

Master Forensic Science

Research Projects 2021-2022



Research projects 2021-2022

The University of Amsterdam's (UvA) Master's programme in Forensic Science, offered by the Faculty of Science, is unique in the Netherlands. The programme distinguishes itself from most international Master's programmes in Forensic Science by building on a range of scientific disciplines, such as Chemistry, Computer Science, Life Sciences, Mathematics, Physics, and other exact sciences. The goal of the programme is to train good scientists, armed with forensic knowledge and skills.

A part of the curriculum is a six-month internship during which scientific research is executed that is relevant to the forensic field. This document gives an overview of the capabilities of our students and the many ways in which a research project can be conducted.

For more information please contact:
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| Title | Organisation | Student | Previous education |
|--|---|----------------------------|--|
| Criminalistics | | | |
| Bridging the gap between scenarios and traces: An exploratory study into the sensemaking process at crime scenes driven by a scenario-based approach | Netherlands Forensic Institute (NFI) | Lissy Hoogenboom | Forensic Research |
| Digital Forensics | | | |
| What Is Wrong With This Voice? Comparing Explainable Artificial Intelligence Techniques for Synthetic Speech Detection | NFI | Jeroen Bergers | Information Science |
| VaaFSA - Validating application analysis Forensic Software Argus | NFI | Christos Hadjigeorgiou | Computer Science |
| How well can steganography be detected in images using different steganalysis tools? | NFI | Madina Habib | Artificial Intelligence |
| Forensic Biology | | | |
| Rapid Body Fluid Identification with Direct RT-qPCR | NFI | Marie Louise Trinder | Biology |
| ForenSeq MainstAY kit - Evaluation of a Massively Parallel Sequencing STR Panel for the Identification of Missing Persons using Skeletal Remains | International Commission on Missing Persons | Maria Dede | Molecular Biology and Genetics |
| A Rapid and Direct Nanopore Sequencing Assay for Onsite Forensic Screening of Phenotypic and Genotypic Characteristics | AUMC | Desiree de Bruin | Biologie en medisch laboratorium onderzoek |
| Forensic Biophysics | | | |
| The Use of Hyperspectral Imaging and Deep Neural Networks for Non-Contact Age Estimation of Bloodstains | Amsterdam University Medical Center (AUMC) | Simone Lerco | Biomolecular sciences and technology |
| Towards age estimation of semen traces with a portable fluorescence spectrometer for forensic purposes | UvA | Mathijs Geurts | Psychobiology |
| Multimodal Latent Trace Imaging | NFI | Josca Rouw | Chemie, forensisch laboratorium onderzoek |
| Towards robust onsite time since deposition estimation of semen stains with a portable spectrofluorometer. | AUMC | Caren Leemberg | Life Sciences: biomolecular research |
| Evaluation of organ autofluorescence as a potential measure for the postmortem interval of buried remains | AUMC | Sifra Faasse - van Asperen | Life Science and Technology |

| Title | Organisation | Student | Previous education |
|---|-------------------------------|------------------------|----------------------------------|
| Forensic Chemistry | | | |
| Identification and differentiation of smokeless powders based on nitration profiles | University of Amsterdam (UvA) | Ids Lemmink | Bèta-Gamma major Chemistry |
| Rapid, on-scene classification of bulk explosives using a portable near-infrared analyzer coupled to a k-nearest neighbours algorithm | UvA | Pol Metres I Fito | Chemistry |
| Impurity profiling of fentanyl analogues with LC-MS/MS | TNO | Meike Kerklaan | Pharmaceutical Sciences |
| Optimization of a GC-MS method for the identification of illicit drugs | UvA | Esmee Schoonerderwoerd | Molecular Science and Technology |
| Background, Transfer, Persistence, and Recovery of Flash Powder Contaminated (Biological) Traces | NFI | Selma Wagenmakers | Chemistry |
| Mapping Dutch Illicit Drug Consumption through Wastewater Analysis | KWR Water Research Institute | Nicole Dolot | Computer Science |
| Towards the development of an Immuno-PCR assay to retrieve donor profiling information from fingerprints | AUMC | Mireia Perez Orts | Biotechnology |
| Forensic Medicine | | | |
| Using Alternate Light Sources for the Analysis of Burned Human Remains in Fire Scene Investigations | AUMC | Parnia Schariatmadary | Biology |
| The value of physical examination and forensic evidence collection in acute cases of suspected child sexual abuse | NFI | Willemijn Lolcama | Science, Business & Innovation |
| Precision and validation accuracy test of an ISO-9001 certified tooth cementum annulation protocol for age-at-death estimation in a forensic context | NFI | Yolanda Pressler | Biology |
| The inter- and intra-rater reliability of the Sexual Knowledge Picture Instrument (SKPI) - a tool to detect verbal and non-verbal signs of child sexual abuse | Emma Childrens Hospital | Shanti Bolt | Biomedical Sciences |
| Forensic Physics | | | |
| Virtualisation of striation patterns caused by knife stabbings | NFI | Britt Meijer | Physics and Astronomy |

