> *king evaluations are useful* **for** *stabilizing the early game evaluations*

> t_1 : *territorial evaluation* **by** *queen moves*$\cdot$ (*plays reasonably*
> . *especially shortly before the filling phase*)

> t_2 : *territorial evaluation* **by** *king moves*$\cdot$ (*useful* **in** *beginning of game,*
> *less significant as the game goes on*)

> c_1 : **local** *advantage relative* **to** *queen moves*
> $\cdot$ (*counter balances early game territorial evaluation drawbacks*)

> c_2 : **local** *advantage relative* **to** *king moves*
> $\cdot$ (*only large values represent a clear advantage* **for** *one player*)

> w : *decreases as game goes on, becomes zero when all that's left is* **to** *fill* **in** *the board*
> $\cdot$ (*ie. the winner can be calculated based on moves remaining*)

> $g := (w) \rightarrow \begin{cases} \dfrac{w}{70} & w \leq 70 \\ 1 & w > 70 \end{cases}$

$$g := w \mapsto \begin{cases} w \cdot \left(\dfrac{1}{70}\right) & w \leq 70 \\ 1 & 70 < w \end{cases} \tag{1}$$

> $g_2 := (w) \rightarrow 0 - \left(\dfrac{1 - 0.75 + 0.001}{1 - g(w) + (1 - 0.75 + 0.001)}\right) + 1$

$$g_2 := w \mapsto 0 + \left(-(1 - 0.75 + 0.001)\,\frac{1}{1 + (-g(w)) + (1 - 0.75 + 0.001)}\right) + 1 \tag{2}$$

> $f_1 := (w) \rightarrow (g_2(w))$

$$f_1 := w \mapsto g_2(w) \tag{3}$$

> $f_2 := (w) \rightarrow g(w) \cdot (1 - f_1(w) - f_4(w))$

$$f_2 := w \mapsto g(w)\,(1 + (-f_1(w)) + (-f_4(w))) \tag{4}$$

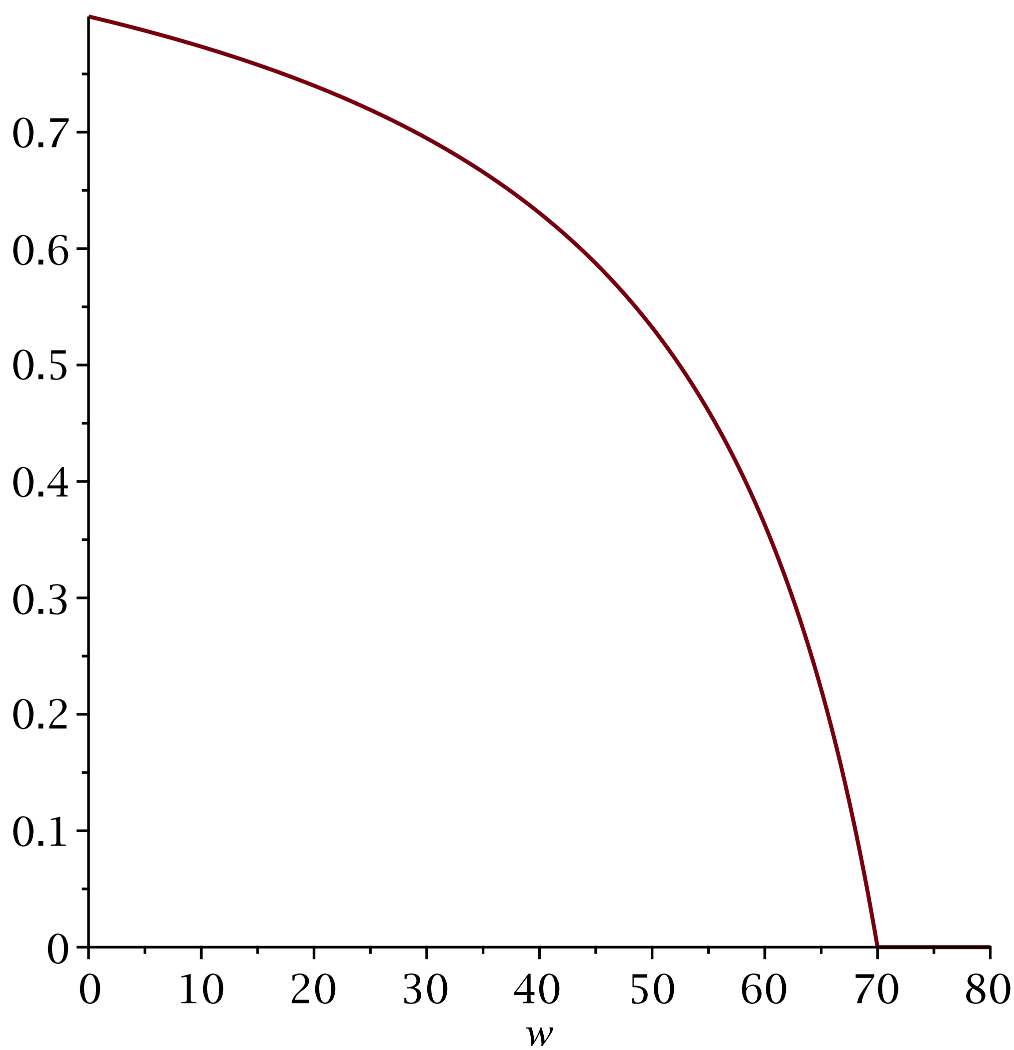
> $f_3 := (w) \rightarrow (1 - f_1(w) - f_2(w) - f_4(w))$

