Legal certified software through proof assistants: a global scientific and managerial perspective

EuroProofNet

Joost J. Joosten + Team

University of Barcelona

Valencia, Friday 11-02-2022

The Formal Verification Team

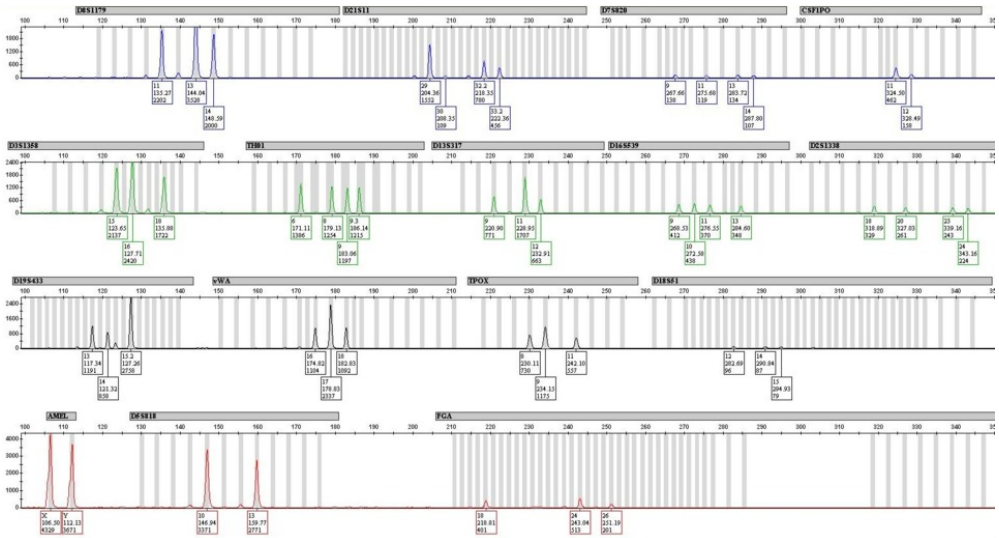
- The team is based in the University of Barcelona, and works conjointly with Formal Vindications S.L. and Guretruck S.L.
- Ana de Almeida Borges, Joaquim Buñuel Casals, Eduardo Hermo Reyes, Mireia González Bedmar, among others.

Project funded by the "Ministry of Science, Innovation and Universities", the "State Agency for Research" and the "European Regional Development Fund" (ERDF)

Computer evidence

Legal examples concerning unreliable software:

- In three cases, judges from USA have petitioned to **make the software open to the public** from proprietary DNA comparing software, due to some unreliable results:



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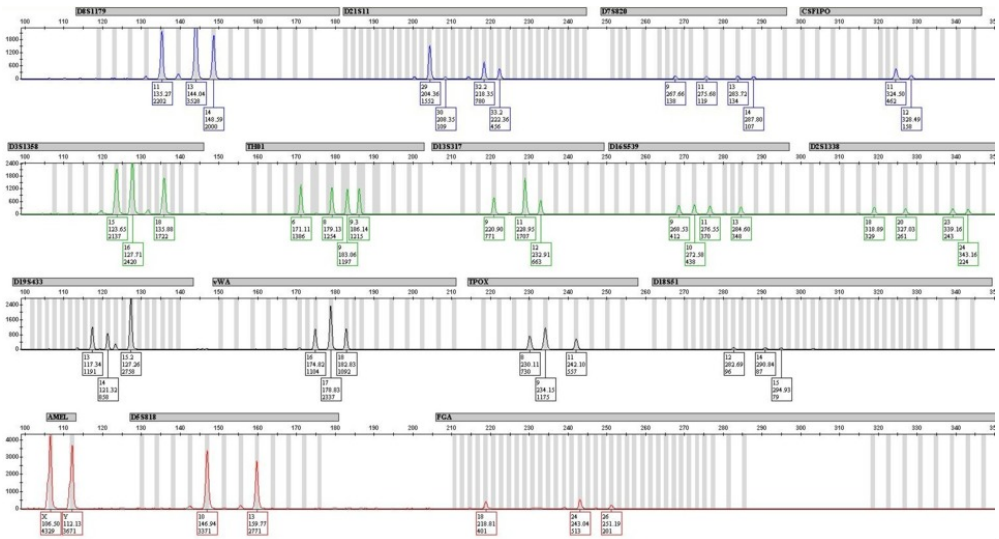