| Title | Organisation | Student | Previous education |
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| Human Factor | | | |
| The availability and use of (forensic) medical information on physical injury in criminal cases. The perspective of public prosecutors. | Public Health Service (GGD) | Joyce Cuijpers | Health and Life Science |
| The influence of human factors in the examination of underwear for biological traces | NFI | Perle Russel | Health and Life Science |
| CSI-CSI: Comparing Several International Approaches Towards Crime Scene Improvement | NFI | Anna Knes | Neuroscience & Behavior |
| Other | | | |
| Determining prior probabilities in forensic archaeology using spatial statistics and radiocarbon dating. | NFI | Maurice Dunne | Medicinal Chemistry |

Criminalistics

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| Student | Lissy Hoogenboom |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | Matthijs Zuidberg |
| <i>Title thesis</i> | Bridging the gap between scenarios and traces: An exploratory study into the sensemaking process at crime scenes driven by a scenario-based approach |
| <i>Abstract</i> | <p>Crime scene investigators need to make various decisions concerning the relevance of traces are to determine whether these traces, which direct the entire criminal investigation, are relevant. Although a number of studies explore the benefits of incorporating intelligence analysis and cognitive science, there is limited knowledge on decision-making regarding crime scenes. Gaining insight into the information processes behind the search strategy of crime scene investigators (CSI) is a challenging task. How do crime scene investigators search for traces and decide whether this data may be relevant information to answer the question “what happened?” This study focuses on the development of “tools” that offer aid in the search for traces at crime scenes. We hypothesize that the scenes and actions of persons of interest (POIs) play a central role in the CSI’s information processes to make sense of traces, where investigators draw up cognitive schemas to generate expectations about scenes and POIs’ actions. To provide a robust and traceable crime scene examination, the gap between scenarios and traces must be bridged. To do so, we studied the sensemaking process through brainstorming with experts by outlining thought processes of experts in the case of a deceased person with a possible stab injury. This study demonstrates that a combination of the scenario reconstruction method (SRM) and crime scripting offers a valuable theoretical background to identify scenes and actions of POIs, which are valuable considerations for crime scene examination. By asking experts how likely these scenes are to occur given a particular main theme (e.g., crime, suicide, accident or natural cause of death), we were able to identify the most common and describe the distribution of Likert scores given each main theme. Our study found that a number of scenes and actions of persons of interest can be identified from experts’ cognitive schemata. Statistical analysis revealed a large variation in Likert scores for a high number of scenes. Nonetheless, there were also scenes that exhibited a small variation in Likert scores, indicating that when most respondents agree, we can identify which scenes are relevant and which ones are less relevant for each main theme. In addition, we were able to distinguish between the main themes for most scenes. The importance of sensemaking in crime scene examination has yet to be fully appreciated. Further research is required to collect additional data, test this data, and determine what the necessary means are to implement such data to eventually enable a robust and traceable crime scene examination.</p> |

