Statement

Report of Norman Fenton

Dated	31 Oct 2018
Specialist Field	Probabilistic Risk Assessment
On the instructions	James Palmer HBA, MBA, International Consultant, Mondex Corporation
Subject matter	The decision of the Dutch Restitution Committee (DRC) to reject the claim of the Lewenstein family relating to a Kandinsky painting auctioned in 1940.

Version approved for public release

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The Author

1. I am Norman Elliott Fenton. I have a PhD in Mathematics and am currently Professor in the School of Electronic Engineering and Computer Science at Queen Mary University of London, where I am Director of the Risk & Information Management Research Group. I am also Director of Agena Ltd (a company that specialises in probabilistic/statistical risk assessment) and of Aldgate Analytics (under whose auspices I am undertaking this work). I have published 7 books and 250 refereed articles in various areas of mathematics and probability, computing, and risk analysis.

2. My current work is focused mainly on probabilistic risk assessment using Bayesian statistical methods with a special focus on improved legal reasoning and improved medical decision making. The approach enables improved risk assessment by taking account of both statistical data and also expert judgment. My experience in risk assessment covers a wide range of application domains such as: law and forensics; medicine; system safety and reliability; embedded software, transport systems, financial services, and football prediction.

3. I have been an expert witness or consultant in many major criminal and civil cases that involve statistical or probabilistic reasoning including several that concerns errors in forensic evidence. I have undergone expert witness training with Bond Solon under the auspices of Cardiff University Law Dept.

4. I have a special interest in raising public awareness of the importance of probability theory and Bayesian reasoning in everyday life (including how to present such reasoning in simple lay terms) and I maintain a website dedicated to this and also a blog focusing on probability and the law.

5. Since June 2011 I have led an international consortium (Bayes and the Law) of statisticians, lawyers and forensic scientists working to improve the use of statistics in court (I have published numerous recent articles on this subject). In 2016 I led a prestigious 6-month Programme on Probability and Statistics in Forensic Science at the Isaac Newton Institute for Mathematical Sciences, University of Cambridge, where I was also a Simons Fellow. I was appointed as a Fellow of the Turing Institute in 2018.

6. I am a Chartered Mathematician (being a Fellow of the Institute of Mathematics and its Applications), a Chartered Engineer (being a member of the Institution of Engineering and Technology and a Fellow of the British Computer Society.

7. My full CV can be found at www.eecs.qmul.ac.uk/~norman/

Background and Objectives of this Report

8. The Lewenstein family claim that the painting ‘Bilt mit Hausern’ by Kandinsky, which they are known to have owned, and which was sold at auction in 1940, was stolen from them during the War. Their restitution request was recently denied by the Dutch Restitution Committee (DRC)

9. There are concerns that the DRC based its decision upon logically flawed reasoning that was designed, from the very beginning, to refuse to restitute the painting to the Lewenstein family.

10. I have been asked by James Palmer to review the material in this case and to assign an estimated probability to the assumptions postulated by the DRC.

11. The objective of this report is to provide an initial brief statement based only on the summary of the facts of the case and the arguments used by the DRC.

12. My focus is solely on the relevant logical, statistical and probabilistic issues.

Analysis

13. The DRC reasoning is essentially based on the following argument:

    S1: Only Robert, and not Wilhelmine, had the painting after their mother died

    S2: Robert left the painting with Irma when they separated

    S3: Irma was still in possession of the painting in October 1940

    S4: Irma sold the painting at the auction in October 1940

    S5: Irma received the proceeds of the auction in October 1940

    (In what follows I refer to the five individual argument components simply as scenarios S1, S2, S3, S4, and S5 respectively).