$$f_3 := w \mapsto 1 + (-f_1(w)) + (-f_2(w)) + (-f_4(w)) \tag{5}$$

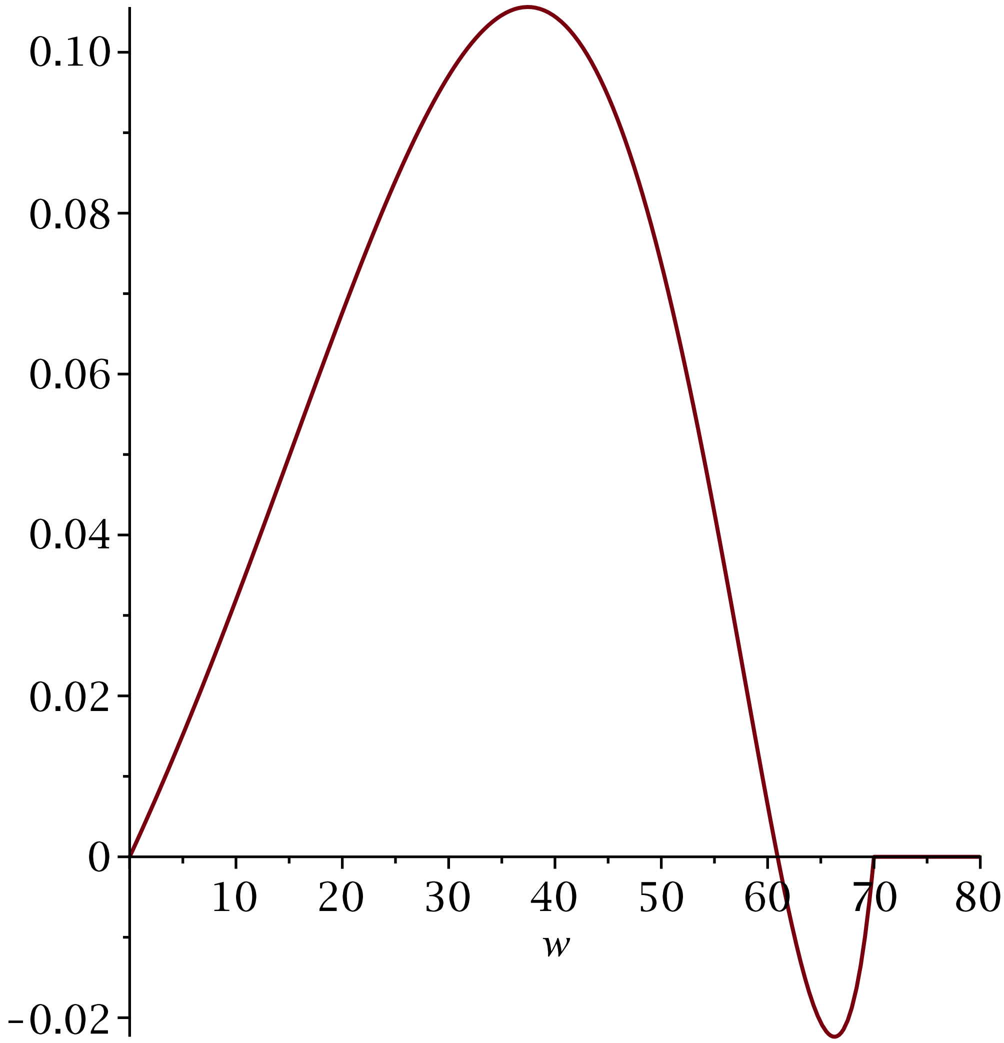
> $f_4 := (w) \rightarrow g(w)^3$