Digital Forensics





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| Student | Jeroen Bergers |
| <i>Research carried out at</i> | UvA |
| <i>Supervisor</i> | dr. Bob Pirok |
| <i>Title thesis</i> | What Is Wrong With This Voice? Comparing Explainable Artificial Intelligence Techniques for Synthetic Speech Detection |
| <i>Abstract</i> | <p>With the introduction and rapid advancements in generative modelling, the dangers of malicious activity have increased. The increased concern of hostile actions via, for example, deepfakes makes good detection models necessary. Most of the research is going into the detection of synthetic video files, as a result, the detection of synthetic audio is severely lacking. As lots of communication is happening via speech audio, research into reliable synthetic audio detectors is essential. Current synthetic media detectors are often closed algorithms that produce a numerical output based on an input, giving limited additional information. New explainable artificial intelligence (xAI) techniques can visualize how the result is formed. In this research, the usefulness of the xAI techniques in synthetic audio detection is discussed. We trained two neural network-based spoofing models on our own created forensic speech synthesis database. Using four local explainers and multiple audio input formats (RAW, CQT), we create attention maps showing how the models form their output. We compare the obtained explanations for consistency and usability. Further, we investigate the sum of explanations to give an overall overview of the synthetic speech creation method in the test dataset. We finalize the research with a user study collecting opinions regarding the usefulness of the explainers.</p> |

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| Student | Christos Hadjigeorghiou |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | Abdul Boztas MSc |
| <i>Title thesis</i> | VaaFSA - Validating application analysis Forensic Software Argus |
| <i>Abstract</i> | <p>This research validates the application analysis forensic software Argus accompanied with a GUI with respect to android phones and emulators. It has been developed while considering the best practises and documentation guidance published by acknowledged bodies like ENSFI, NIST, SWGDE and the FSR relating to validating methods in digital forensics. Argus is developed by the NFI which records the created, modified, and deleted files in a physical phone or emulated device during an experiment using the metadata of the files. This research demonstrates the applicability, the reliability, and the reproducibility of the results of Argus acting as a validation study for Android phones and emulators. This way, it assesses the strengths and the limitations of the software and enables the digital forensic experts to make informed decisions relating to its usage in their work. A user-friendly GUI with extensive documentation has been developed to enable easy access to a device and alter its content while using Argus to record the changes. It can compare Argus results between repeated experiments manually or automatically using the frequency of detected records and subsequently compute an accuracy percentage. These results are stored in a database (local or remote) to encourage discussion and cooperation using a centralised phone artifact database. This database can be used to validate results obtained in further experiments and both the GUI and the databases are extensible as more functionality can be easily added like including popular phone applications. Throughout different and repeated experiments, Argus successfully detects all altered files resulting in an accuracy of 100% if and only if the experiments are performed on the directories that Argus reads and a rooted device is used. Similarly, the files that are added and deleted in the same experiments are not reported.</p> |

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| Student | Madina Habib |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | Meike Kombrink MSc |
| <i>Title thesis</i> | How well can steganography be detected in images using different steganalysis tools? |
| <i>Abstract</i> | <p>Steganography is the concealing of information within a medium. This can be done through different methods, such as through the spatial domain, transform domain, or through machine learning techniques. Steganalysis is the detection of said concealed information. There are different tools available for the detection of steganography, in this research five of these tools have been tested with datasets containing different types of steganographic images: OpenPuff, Virtual Steganography Laboratory, StegDetect, StegExpose, and StegoHunt. Seven datasets have been used to test these tools varying between 1000 to 2000 images per dataset. The datasets contain stego-images embedded through spatial domain techniques, transform domain techniques, and deep learning techniques. Overall, the research found that the used steganalysis tools do not produce accurate results for detection of steganographic content within images.</p> |

Forensic Biology

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| Student | Marie-Louise Trinder |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | dr. Margreet van den Bergen |
| <i>Title thesis</i> | Rapid Body Fluid Identification with Direct RT-qPCR |
| <i>Abstract</i> | <p>In forensic casework, evidential traces in form of body fluid stains are often left behind, for example blood, saliva, semen, vaginal mucosa, menstrual secretion and nasal mucosa. By analysing the DNA, the donor of the stain can be identified, but determining the cellular origin of these traces can be useful for reconstructing events. Current methods for body fluid identification are limited to presumptive tests for specific types of body fluids, which are often unspecific and insensitive. Additionally, time- and labour-consuming mRNA typing multiplex assays are in use. The aim of this research is to develop a quick, sensitive and specific method for rapid body fluid typing based on reverse transcription quantitative polymerase chain reaction (RT-qPCR) using cell type-specific markers which could eventually be used to replace current presumptive tests. Efficiency, specificity and robustness of RT-qPCR was tested on extracted RNA and lysates of six body fluids commonly found at crime scenes, namely blood, saliva, menstrual secretion, vaginal mucosa, semen and nasal mucosa. Results are promising, indicating first signs of RT-qPCR being specific, sensitive, rapid and convenient. More research, optimisation and testing is necessary before it can fulfil its potential role in rapid body fluid identification on crime scene stains.</p> |

