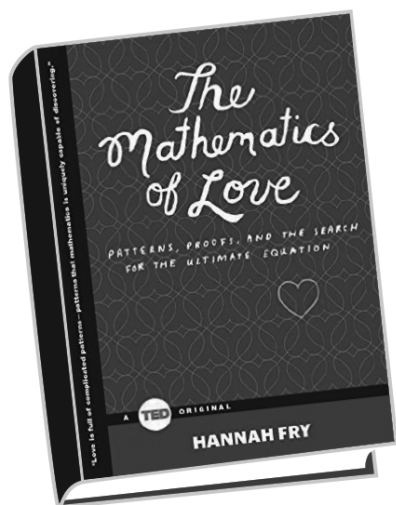




# The Mathematics of Love

*Reviewed by Mark Colyvan*




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*The Mathematics of Love: Patterns, Proofs, and the Search for the Ultimate Equation*

Hannah Fry

Simon and Schuster, February 2015

US\$16.99, xii + 113 pages

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On the face of it, affairs of the human heart are far removed from the world of mathematics. On the one hand, the mathematicians among us might see the lack of precision in love as reason enough to dismiss it from the proper domain of mathematical analysis. On the other hand, the romantics among us might see the cold, calculating nature of mathematics as an inappropriate tool for the study of love. *The Mathematics of Love* goes some way toward dispelling both these lines of thought and shows how mathematics can, indeed, shed light on love, sex, and romance.

The book is not written for a mathematical audience; it's written for a lay audience and presupposes very little

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*Mathematics can indeed shed light on love, sex, and romance*

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by way of mathematical training. The few technical details presented are introduced with such care and patience that even those averse to mathematics should not be put off—such people may even warm to mathematics once some of what it can do is better appreciated. Indeed, this is a large part of Hannah Fry's mission in this book: "my great hope is that a little bit of insight into the mathematics of love might just inspire you to have a little bit more love for mathematics" (p. xii). The fact that the book is not written for a mathematical audience does not mean, however, that there is no interest here for mathematicians. The book is engaging, humorous, and full of nice examples of applications of various branches of mathematics to human relationships. It would make a good supplementary text for teaching purposes at both the high school and the undergraduate levels.

The book consists of nine chapters, along with a brief introduction and epilogue. The first chapter deals with the chances of finding love and introduces the reader to some elementary probability theory. The second chapter considers the question of how important beauty is in attracting a suitable partner. This chapter is more concerned with the relevant psychology than any area of mathematics. Chapter three concerns optimising a night out, with the aim of finding a partner. Here the reader is introduced to elementary game theory and the Gale-Shapley matching algorithm. Chapter four addresses online dating and considers one of the more successful algorithms: the OKCupid matching algorithm. The fifth chapter concerns dating and game theory. Chapter six looks at network theory and its applications to sex. Chapter seven looks at settling down, optimal stopping theory, and the secretary problem. Chapter eight looks at how mathematics can help in wedding planning: expected utility theory for

choosing guest numbers and optimisation theory for seating arrangements. Chapter nine looks at the mathematics and psychology of living happily ever after.

I can't do justice to all these topics here, but I will say a bit about the game theory applications found in chapter five. The central issue here is that of achieving a stable, monogamous relationship. In particular, what prevents a partner defecting from a relationship by having an affair? The situation can be modelled in game theory as cooperative games such as the Prisoner's Dilemma or the Stag Hunt (Skyrms 2004). In the Prisoner's Dilemma the four outcomes are: (i) both partners cooperate in the monogamous relationship, (ii) partner 1 defects and has an affair while the other remains faithful, (iii) partner 2 defects while the other partner remains faithful, and (iv) both partners defect and have affairs. The payoffs for each of these four states depend on many things, including the psychology of the two parties and the level of knowledge each has about the faithfulness of the other. A plausible preference structure is as follows: partner 1 has from best to worse (ii), (i), (iv), (iii) and partner 2 has from best to worst (iii), (i), (iv) and (ii). As is well known, this is the Prisoner's Dilemma game, which has a Pareto optimal solution (i) that fails to coincide with the Nash equilibrium (iv). If this is the correct model of monogamous relationships, they'd be hard to achieve and maintain because of the attraction of the Nash equilibrium. Fortunately, for the romantics among us, things look brighter when we iterate such games. When we iterate such cooperative games, defection is suboptimal and cooperation is the preferred strategy. Indeed, as Axelrod points out in his 1984 book *The Evolution of Cooperation*, the game need not even be iterated; all that's required is that the agent in question believes that there is a non-trivial chance of iterations. Axelrod calls this "the shadow of the future" hanging over present decisions.

A concern might be raised about this approach to relationships: It's immoral to cheat on your partner, at least once both parties have agreed to be faithful, and this does not seem to be addressed by the game theory models. The thought here is that the game theory, by focusing on self-interest, treats agents as being very shallow and misses the all-important ethical dimension. But it can be argued that ethics is just more game theory (Colyvan 2010). The idea here is straightforward: ethics is all just a big cooperative game. This is to be contrasted with other ethical theories such as deontology, according to which some acts such as lying are prohibited, some such as preventing suffering are obligatory, and some such as studying mathematics are permissible—neither prohibited nor obligatory. Take the prohibited acts. It might be thought that there is something intrinsically wrong with lying, irrespective of its consequences. But according to the game theory account, all that matters are the costs and benefits to the self-interested individual. Of course being self-interested does not prohibit taking on board consequences for others: An agent might choose to ensure the well-being of those around her but the reason for this will be cashed out in terms of the benefit

this brings to her. Such an account of ethics is certainly controversial, but on such an account, there is no clash between the game-theory approach to relationships and ethics. It's all just game theory.

In general, I like the choice of topics in this book. Personally, I'd have liked a bit more detail on each of the topics, but that would have taken away from the admirable brevity of the book—it can easily be read in one sitting in a couple of hours. There are some useful suggestions for further reading, and this allows the author to survey the most interesting material without getting bogged down in technical details. One obvious item, however, does not appear in the further reading lists: Clio Cresswell's excellent 2003 book *Mathematics and Sex*. It is a little surprising that Cresswell's book is not mentioned, since it covers some of the topics in question in more detail and also covers other topics not found in the book under review. It would have made excellent further reading. Moreover, Cresswell's book is also aimed at a popular audience, and there are so few popular treatments of the mathematics of love and sex.

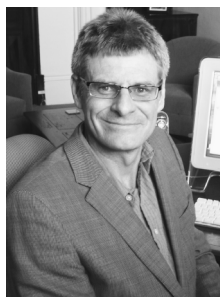
In summary, *The Mathematics of Love* is a delightful little book and a fun read. I recommend it wholeheartedly. I doubt that the readers of this journal will learn any new mathematics from it, but it is a good book to plunder for examples in your teaching and to recommend to your non-mathematician friends. While you might not learn any new mathematics, you might just learn a little about love.

## References

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## Credit

Photograph of Mark Colyvan courtesy of Mark Colyvan.



### ABOUT THE REVIEWER

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