14. The dependencies between the five scenarios and the claim

    M: Municipality of Amsterdam owns the painting

    is shown in Figure 1

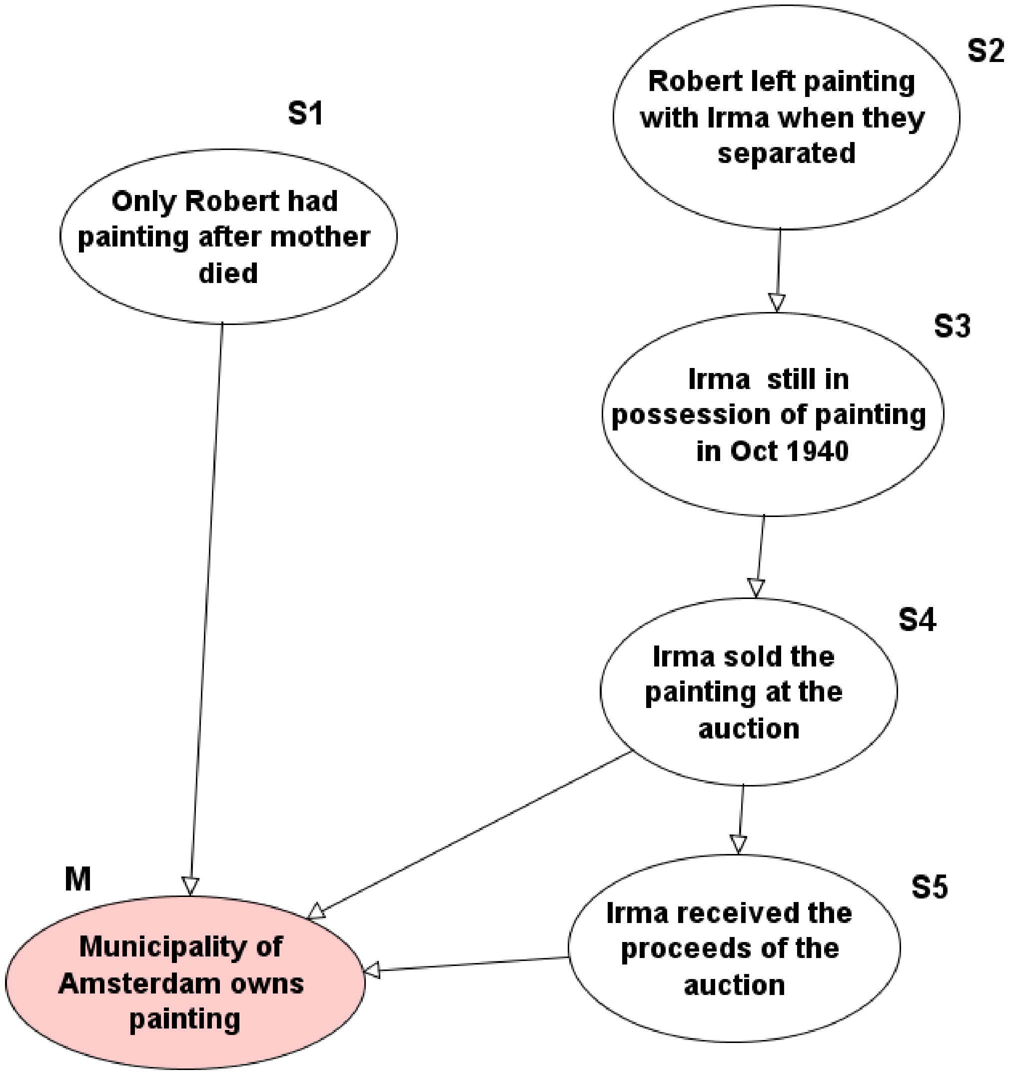

Figure 1 Dependency diagram (causal model)

15. The arrows between the hypotheses indicate a dependency.

16. It is important to note that none of the five scenarios, nor M, is known to be TRUE or FALSE. They are all 'unknown hypotheses' where, for each, the probability of being TRUE or FALSE should be updated as we discover relevant evidence.

17. The most important dependency is that of M on S1, S4 and S5. Specifically:

    M is TRUE when S1, S4 and S5 are all TRUE and is FALSE otherwise.

    In other words the DRC case is TRUE only if S1, S4 and S5 are all TRUE.

18. All of the other dependencies are 'uncertain': for example, if S2 is TRUE then S3 may or may not be TRUE.

19. Even without considering any evidence, we can use the model in Figure 1, together with basic probability calculations, to determine the probability that M is TRUE once we make certain assumptions.