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| Student | Maria Dede |
| <i>Research carried out at</i> | ICMP |
| <i>Supervisor</i> | Kieren Hill |
| <i>Title thesis</i> | ForenSeq MainstAY kit - Evaluation of a Massively Parallel Sequencing STR Panel for the Identification of Missing Persons using Skeletal Remains |
| <p><i>Abstract</i></p>     | <p>To address the issue of missing persons' identification, DNA-led approaches targeting informative genetic markers, short tandem repeats (STRs), are implemented in accredited forensic laboratories. More recently, massive parallel sequencing (MPS) methods continuously gain ground due to their ability to target and sequence a larger number of genetic markers in a processing run with comparable sample throughput to conventional capillary electrophoresis (CE)-STR analysis. The ForenSeq MainstAY kit is a novel MPS method that targets 27 autosomal (Au)-STR and 25 Y-STR markers and is characterized by backward compatibility to pre-established STR databases. In the present work, the performance of this forensic kit with samples that are representative of the ICMP's reference samples and (challenging) skeletal remains, was investigated. To this aim, several investigative parameters were established, such as reproducibility, sensitivity, concordance, robustness, and allele drop-out probability. Overall, results showed higher concordance to CE-STR genotypes for homozygote Au-STR loci and for ante-mortem samples. The kit was reproducible for replicates within the same run. However, reproducibility was not demonstrated for sample replicates spread across multiple runs due to increased stutter artifacts and/or allele drop-outs. Sensitivity studies revealed no consistent trend in the kit's performance linked to sample categorization. Moreover, the probability of an allele drop-out and therefore, the risk of a homozygote STR locus misinterpretation, could be significantly reduced by applying a cut-off value of 200 reads per allele. This work investigated the kit's performance with default manufacturer's protocols and UAS analytical thresholds. Further optimization efforts (e.g., library quality control, dedicated protocols for challenging post-mortem samples, tailored stutter analytical thresholds) must be made prior to the implementation of the kit in the context of missing persons identification.</p> |

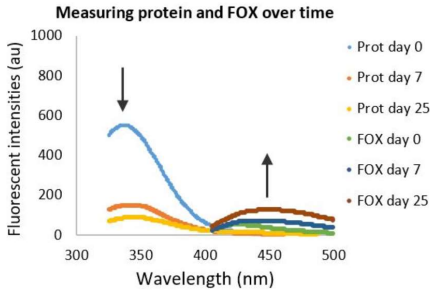
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| Student | Desiree de Bruin |
| <i>Research carried out at</i> | AUMC |
| <i>Supervisor</i> | Peter Henneman |
| <i>Title thesis</i> | A Rapid and Direct Nanopore Sequencing Assay for Onsite Forensic Screening of Phenotypic and Genotypic Characteristics |
| <i>Abstract</i> | <p>DNA is frequently encountered at crime scenes, but DNA evidence is hardly used during the investigative phase of police inquiries. Classic DNA analysis performed in forensic laboratories has a turnaround time of several weeks, while the police needs fast results that provide new investigative leads. In this study, we used a direct Nanopore sequencing approach and combined previously published forensic markers that are predictive of hair/eye/skin colour, biogeographical origin, and age in a single MinION assay. We also added forensic short tandem repeat markers, resulting in a genotype profile that can be compared to crime-related DNA profiles or profiles stored in (inter)national DNA databases. We validated MinION performance with contemporary DNA methods and obtained an accuracy of 87% for genotype markers, 78% for biogeographical origin markers, and 98% for hair/eye/skin colour markers, provided that MinION generated sufficient sequencing coverage. Marker regions were enriched using an adaptive sequencing approach, resulting in average read depths <10 per marker. In addition, age predictive markers were enriched with a hybrid adaptive and CRISPR/Cas9 approach, resulting in an average read depth between 10 and 35. Further optimisation of enrichment strategies, and subsequent increase in read depth, development of accurate data analysis scripts, and building an age prediction tool based on MinION data are required before MinION can be applied in forensic casework. Despite these hurdles, we demonstrated that MinION is technically capable of sequencing a wide variety of forensic marker types directly from genomic DNA and in a single experimental procedure. Therefore, MinION holds great promise as a future onsite tool for combined genotype and phenotype DNA analysis.</p> |