$$f_4 := w \mapsto g(w)^3 \tag{6}$$

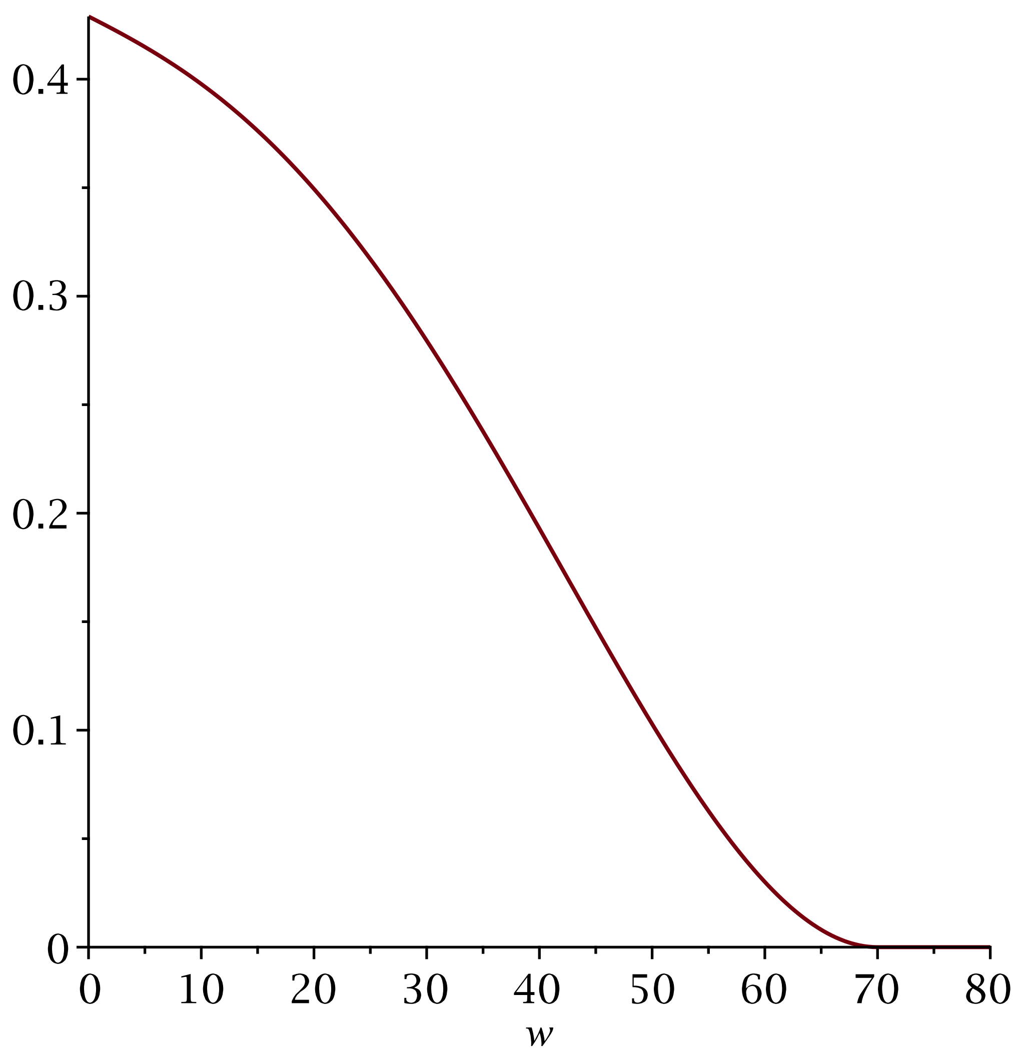
> $plot(f_1(w), w = 0..80)$