20. For example, let us make the following assumptions:

> S1 is equally likely to be TRUE as FALSE (so the probability S1 is TRUE is 0.5, i.e. 50%)
>
> S2 is equally likely to be TRUE as FALSE
>
> S3 is equally likely to be TRUE as FALSE providing S2 is TRUE
>
> S4 is equally likely to be TRUE as FALSE providing S3 is TRUE
>
> S5 is equally likely to be TRUE as FALSE providing S4 is TRUE

21. Once the set of ‘prior’ probabilities listed in paragraph 20 are given, we can calculate the probability that M is TRUE. It turns out that, for the particular assumptions made in paragraph 20, **the probability that M is TRUE is extremely low – about 3%** as shown in Figure 2.

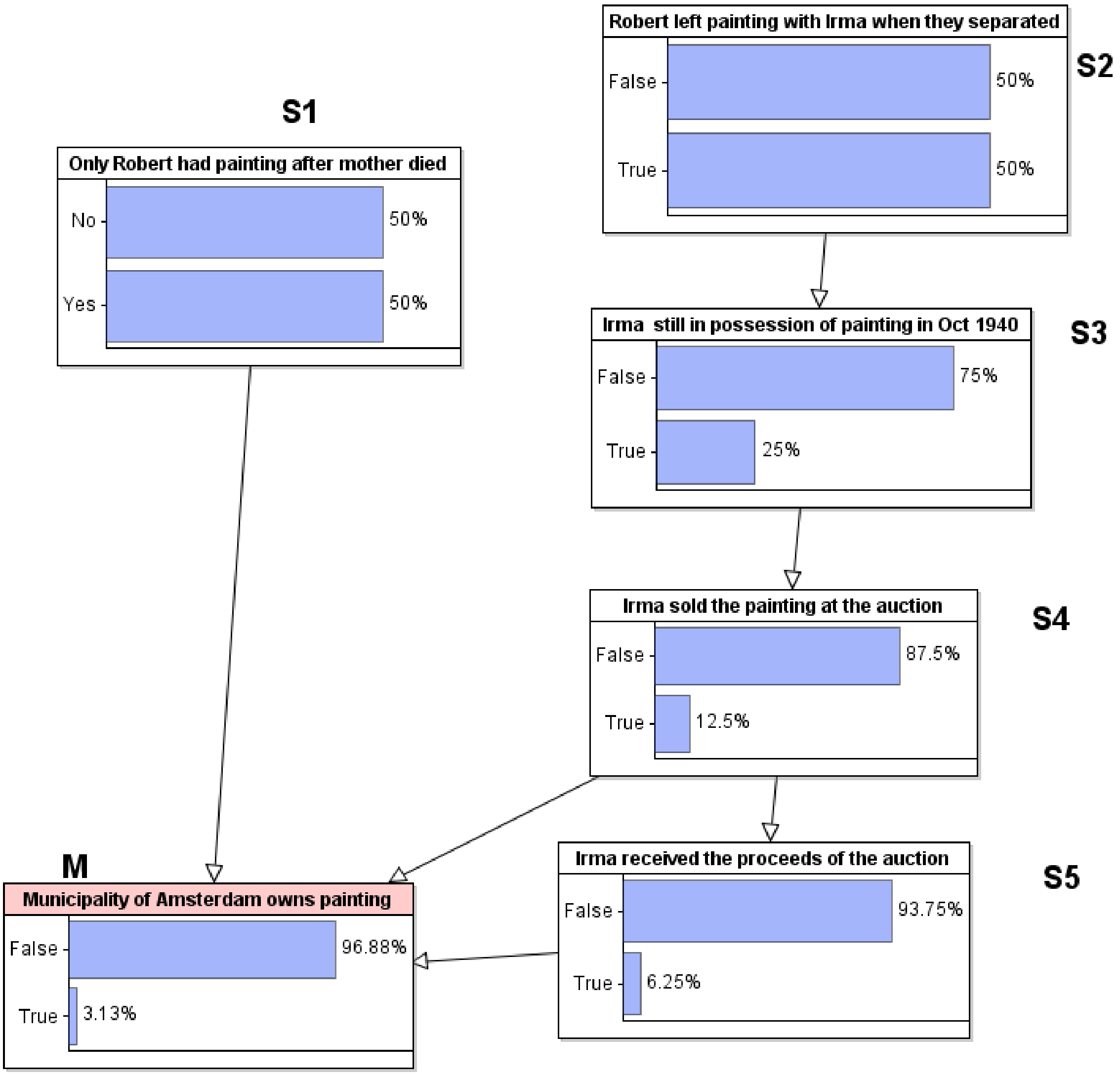

Figure 2 Probability results

22. Of course, if we change any of the assumptions in paragraph 20 then the resulting probability that M is TRUE will change. For example, let us assume the probability that S1 is TRUE is almost certain - say 90% - rather than 50%. Then the probability that M is TRUE increases – but it only increases to about 5%.

23. An explanation of how the calculations are performed is provided in the Appendix.

24. A thorough analysis of the case would require me to incorporate all of the available evidence (and lack of evidence) to determine more justifiable probabilities for those in paragraph 20 and to then apply relevant probabilistic updating methods. I will also be able to do sensitivity analysis on any of the prior assumptions and would also be able to say how 'certain' we would need to be about the truth of S1, S4 and S5 for the DRC case to be TRUE with, say 95% probability.

25. Based on a cursory review of the evidence – and based on my previous experience of performing this type of analysis – I suspect that the probability that when a full analysis is undertaken the probability that M is TRUE will actually decrease. In other words it seems exceptionally unlikely that the DRC claim is valid.

Summary

26. Based on an initial logical and probabilistic assessment of the case I conclude that the DRC claim is extremely unlikely to be valid. Specifically, with very basic assumptions that I suspect will turn out to be favourable to the DRC, the probability that their claim is TRUE is about 3%.

Concluding Statement

This statement signed by me is true to the best of my knowledge and belief and I make it knowing that, if it is tendered in evidence, I shall be liable to prosecution if I have wilfully stated anything in it which I know to be false or do not believe to be true.