Forensic Biophysics

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| Student | Simone Lerco |
| <i>Research carried out at</i> | AUMC |
| <i>Supervisor</i> | Leah Wilk MSc |
| <i>Title thesis</i> | The Use of Hyperspectral Imaging and Deep Neural Networks for Non-Contact Age Estimation of Bloodstains |
| <i>Abstract</i> | <p>During a crime scene investigation, forensic investigators are tasked with examining and retrieving all crime-related evidence at the scene, as well as establishing a scenario and timeline of events. It is common practice to record the crime scene through pictures, and a way to collect more data over such practice is through the use of hyperspectral cameras, capable of recording the electromagnetic profile of the light reflected by a substrate. The chemical profile of blood changes as time passes, and so does its reflection spectrum, making it possible to use this information to predict the age of a bloodstain. This study aims at using neural networks to estimate the time since deposition of bloodstains using the reflection spectra extracted from hyperspectral pictures, thus developing a quick and contactless method that can be employed directly at the crime scene without disturbing the evidence, using common equipment that is already in use by forensic practitioners. A median error as low as 7.573% was reached, showing that this approach has promising implications for the field of forensic science, although more research is needed before being able to apply the method in real forensic casework.</p> |

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| Student | Mathijs Geurts |
| <i>Research carried out at</i> | UvA |
| <i>Supervisor</i> | Dr. Katrien Keune |
| <i>Title thesis</i> | Towards age estimation of semen traces with a portable fluorescence spectrometer for forensic purposes |
| Abstract | <p>Background: Estimating the age of traces has high forensic relevance, since this information can help to distinguish between crime-related and unrelated traces and to indicate the time of events. Previous studies have shown promising results to estimate the time of deposition with the use of fluorescence spectroscopy. By measuring the ratios of the protein and fluorescent oxidation products (FOX) fluorescence intensities over time in a biological sample, a model for the age estimation can be created. To actually bring this approach to the crime scene, a portable fluorescence spectrometer (PFS) is in development which enables fast, noncontact, onsite analysis. The aim of this research project is to compare this novel handheld spectrofluorometer with a validated benchtop spectrofluorometer, in terms of measuring the changes of protein and FOX fluorescence intensities that happen in semen traces over time. Methods: Semen samples were collected from 10 different donors, which were analysed in triplicates with both devices over a period of 25 days. On each measurement day, the 30 semen spots were examined by both devices with two sets of wavelengths, one to measure the fluorescence intensities of the Proteins and the other set to measure the intensities of the FOX. From each obtained spectrum, the Protein/FOX ratios were calculated per spot per time point. With the gathered data, estimations of the time of deposition were performed. The differences in reported ratios between the two devices were evaluated with the Pearson correlation analysis and the age estimations were judged with a Spearman correlation analysis. Data analysis and application of the age estimation function were performed with Matlab and SPSS. Results: Most changes in protein and FOX fluorescence intensities are measured during the first week after deposition. On average the PFS is able to report similar ratios as the benchtop per time point ($r = 0.9023$, $p < 0.0001$). The PFS reports, however, high intra-sample variability whereas the benchtop contradicts this finding, indicating problems with the repeatability of the PFS. Furthermore, age estimation of semen stains was achieved with the benchtop, up to 9 days, but not with the PFS. Conclusion: Overall the PFS was able to report kinetics similar to the benchtop, which makes the PFS a promising addition for onsite trace analysis. This study also confirms that the aging model can successfully be used to estimate the time of deposition of semen stains, although not yet with the results acquired using the PFS. Challenges need to be overcome and the first next objectives are to analyse and improve the deficient repeatability of the PFS and to optimise the aging model for the PFS data.</p> |