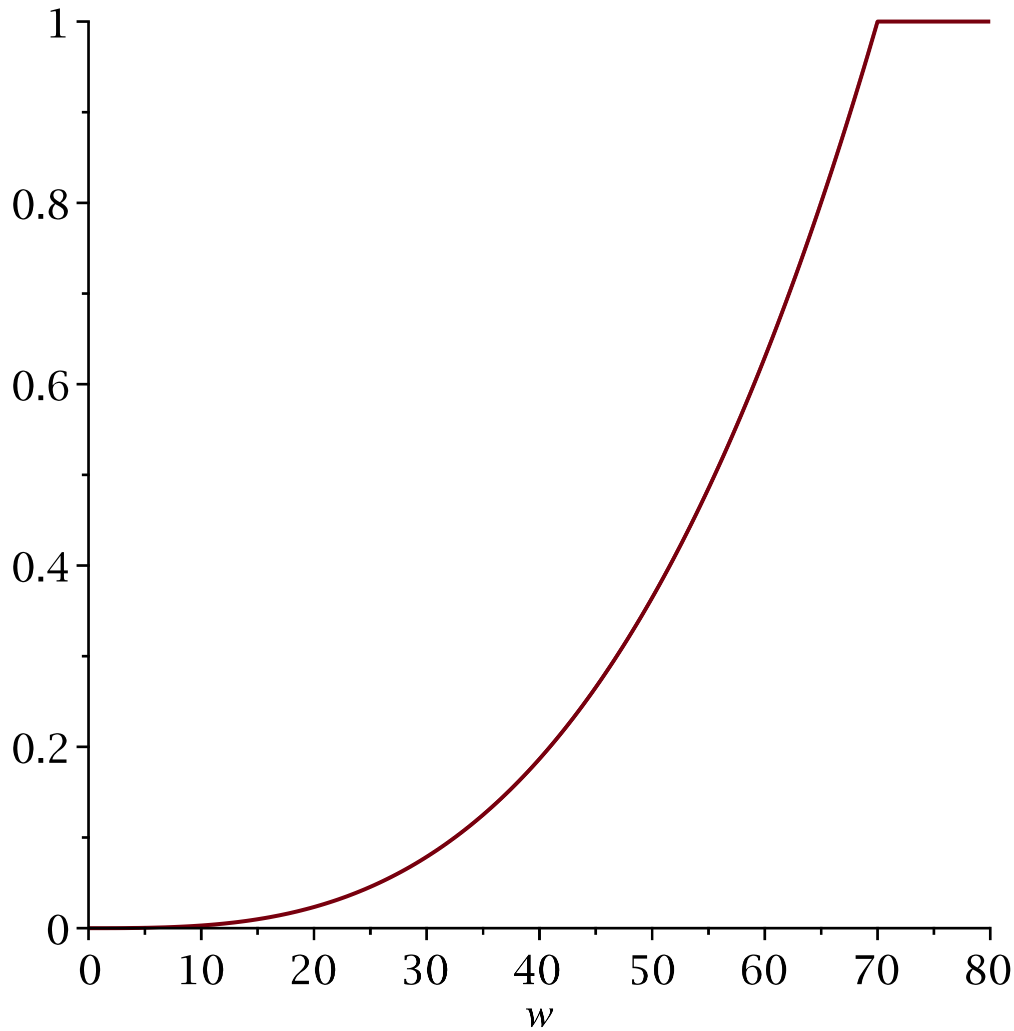
> $plot(f_2(w), w = 0..80)$



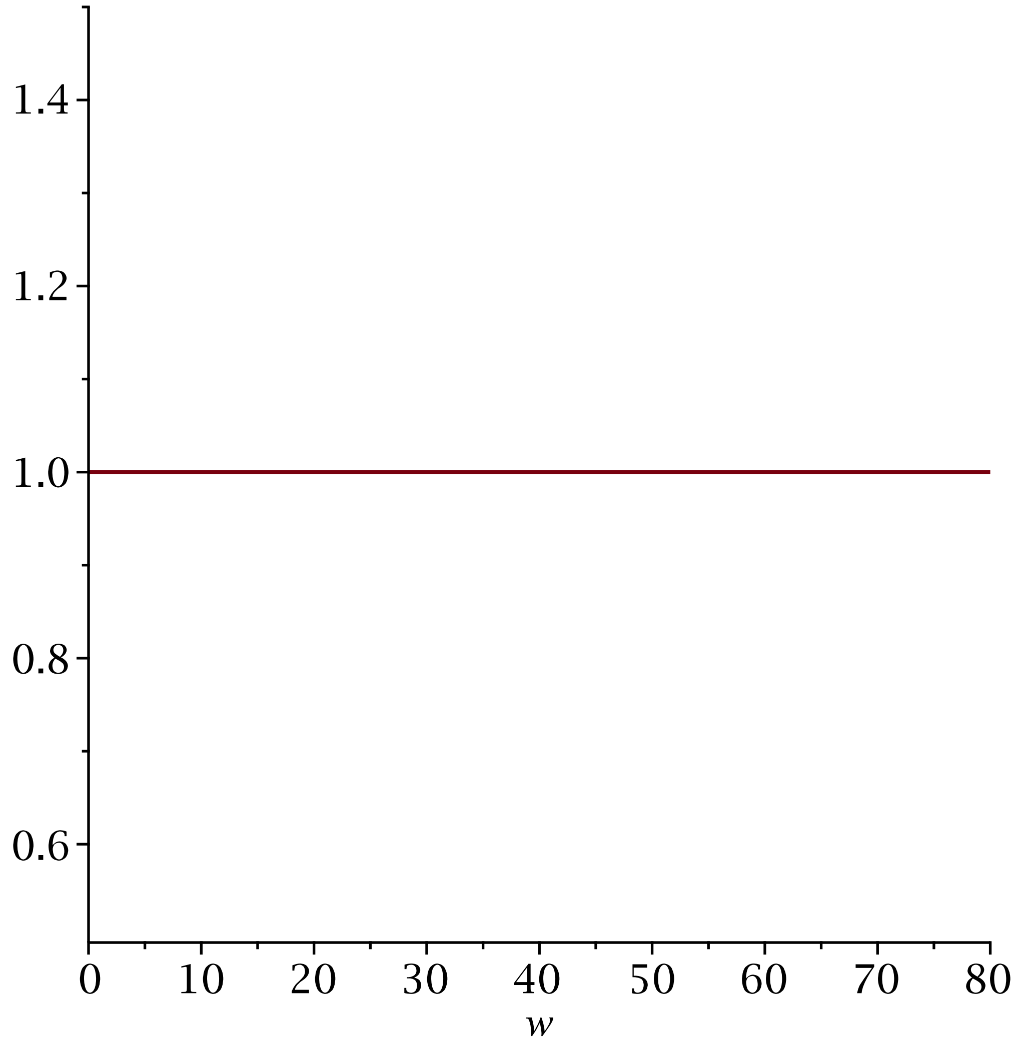
> $plot(f_3(w), w = 0..80)$



