Dealing with long equations

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An example of a long formula:

$$\left(1+x\right)^n = 1 + nx + \frac{n\left(n-1\right)}{2!}x^2 + \frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3 + \frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4 + \ldots \tag{1}$$

LaTeX doesn't break long equations to make them fit within the margins as it does with normal text. It is therefore up to you to format the equation appropriately (if they overrun the margin.) This typically requires some creative use of an `eqnarray` to get elements shifted to a new line to align nicely.

```
\begin{eqnarray*}
  \left(1+x\right)^n & = & 1 + nx + \frac{n\left(n-1\right)}{2!}x^2 \\
  & & + \frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3 \\
  & & + \frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4 \\
  & & + \ldots
\end{eqnarray*}
```

$$\begin{aligned}\left(1+x\right)^n &= 1 + nx + \frac{n\left(n-1\right)}{2!}x^2 \\ & +\frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3 \\ & +\frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4 \\ & +\ldots\end{aligned}$$

It may just be that I'm more sensitive to these kind of things, but you may notice that from the 2nd line onwards, the space between the initial plus sign and the subsequent fraction is (slightly) smaller than normal. (Observe the first line, for example.) This is due to the fact that LaTeX deals with the $+$ and $-$ signs in two possible ways. The most common is as a binary operator. When two maths elements appear either side of the sign, it is assumed to be a binary operator, and as such, allocates some space either side of the sign. The alternative way is a sign designation. This is when you state whether a mathematical quantity is either positive or negative. This is common for the latter, as in maths, such elements are assumed to be positive unless a $-$ is prefixed to it. In this instance, you want the sign to appear close to the appropriate element to show their association. It is this interpretation that LaTeX has opted for in the above example.

To add the correct amount of space, you can add an *invisible* character using $\{\}$, as illustrated here:

```
\begin{eqnarray*}
  \left(1+x\right)^n & = & 1 + nx + \frac{n\left(n-1\right)}{2!}x^2 \\
  & & {} + \frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3 \\
  & & {} + \frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4 \\
  & & {} + \ldots
\end{eqnarray*}
```

$$\begin{aligned}(1+x)^n &= 1+nx+\frac{n\left(n-1\right)}{2!}x^2\\ &\quad +\frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3\\ &\quad +\frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4\\ &\quad +\ldots\end{aligned}$$

Alternatively, you could avoid this issue altogether by leaving the $+$ at the end of the previous line rather at the beginning of the current line:

$$\begin{aligned}(1+x)^n &= 1+nx+\frac{n\left(n-1\right)}{2!}x^2+\\ &\quad \frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3+\\ &\quad \frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4+\\ &\quad \ldots\end{aligned}$$

There is another convention of writing long equations that LaTeX supports. This is the way I see long equations typeset in books and articles, and admittedly is my preferred way of displaying them. Sticking with the `eqnarray` approach, using the `\lefteqn` command around the content before the $=$ sign gives the following result:

$$\begin{aligned}&(1+x)^n =\\ &\qquad 1+nx+\frac{n\left(n-1\right)}{2!}x^2+\\ &\qquad \frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3+\\ &\qquad \frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4+\\ &\qquad \ldots\end{aligned}$$

```
\begin{eqnarray*}
  \lefteqn{\left(1+x\right)^n = } \\
  & & 1 + nx + \frac{n\left(n-1\right)}{2!}x^2 + \\
  & & \frac{n\left(n-1\right)\left(n-2\right)}{3!}x^3 + \\
  & & \frac{n\left(n-1\right)\left(n-2\right)\left(n-3\right)}{4!}x^4 + \\
  & & \ldots
\end{eqnarray*}
```

Notice that the first line of the `eqnarray` contains the `\lefteqn` only. And within this command, there are no column separators (&). The reason this command displays things as it does is because the `\lefteqn` prints the argument, however, tells LaTeX that the width is zero. This results in the first column being empty, with the exception of the inter-column space, which is what gives the subsequent lines their indentation.