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| Student | Josca Rouw |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | dr. Mattijs Koeberg |
| <i>Title thesis</i> | Multimodal Latent Trace Imaging |
| <i>Abstract</i> | <p>In the preliminary investigation phase of a forensic investigation, the importance of traces on a piece of evidence is not always immediately clear and may change during the investigation. It is challenging to detect tiny traces on large surfaces when their present and exact location is unknown. Therefore, it could be challenging to determine a sampling strategy. Moreover, activity level scenario testing is becoming increasingly important in forensic investigations. For that reason, it is important to get a good overview of all traces present, and their location on a piece of evidence before any invasive investigative measures are taken. Consequently, the goal of the study was to provide the basis for developing a multidisciplinary imaging strategy by evaluating the additional value of combining techniques for forensic casework and exploring data combination possibilities. Multiple trace-substrate combinations were analysed using X-ray fluorescence (XRF), hyperspectral imaging (HSI) and a forensic light source (FLS) to determine their advantages and limitations for a multimodal imaging device. Most trace-substrate combinations that forensic experts labelled as challenging to visualise were visualised with at least one of the three techniques, except pepper spray. Together, the techniques provide spectral and elemental information, allowing 38 of the 42 trace-substrate combinations to be visualised. Moreover, the techniques together indicate of the type of trace. The data analysis was performed separately per technique, after which the information was combined. However, there is a possibility that even more contrast and information of the traces and substrates can be obtained if the hyperspectral data and the data combination of the various techniques are analysed in more detail. Nevertheless, the combination of XRF, FLS and HSI already shows that it can be used as a non-invasive tool to make multiple types of forensic traces visible on different substrates. Therefore, the combination of XRF, FLS and HSI will make it possible to formulate a well-thought-out sampling strategy, which will lead to better decision-making in the preliminary phase of a forensic investigation and to evaluate the activity level scenarios since the exact location of traces can be determined.</p> |

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| Student | Caren Leemberg |
| <i>Research carried out at</i> | AUMC |
| <i>Supervisor</i> | Dr. Nihad Achetib |
| <i>Title thesis</i> | Towards robust onsite time since deposition estimation of semen stains with a portable spectrofluorometer. |
| <i>Abstract</i> | <p>Estimating the age of semen traces has high forensic relevance in cases of sexual assault, as this information can help reconstruct the sequence of events. Previous studies have shown that the age of fingerprints and semen traces can be estimated using fluorescence spectroscopy in combination with an aging model. By monitoring the decrease in protein fluorescence and the increase in the formed fluorescent oxidation products over time, a protein/FOX ratio was calculated, which was used in an aging model to estimate the age of fingerprints and semen stains successfully. However, the fluorescence spectrometer used in these studies is heavy and oversized. Evidently, leaving the forensic community still in need of a portable fluorescence spectrometer (PFS) that allows for fast, non-contact, and onsite analysis. This research project aimed to compare a newly developed PFS in signal, accuracy, and precision with the benchtop spectrofluorometer (LS55) for estimating the age of semen stains. Semen samples from fifteen donors were analyzed over twenty-seven days with both devices to measure the protein and FOX fluorescence upon aging. Ten of these donors were used to train the aging model, and five other donors were used to test the trained aging model for both devices. The age estimates of the two devices were evaluated with a Spearman correlation analysis, which analyzed the correlation between the estimated age and true age for both devices. The training set of the LS55 showed a very strong correlation between actual and estimated age (Spearman $r = 0.909$, $P < 0.001$) with an MAE of 1.6 and a correlation (Spearman $r = 0.988$, $p < 0.001$) with an MAE 1.6 days observed with the test set of the LS55. Age estimation was possible up to 11 days with the LS55. The training set of the PFS showed a very strong correlation between true and estimated age (Spearman $r = 0.912$, $P < 0.001$) with a mean absolute error (MAE) of 1.4 days and a correlation (Spearman $r = 0.978$, $P < 0.001$) with an MAE of 0.8 days was observed with the PFS test set, making age estimation possible up to 12 days with the PFS. In conclusion, the PFS can be successfully used to estimate the age of semen stains, even better than the LS55 in terms of signal, accuracy, and precision.</p> |