> $plot(f_4(w), w = 0..80)$



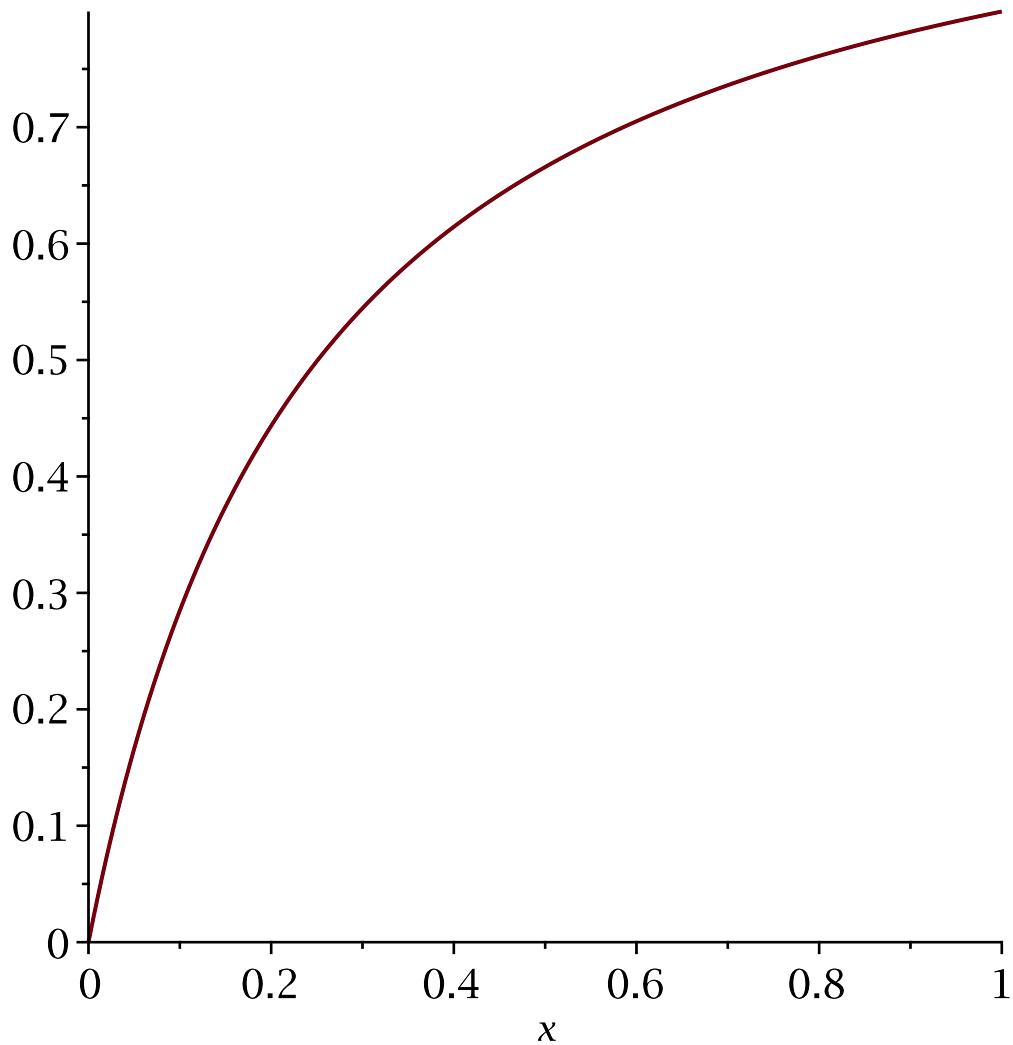
> $plot(f_1(w) + f_2(w) + f_3(w) + f_4(w),\ w = 0..80)$



