frac{1}{4} \cdot \frac{1}{2} = \frac{1}{2} \\
C_O &= \left(0, 2\frac{1}{8}255, 2\frac{3}{8}255, \frac{1}{2}\right) \\
O &= \left(0, \frac{1}{4}255, \frac{3}{4}255, \frac{1}{2}255\right) \\
&= (0, 63.75, 191.25, 127.50) \\
&\approx (0, 64, 191, 128)
\end{aligned}
$$

The test has $(0, 63, 191, 127) \pm 5$: approved with `s/63/64/` and `s/127/128/`.

2.10 `copy`

The associated Porter–Duff operator is

$$A.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1, F_B = 0.$$

We find

$$\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= 1 \cdot c_A + 0 \cdot c_B = \left(0, 0, \frac{3}{4} \cdot 255\right) \\
\alpha_O &= 1 \cdot \frac{3}{4} + 0 \cdot \frac{1}{2} = \frac{3}{4} \\
C_O &= \left(0, 0, \frac{4}{3}\frac{3}{4}255, \frac{3}{4}\right) \\
O &= \left(0, 0, 255, \frac{3}{4}255\right) \\
&= (0, 0, 225.00, 191.25) \\
&\approx (0, 0, 225, 191)
\end{aligned}$$

The test has $(0, 0, 255, 191) \pm 5$: approved.

2.11 `lighter`

The associated Porter–Duff operator is

$$A \text{ plus } B.$$

The test uses

$$C_A = \left(0, 0, 255, \frac{3}{4}\right), C_B = \left(0, 255, 0, \frac{1}{2}\right),$$

and we get

$$F_A = 1, F_B = 1.$$

We find

$$
\begin{aligned}
c_A &= \left(0, 0, \frac{3}{4} \cdot 255\right) \\
c_B &= \left(0, \frac{1}{2} \cdot 255, 0\right) \\
c_O &= 1 \cdot c_A + 1 \cdot c_B = \left(0, \frac{1}{2} \cdot 255, \frac{3}{4} \cdot 255\right) \\
\alpha_O &= \max\left(1, 1 \cdot \frac{3}{4} + 1 \cdot \frac{1}{2}\right) = 1 \\
C_O &= \left(0, \frac{1}{2}255, \frac{3}{4}255, 1\right) \\
O &= \left(0, \frac{1}{2}255, \frac{3}{4}255, 255\right) \\
&= (0, 127.50, 191.25, 255) \\
&\approx (0, 128, 191, 255)
\end{aligned}
$$

The test has $(0, 63, 191, 127) \pm 5$: approved with `s/127/128/`.

Contents

References

[1] P. Taylor, "`<canvas>` tests." [Online]. Available: http://dvcs.w3.org/hg/html/raw-file/43589d3b48db/tests/submission/PhilipTaylor/canvas/index.html

[2] I. Hickson, *HTML*. WHATWG. [Online]. Available: http://www.whatwg.org/html

[3] T. Porter and T. Duff, "Compositing digital images," *Computer graphics*, vol. 18, no. 3, pp. 253–259, Jul. 1984.