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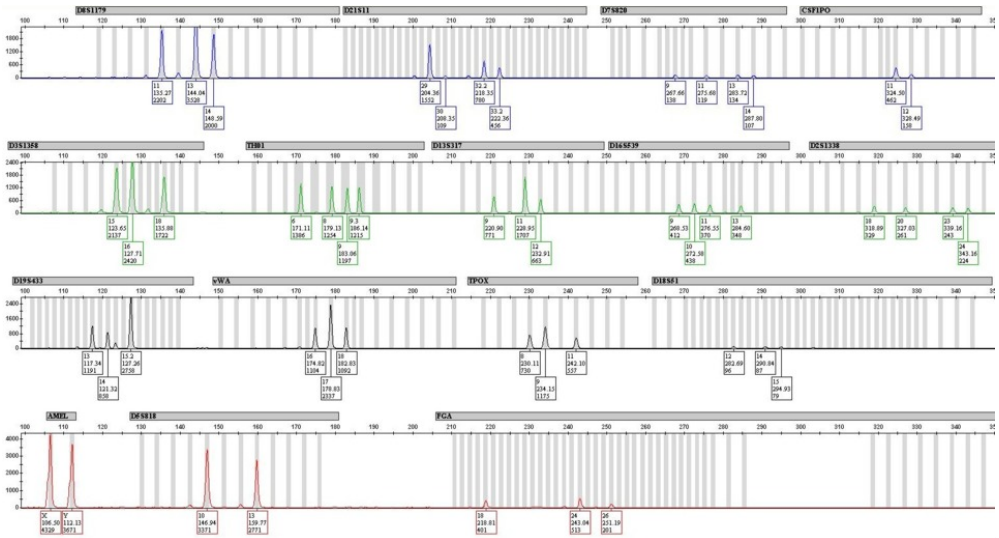

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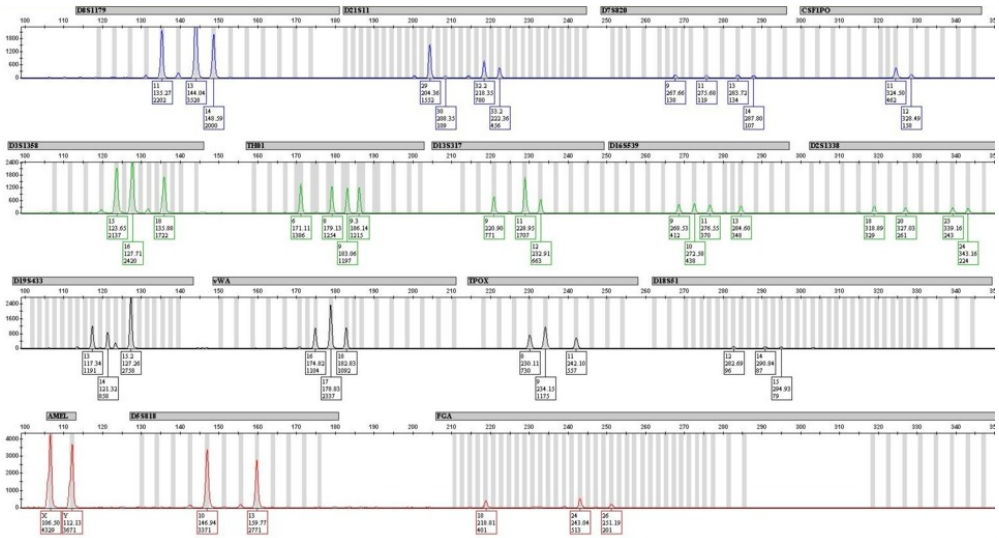
  - TrueAllele (still proprietary)



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- N. Sentence: 30/2019, CONTENCIOSO/ADMTVO court. N. 4 of Valladolid (Spain)

ADMINISTRACION DE JUSTICIA

infracción imputada y sancionada en cuanto que no se han incumplido los tiempos de descanso semanales.

En segundo lugar considera que los hechos denunciados no están suficientemente probados a efectos de poderlos considerar constitutivos de la infracción sancionada. En este apartado señala que el tacógrafo del que se han obtenido datos tiene una programación o configuración de fábrica que adolece de errores y que hace que sus resultados no sean fiables ni ciertos. No se trata de una avería o de un mal funcionamiento sino de errores de fabricación, configuración y/o programación llamando la atención sobre la falta de homologación del tacógrafo y, especialmente, del software utilizado dentro del mismo. A lo anterior añade que no consta, y por lo tanto falta, la homologación del software utilizado por las autoridades para obtener y procesar los datos registrados en el tacógrafo.

Se acepta lo alegado por la parte demandante en lo que se refiere a la ausencia de prueba de cargo suficiente respecto al software utilizado por la autoridad correspondiente para obtener los datos registrados en el tacógrafo por lo que, sin necesidad de analizar el resto de la fundamentación jurídica

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- We decided to isolate a 'non-problematic' part: Time Library

The FV Time Library

- Translation between times and timestamps

  $$\text{2022-02-11 10:20:00 UTC} \leftrightarrow 1644574827$$

- Timestamp: number of seconds since 1970-01-01 00:00:00, including leap seconds
- Time arithmetic:

  $$\text{2022-02-11 10:20:00} + 5 \text{ minutes} = \text{2022-02-11 10:25:00}$$

- Formalized in Coq
- Simple specifications, efficient implementations

Challenges

- Building a bridge (refinement) between proof-friendly types (unary `nat`) and computation and extraction-friendly types (primitive int)
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Our solutions led to nice tools in their own right.

`http://formalvindications.com/work/`

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- Is the formal specification the intended specification?

Some results

- Papers mathematically/logically/computationally analysing the law, see, e.g.

  `http://www.joostjjoosten.nl/papers.html`

  most notably
  A. de Almeida Borges, J. J. Conejero Rodríguez, D. Fernández Duque, M. González Bedmar, J. J. Joosten. **To drive or not to drive: A logical and computational analysis of European transport regulations.** *Information and Computation*, 2020.
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- Forthcoming event:
  `https://www.ub.edu/prooftheory/event/lawdesign/`
  Conference on Algorithmic Law Design and Implementation