> $c := 0.75;\ o := 0.75;\ plot\left(0 - \left(\frac{1 - c + 0.001}{x + (1 - o + 0.001)}\right) + 1,\ x = 0\,..1\right)$

$$c := 0.75$$

$$o := 0.75$$



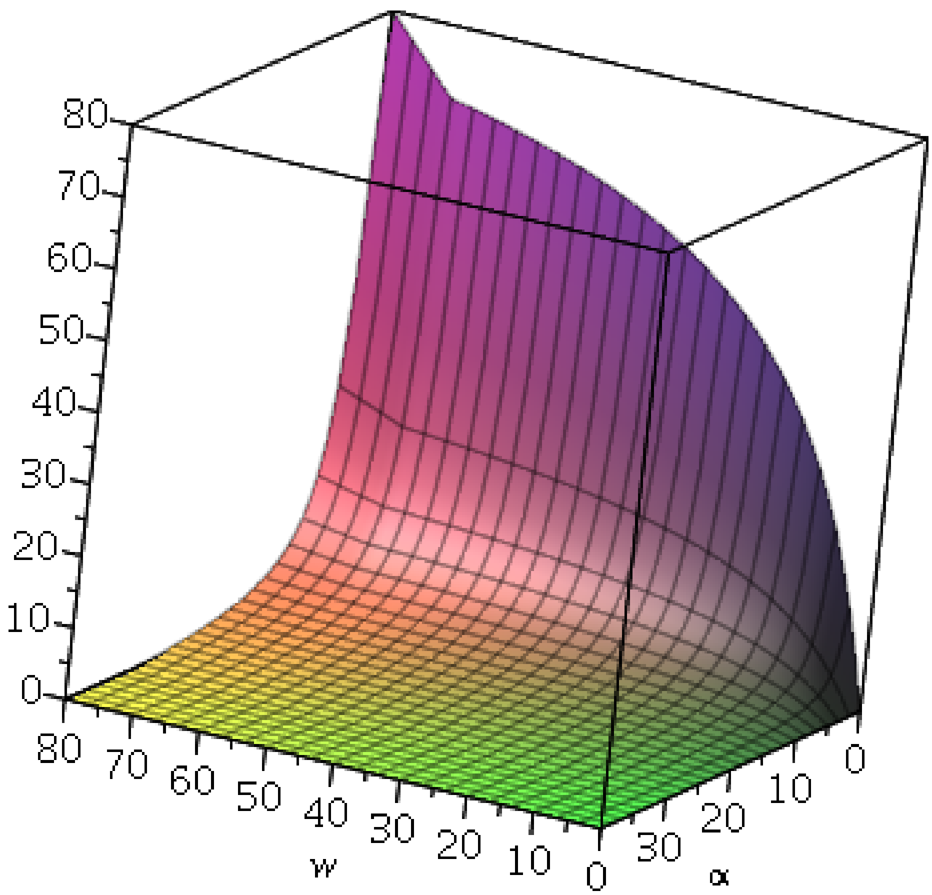
> $f := (w, \alpha) \rightarrow \left(1 - \left(\min\left(1, \frac{(\alpha)}{30}\right)\right)\right) \cdot \frac{5\, w}{(\alpha + 1)} \cdot \left(\frac{1 - 0.75}{\min\left(1, \frac{(w)}{70}\right) + (1 - 0.75)}\right)$

$$f := (w, \alpha) \mapsto \left(1 + \left(-\min\left(1, \alpha \cdot \left(\frac{1}{30}\right)\right)\right)\right) \left(5\, w\, \frac{1}{\alpha + 1}\right) \left((1 - 0.75)\, \frac{1}{\min\left(1, w \cdot \left(\frac{1}{70}\right)\right) + (1 - 0.75)}\right) \quad \textbf{(7)}$$

> $f(80, 0)$

$$53.33333333 \quad \textbf{(8)}$$

> $plot3d(f(w, \alpha),\ w = 0..80, \alpha = 0..40)$



> $(0,\infty) = \infty$
$(0,\,0) = 0$
$(80,\,0) = 0$
$(80,\infty) = \infty$

false **(9)**

> $0 - \left(\dfrac{1 - 0.75 + 0.001}{1 - \min\left(1,\, \dfrac{\alpha}{50}\right) + (1 - 0.75 + 0.001)} \right) + 1$