N Fenton

31 Oct 2018

Signature **Date**

Appendix

The percentages shown in Figure 2 are the probabilities. So for a node (box) without parents, like the node S1, the probability of TRUE is assumed here to be 0.5 or equivalently 50%.

For a node with at least one parent, such as S3, the probability calculation has to take account of:

Prob 1: The probability S3 is TRUE if S2 is TRUE; and

Prob 2:. The probability S3 is TRUE if S2 is FALSE;

Here we assume that *Prob 1* is 0.5 (i.e. 50%) and that *Prob 2* is 0

Using standard probability theory, the probability that S3 is TRUE is then calculated as

[*Prob 1* × (Probability S1 is TRUE)] + [(*Prob 2* × Probability S1 is FALSE)]

which is equal to 0.5*0.5 + 0*0.5 = 0.25 (i.e. 25%)

We can also see what happens if we change our 'prior assumption' about the probability S2 is TRUE. Suppose we assume it is 0.9 (i.e. 90%). Then the probability S2 is TRUE is

0.5*0.9 + 0*0.9 = 0.45 (i.e. 45%)

So even if we are 'very sure' that S2 is TRUE, the fact that there is still some uncertainty about S3 being TRUE when S2 is TRUE results in a probability of less than 50% of S3 being TRUE.

If this is confusing think of a neutral example like tossing a coin twice.

Let S2 represent "the first toss is a Head"

Let S3 represent "Both tosses are Heads"

The probability of S2 being TRUE is 0.5.

The probability of S3 being TRUE if S2 is TRUE is 0.5

The probability of S3 being TRUE if S2 is FALSE is 0

So the probability S3 is true is (0.5 x 0.5) + (0.5 x 0) = 0.25

Now while the computations in the model of Figure 2 are simple enough to do 'by hand', when things get more complicated we need Bayesian network software to do the calculations automatically (in fact that is what I used even for this example). In particular, once we start entering evidence the necessary calculations involve what is called backward inference' rather than just 'forward inference'. This is where we have to determine things like: "What is the probability that S2 is TRUE once we know S3 is TRUE". For this type of probability inference we need Bayes Theorem and when there are many related nodes we have to use software to do all the necessary Bayesian 'propagation'.

An overview of the approach is provided in the first 7 pages of this report

https://www.eecs.qmul.ac.uk/~norman/papers/lsm.pdf