Bug 1484996 – Implementing a weighted shuffle

Suppose $w_1, w_2 \in \mathbb{R}^{>0}$. We can think of these as two 'weights'.

Let $X_1, X_2 \sim U[0,1]$ be independent random variables uniformly distributed in the unit interval.

Then

$$
\begin{aligned}
\mathrm{P}\big(X_1^{(1/w_1)} < X_2^{(1/w_2)}\big) &= \mathrm{P}\big(X_1 < X_2^{(w_1/w_2)}\big) \\
&= \int_0^1 \int_0^{X_2^{(w_1/w_2)}} 1 \,\mathrm{d}X_1 \,\mathrm{d}X_2 \\
&= \int_0^1 X_2^{(w_1/w_2)} \,\mathrm{d}X_2 \\
&= \frac{w_2}{w_1 + w_2}
\end{aligned}
$$

$$
\mathrm{P}\big(X_1^{(1/w_1)} > X_2^{(1/w_2)}\big) = \frac{w_1}{w_1 + w_2}
$$

Equivalently, $X_1^{(1/w_1)} > X_2^{(1/w_2)}$ is $\frac{w_1}{w_2}$ 'times' as likely as $X_1^{(1/w_1)} < X_2^{(1/w_2)}$.

This motivates the following method of obtaining a weighted shuffle. Given a list of n objects with strictly-positive weights $w_1, \ldots, w_n$, assign each the corresponding rank $x_i^{(1/w_i)}$ (where x_i is chosen uniformly at random from the unit interval), and sort the list by that rank.