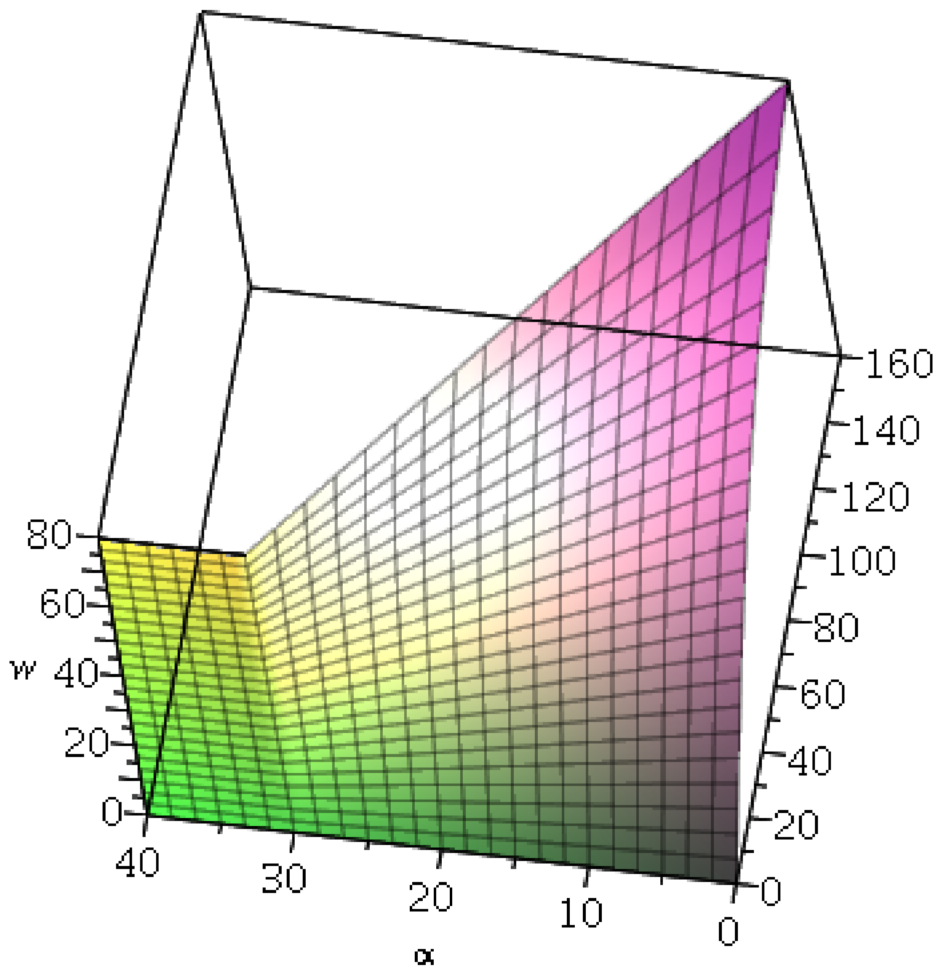
$$- \frac{0.251}{1.251 - \min\left(1,\, \frac{\alpha}{50}\right)} + 1 \quad \textbf{(10)}$$

> $f := (w, \alpha) \rightarrow w \cdot \left(\dfrac{1 - 0.75}{1 - \min\left(1,\, \dfrac{(w)}{80}\right) + (1 - 0.75)} + 1 \right) \cdot \left(1 - \left(\min\left(1,\, \dfrac{(\alpha)}{30}\right)\right)\right)\left(\dfrac{w}{1.5 \cdot (\alpha^2 + 6)}\right)$

(11)

$$f := (w, \alpha) \mapsto w \left((1-0.75) \frac{1}{1 + \left(-\min\left(1, w \cdot \left(\frac{1}{80}\right)\right)\right) + (1-0.75)} + 1 \right) \left(1 + \left(-\min\left(1, \alpha \cdot \left(\frac{1}{30}\right)\right)\right)\right) \left(w \frac{1}{1.5\,(\alpha^2 + 6)} \right) \quad \textbf{(11)}$$

> $plot3d(f(w, \alpha), w = 0..80, \alpha = 0..40)$



> $f(10, 2)$

$$11.40740741 \quad \textbf{(12)}$$

> $\frac{df}{dw} = diff(f(w, \alpha), w)$

$$\frac{df}{dw} = \frac{0.75 \left(- \frac{0.75}{1.75 - \min\left(1, \frac{\alpha}{30}\right)} + 1 \right)}{\min\left(1, \frac{w}{80}\right) + 0.75} \quad \textbf{(13)}$$

$$-\frac{0.75\,w\left(-\frac{0.75}{1.75-\min\left(1,\frac{\alpha}{30}\right)}+1\right)\left(\begin{cases}\frac{1}{80} & w<80\\ \mathit{undefined} & w=80\\ 0 & 80<w\end{cases}\right)}{\left(\min\left(1,\frac{w}{80}\right)+0.75\right)^2}$$

> $da := eval(diff(f(w, \mathrm{alpha}), \mathrm{alpha}))$

$$da := -\frac{0.5625\,w\left(\begin{cases}\frac{1}{30} & \alpha<30\\ \mathit{undefined} & \alpha=30\\ 0 & 30<\alpha\end{cases}\right)}{\left(\min\left(1,\frac{w}{80}\right)+0.75\right)\left(1.75-\min\left(1,\frac{\alpha}{30}\right)\right)^2} \qquad \textbf{(14)}$$

