Calculating the corrected "what the width has reduced down to as a percentage"

If you view a rectangle at an angle it makes it look less wide and less long. Let's call the width and length of the rectangle, when viewed at an angle, the "apparent width" and the "apparent length", respectively.

In order to study how the length and width are reduced it is an idea to have another copy of the rectangle which you don't view at an angle, let's call this the "reference rectangle". Let's call the rectangle that you are viewing at an angle the "angled rectangle".

I am interested in what the width has reduced down to, by viewing the rectangle at an angle, expressed as a percentage (**we will abbreviate this as WRDP**). That is, the WRDP is obtained by dividing the "apparent width" of the "angled rectangle" by the width of the "reference rectangle" ×100. (Similarly for the length)

There was this instance where I used a margarine lid as my angled rectangle and the margarine tub as the reference rectangle. However, a margarine tub is actually a few millimeters smaller than a margarine lid - because a margarine lid fits over the margarine tub. This introduces a very slight bias. At this point I need to introduce some symbols:

We denote the "apparent width" of the margarine lid in the photo by W_{lid}^{photo}

We denote the width of the margarine tub in the photo by W_{tub}^{photo}

Measuring W_{lid}^{photo} and W_{tub}^{photo} we obtained:

The (biased) WRDP $= \dfrac{W_{lid}^{photo}}{W_{tub}^{photo}} \times 100 = 90\% \quad (Equation\ 1)$

You correct for the slight bias by upscaling the size of the margarine tub in the photo by the appropriate amount and then by using the upscaled version of W_{tub}^{photo} in Equation 1 in place of W_{tub}^{photo}! The amount you upscale by is determined by taking an actual margarine lid and tub and finding out how much bigger the lid is than the tub. At this point I need to introduce more symbols:

We denote the width of an actual margarine lid by W_{lid}

We denote the width of an actual margarine tub by W_{tub}

Let's denote the upscaled version of W_{tub}^{photo} by $\uparrow W_{tub}^{photo}$. You want $\uparrow W_{tub}^{photo}$ to be equal to the width the margarine lid would have in the photo if you **weren't** viewing it at an angle. With this in mind, it should fairly obvious that $\uparrow W_{tub}^{photo}$ satisfies:

$$\frac{\uparrow W_{tub}^{photo}}{W_{tub}^{photo}} = \frac{W_{lid}}{W_{tub}}.$$

From which we obtain a formula for the upscaled version of W_{tub}^{photo}!:

$$\uparrow W_{tub}^{photo} = \frac{W_{lid}}{W_{tub}} \times W_{tub}^{photo}$$

We can now obtain the formula for the "corrected WRDP" by dividing W_{lid}^{photo} by the upscaled version of W_{tub}^{photo}:

$$\text{corrected WRDP} = \frac{W_{lid}^{photo}}{\frac{W_{lid}}{W_{tub}} \times W_{tub}^{photo}} \times 100 = \frac{W_{tub}}{W_{lid}} \times \frac{W_{lid}^{photo}}{W_{tub}^{photo}} \times 100 = \frac{W_{tub}}{W_{lid}} \times 90\%$$

Given that the ratio $\frac{W_{tub}}{W_{lid}}$ is very close to 1, the "(biased) WRDP" will be hardly changed! We now plug in the actual numbers into the formula. The width of an actual margarine tub is 9.2cm and the width of an actual margarine lid is 9.5cm, and so,

$$\text{corrected WRDP} = \frac{9.2}{9.5} \times 90\% = 87\%$$

and so it has hardly changed, and it has not gone down to 50%!

A similar calculation can be done to obtain the corrected "what the length has reduced down to as a percentage", with the same result that the answer is hardly changed!

That finishes the calculation. Below I explain the algera I did. You don't need to go through it if you don't want.

Explaining the algebra I did (included for if you are interested)

I thought I would just include an explanation of the algebra because it mainly involves just applying a formula that generalises the forumula for multiplying fracions.

At GCSE maths you learn how to mulpiply fractions. It works the folowing way

$$\frac{4}{7} \times \frac{2}{5} = \frac{4 \times 2}{7 \times 5}$$

Let a, b, c, d denote any numbers, they don't have to be integers. Then there is the general formula:

$$\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d} \qquad (Equation\ 2(a)).$$

The other formula that I use is:

$$e \times \frac{f}{e} = f \qquad (Equation\ 2(b)).$$

where e and f are any numbers.

Now I can explain the algebra that led to the end formula for the CPRW. First note that if you divide a number by itself you get 1, so

$$\frac{W_{tub}}{W_{tub}} = 1.$$

If you multiply any number by 1 it doesn't change that number, therefore we can write:

$$\begin{aligned}
\text{CPRW} &= \frac{W_{tub}}{W_{tub}} \times \frac{W_{lid}^{photo}}{\frac{W_{lid}}{W_{tub}} \times W_{tub}^{photo}} \times 100 \\
&= \frac{W_{tub} \times W_{lid}^{photo}}{W_{tub} \times \frac{W_{lid}}{W_{tub}} \times W_{tub}^{photo}} \times 100 && \text{(have used Equation 2(a) to get here)} \\
&= \frac{W_{tub} \times W_{lid}^{photo}}{W_{lid} \times W_{tub}^{photo}} \times 100 && \text{(have used Equation 2(b) to get here)} \\
&= \frac{W_{tub}}{W_{lid}} \times \frac{W_{lid}^{photo}}{W_{tub}^{photo}} \times 100 && \text{(have used Equation 2(a) to get here)} \\
&= \frac{W_{tub}}{W_{lid}} \times 90\%.
\end{aligned}$$