CONSIDERATIONS ON THE UK RE-ARREST HAZARD DATA ANALYSIS:
HOW MODEL SELECTION CAN ALTER CONCLUSIONS FOR POLICY DEVELOPMENT

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Introduction

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- All non-convicted or cautioned individuals should have the same right to a private life.
- Alternatively, other than if a person were to commit a future offence, such profiling should have no direct consequence.
- Studies have claimed that persons subject to NFA are statistically more likely to be re-arrested.
ACPO Retention

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- By 2010, over 5 million people on the UK database with approximately 1 million of NFA.
In December 2008 the ECtHR (*Marper vs. UK*) ruled this was a violation of a person’s rights under Article 8 ECHR:
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1. Everyone has the right to respect for his private and family life, his home and his correspondence.
2. There shall be no interference ... except such as is ... necessary ... for the prevention of disorder or crime ...
Government Response

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- In May 2011 the UK Supreme Court found ACPO’s Guidelines as unlawful under the Human Rights Act.
"I want finally to turn to DNA ... My right hon. Friend ... had already legislated for safeguards on DNA use, including a six-year limit on retention ... He based those safeguards on analysis of reoffending rates ..."

Rt. Hon Yvette Cooper (Shadow Home Secretary), 2nd Reading of the Protection of Freedom Bill.
Re-Arrest Data Analysis

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- Denoting $T$ as the unknown number of years until future arrest, interest was in estimating the hazard rate $h(t)$:

$$h(t) = \lim_{\Delta t \to 0} P(t < T < t + \Delta t | T > t) \approx P(t < T < t + 1 | T > t)$$
## Data

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Weibull & Exponential Models

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- The parameters were found to be \( a = 0.166 \) and \( b = -0.686 \).
- An all-person comparator value of general arrest risk was also estimated as \( h(t) = 0.049 \), which arises from an Exponential survival model.
Results

![Graph showing the estimated probability of arrest within the next year conditional on an arrest not having already occurred over years from the initialization of the study. The graph compares the NFA Group and All Person Comparator.](image)
Alternative Mixture-Exponential

- An alternative is to use a Two-Mixture Exponential.
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- The time to future arrest $T$ either follows the Exponential model of the all-person comparator with probability $p$, or follows another Exponential with rate parameter $\alpha > 0.049$. 

- Allows modelling of a situation whereby some of the NFA group are no different to the general un-arrested population, whilst others are more inclined to criminality.
- Denote these as NFA-G1 and NFA-G2, respectively.
- Optimal fit under $p = 0.72$ and $\alpha = 0.87$, meaning 72% of the NFA group are no different to the un-arrested population, with the other 28% being nearly 18 times more likely to be arrested.
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The graph shows the estimated probability of arrest within the next year, conditional on arrest not already occurring. The x-axis represents years from the initialization of the study, ranging from 0 to 8. The y-axis represents the estimated probability of arrest, ranging from 0.00 to 0.30.

The graph includes several lines:
- Solid line: NFA Group (Weibull)
- Dotted line: NFA Group (Mixture Exponential)
- Dash-dotted line: All Person Comparator

Key points on the graph:
- Start of use of Model
- End of Monitoring

These lines and points help illustrate the trends and differences in arrest probabilities between different groups over time.
Conditional Probability of Group Assignment

- This allows determination of the conditional probability of assignment given re-arrest has not occurred by time \( t \):

\[
P(NFA - G1 | T > t) = \frac{P(T > t|NFA - G1)P(NFA - G1)}{P(T > t|NFA - G1)P(NFA - G1) + P(T > t|NFA - G2)P(NFA - G2)}
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- $P(T > t | NFA - G_1)$ is the all-person comparator model.
- $P(T > t | NFA - G_2)$ is the increased exponential model with $\alpha = 0.87$. 

Conditional Probability of Group Assignment

- This allows determination of the conditional probability of assignment given re-arrest has not occurred by time $t$:

$$P(NFA \sim G1|T > t) = \frac{P(T > t|NFA \sim G1)P(NFA \sim G1)}{P(T > t|NFA \sim G1)P(NFA \sim G1) + P(T > t|NFA \sim G2)P(NFA \sim G2)}$$

- $P(T > t|NFA \sim G1)$ is the all-person comparator model.
- $P(T > t|NFA \sim G2)$ is the increased exponential model with $\alpha = 0.87$.
- $P(NFA \sim G1) = 1 - P(NFA \sim G2)$ is the estimated value of $p = 0.72$. 
Results

- Probability of Being in NFA-G1 Conditional on re-Arrest Having not Occurred

- Years from Initialization
Discussion

- No causal explanation why arrest with NFA should make re-arrest more likely (other than violation of bail conditions).
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• Mixture-Exponential model has a (slightly) enhanced fit and more appropriate behavior when extrapolated.

• Whilst group membership assignment might be made with additional covariates (offence leading to arrest etc.), it supports a policy of much reduced retention duration, e.g., 95% of being no different to un-arrested population if not re-arrested after 2.42 years.