> $dda := (a, b) \rightarrow subs(w = a, \mathrm{alpha} = b, da)$

$$dda := (a, b) \mapsto subs(w = a, \alpha = b, da) \qquad \textbf{(15)}$$

> $evalf(dda(10, 20))$

$$-0.1825866443 \qquad \textbf{(16)}$$

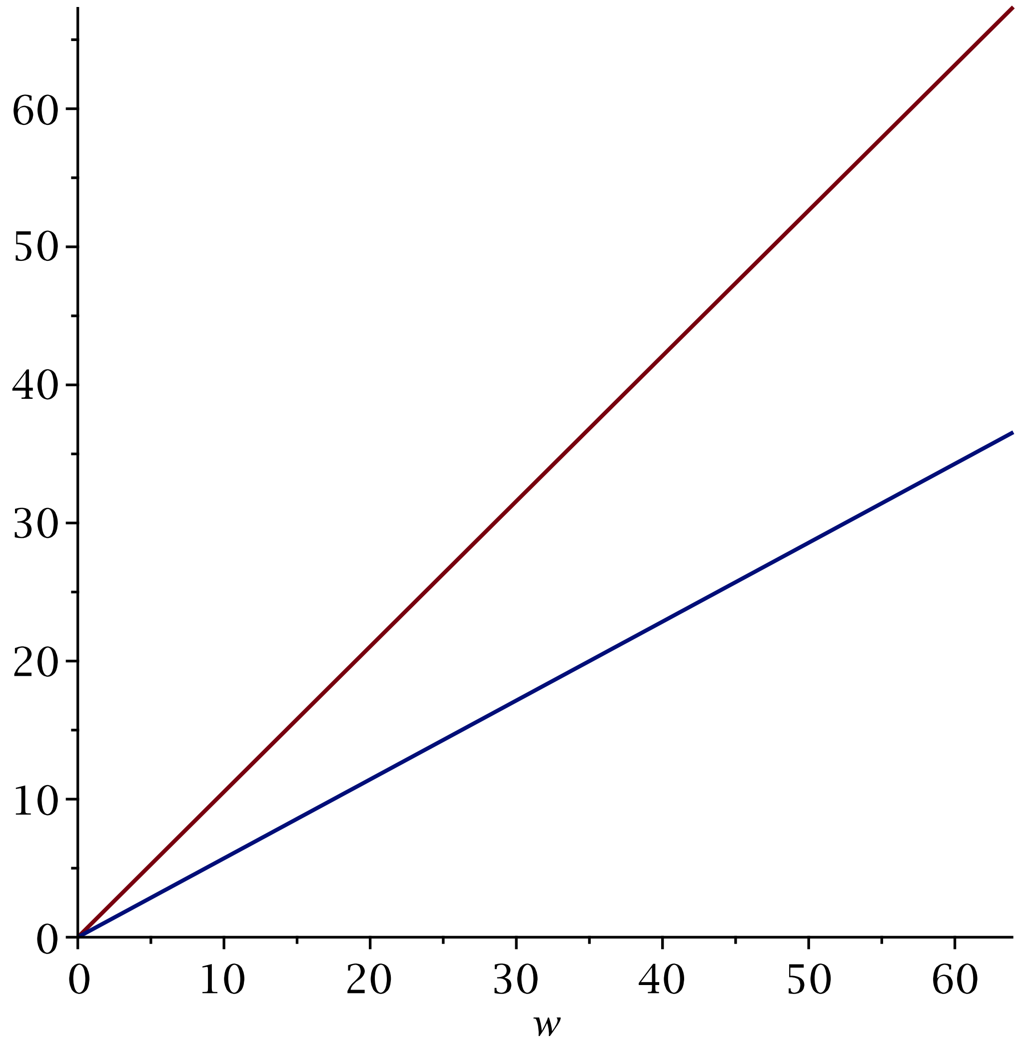
> $\frac{df}{d\alpha} = diff(f(w, \alpha), \alpha)$

$$\frac{df}{d\alpha} = -\frac{0.75\,w\left(\begin{cases}\frac{1}{30} & \alpha<30\\ \mathit{undefined} & \alpha=30\\ 0 & 30<\alpha\end{cases}\right)}{\left(1.75-\min\left(1,\frac{\alpha}{30}\right)\right)^2} \qquad \textbf{(17)}$$

> $2\cdot f(w, 5) < f(w, 0)$

$$\frac{0.3472222222\,w}{\min\left(1,\frac{w}{70}\right)+0.25} < \frac{1.25\,w}{\min\left(1,\frac{w}{70}\right)+0.25} \qquad \textbf{(18)}$$

> $plot([2\cdot f(w, 5), f(w, 0)], w = 0..64)$



> $2 \cdot f(5, 5)$

$$5.263157894 \tag{19}$$

> $f(5, 0)$

$$2.857142857 \tag{20}$$

>