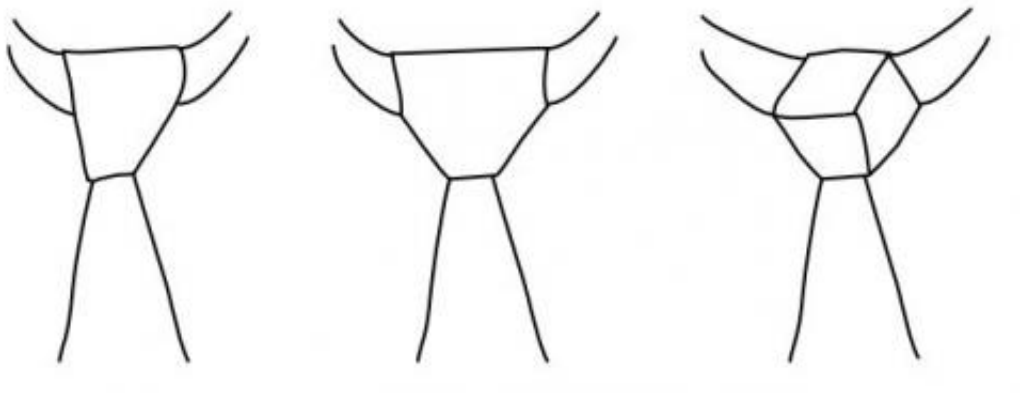
# Mathematicians calculate that there are 177,147 ways to knot a tie

February 10 2014, by Bob Yirka



Different examples of tie knots. Left, a 4-in-hand; middle, a double windsor; right a trinity. The 4-in-hand and double windsor share the flat fac¸ade but have different bodies producing different shapes. The trinity has a completely different fac¸ade, produced by a different wind and tuck pattern. Credit: arXiv:1401.8242 [cs.FL]

(Phys.org) —A small team of mathematicians, led by Mikael Vejdemo-Johansson of the of the KTH Royal Institute of Technology in Stockholm, has uploaded a paper to the preprint server *arXiv* describing a mathematical process they used to determine that the number of ways to tie a tie is 177,147—far more than previous research has suggested.

Most men don't consider more than one, two or maybe three ways to tie their tie, if they tie one at all—but the fact is, there are far more ways to

do it than most would ever imagine and because of that mathematicians have at times set themselves the task of trying to discern if the number is finite, and if so, what that number might be.

Back in 1999, a pair of researches (Yong Mao and Thomas Fink) with the University of Cambridge came up with a mathematical language to describe all the actions that can be performed in tying a tie and used it to calculate that the total number of possible outcomes was a very reasonable 85. In this new effort the researchers say that number is far too small because it leaves out some good possibilities. They've extended the mathematical language and have used it to create a new upper limit—177,147.

Vejdemo-Johansson apparently came to believe that the number produced by Mao and Fink was too small after noting the unique tie knot in the movie "The Matrix Reloaded"—a knot that didn't appear in the researchers list, which meant something wasn't quite right. In reexamining the criteria that Mao and Fink used for inclusion, they noted the pair restricted the number of tucks that would occur at the end of the tie tying, to just one. The pair, it was noted, also assumed that any knot created would naturally be covered in part by a flat section of fabric. Also, they restricted the number of windings that could be made to just eight, believing any more than that would cause the tie to become too short.

Vejdemo-Johansson adjusted the parameters and added nomenclature for describing tie movements and after putting it all together, used their new math language to calculate the new total number of possible tie knots—though, it might not be the last word—some of their parameter assignments, such as setting the maximum winds at 11, for example, could perhaps be adjusted for longer ties, or those made of much thinner material.

**More information:** More ties than we thought, arXiv:1401.8242 [cs.FL] arxiv.org/abs/1401.8242


## Abstract

We extend the existing enumeration of neck tie knots to include tie knots with a textured front, tied with the narrow end of a tie. These tie knots have gained popularity in recent years, based on reconstructions of a costume detail from The Matrix Reloaded, and are explicitly ruled out in the enumeration by Fink and Mao (2000).

We show that the relaxed tie knot description language that comprehensively describes these extended tie knot classes is either context sensitive or context free. It has a sub-language that covers all the knots that inspired the work, and that is regular. From this regular sub-language we enumerate 177 147 distinct tie knots that seem tieable with a normal necktie. These are found through an enumeration of 2 046 winding patterns that can be varied by tucking the tie under itself at various points along the winding.





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