

# **Connect 4 Maths**

By Cal Henderson

I get an email like this from time to time:

*Im doing some gsce coursework at the moment and our aim is to investigate the number of wiining lines in the game connect 4.we have to find a series of formulas. Do you have any info which would help me?*

So here's my stock answer:

Let your grid be x by y squares large  
Let the length of a solution be n squares

(So in a standard game, x=7, y=6, n=4)

horizontal lines =  $y * (x-n)$  (NOTE: while  $x-n > 0$ )

vertical lines =  $x * (y-n)$  (NOTE: while  $y-n > 0$ )

diagonal lines =  $2 * (x-n) * (y-n)$  (NOTE: while  $x-n > 0$  and  $y-n > 0$ )

total lines =  $(y * (x-n)) + (x * (y-n)) + (2 * (x-n) * (y-n))$

If x-n or y-n are 0 or less, then the board is too small to fit a horizontal or vertical winning line in. Obviously this means the game is unplayable (e.g. playing connect 4 on a 3 by 3 grid) but is worth remembering when working out the formulas.

Here's a bit of an extension:

Let your grid be x by y squares large  
Let the solution line be a by b squares large (for solution rectangles)

(So in a standard game, x=7, y=6, a=4, b=1)

horizontal lines =  $(y-(b-1)) * (x-a)$

vertical lines =  $(x-(b-1)) * (y-a)$

diagonal lines =  $2 * (x-(a+b-1)) * (y-(a+b-1))$

total lines =  $((y-(b-1)) * (x-a)) + ((x-(b-1)) * (y-a)) + (2 * (x-(a+b-1)) * (y-(a+b-1)))$

If you want to start getting fancy, consider 3 dimensional grids. Infact, you can quite easily find a general solution for a grid that's a1,a2,a3...an in size, with a winning line of b1,b2,b3...bn in size. I'll leave that one for you to work out ;)

*(end of article)*