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| Student | Sifra Faasse – van Asperen |
| <i>Research carried out at</i> | AUMC |
| <i>Supervisor</i> | Dr. Nihad Achetib |
| <i>Title thesis</i> | Evaluation of organ autofluorescence as a potential measure for the postmortem interval of buried remains |
| <i>Abstract</i> | <p>Knowing the post mortem interval (PMI) is of great importance in forensic death cases, providing temporal information needed to reconstruct crimes. However, the PMI estimation is often inaccurate, even more so when dealing with buried remains. Therefore, new estimation methods are needed. In this study, autofluorescence is evaluated to determine if this can be used to estimate the PMI. To do so, two experiments were set up with the following research questions: I) 'What are the spectral differences of organs at a PMI of less than 1 day and a PMI (and burial period) of 13 weeks?' and II) 'How can we monitor the autofluorescence of the liver in situ in buried remains?'. It was found that autofluorescence cannot readily indicate a PMI yet. The main difference in autofluorescence at T=0 and T=13 was found to be a lower ratio between the protein and other fluorescence peaks, though this was not true for the lung and some liver samples. As this result deviated from outcomes of previous experiments, oxygen availability was evaluated as one of the environmental factors possibly causing this difference. It was found that higher oxygen concentrations cause a faster and larger decrease in ratio compared to less oxygen-rich environments. As the decomposition of buried remains is mostly anaerobe, future experiments should apply anaerobe circumstances as well. Additionally, the increased and decreased ratios were subject to intra- and interpersonal variability. To use autofluorescence for a PMI model, these variabilities should be identified in experiments with larger sample sizes. For the measurement of autofluorescence of the liver in the buried remains, we developed a method using an optical fiber in the liver and a portable spectrometer setup. The results obtained by using this method, suggest a relative decline in protein fluorescence and a relative increase in other fluorescence, but more data is needed for a solid conclusion. The portable setup should be optimized to get more reliable data in future experiments. When optimized, this experimental approach enables acquiring longitudinal autofluorescence data of buried remains needed to make a PMI model.</p> |

Forensic Chemistry

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| Student | Ids Lemmink |
| <i>Research carried out at</i> | UvA |
| <i>Supervisor</i> | Rick van den Hurk MSc |
| <i>Title thesis</i> | Identification and differentiation of smokeless powders based on nitration profiles |
| <i>Abstract</i> | <p>Smokeless powders (SPs) are one of the most commonly used propellants for ammunition but can also be abused as energetic material in improvised explosive devices (IEDs). In a five year period, IED explosions resulted in over 100.000 casualties. When an SP-based IED is found, chemical profiling is often one of the last forensic options to help the investigating authorities obtain a link between the offence and offender. All SPs contain nitrocellulose (NC) and a mixture of additives. NC is a high-molar mass polymer, produced by the nitration of plant-based cellulose. The nitrogen content of NC in SPs differs between 12% and 13.5% with batch-to-batch variation due to slight differences in reaction conditions during production. This variation could make the nitrogen content of NC a characteristic to include in the chemical profiling of SPs. In this study, size exclusion chromatography (SEC) was used to separate NC from the additives. A linear relationship ($R^2 = 0.9722$) between the surface area under the NC-peak in the SEC chromatogram measured at 210 nm and the nitrogen content of the NC was obtained. Combined with a method that determines the amount of additives present in the SP sample, the linear relationship enables the forensic expert to determine the nitrogen content of NC present in all SP. The simplicity and accuracy of the 1D-SEC-UV method reduces analysis time, required amount of sample, manual labor and probability on errors. Additionally, no extensive sample preparation is required. A discrimination power of 80.00% was obtained when studying the nitrogen content of NC. Combined UV absorbance and refractive index (RI) measurements have shown that the nitro group distribution over the MWD of NC varies between different SPs, and is recommended for further research. Furthermore, the validation of the linear relationship using NC standards, and a study on the effect of aging and different storage conditions on the loss of nitro groups is required before SP profiling based on the nitrogen content of NC can become the new forensic standard in SP-based IED cases.</p> |

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| Student | Pol Mestres I Fito |
| <i>Research carried out at</i> | UvA |
| <i>Supervisor</i> | Ruben Kranenburg |
| <i>Title thesis</i> | Rapid, on-scene classification of bulk explosives using a portable near-infrared analyzer coupled to a k-nearest neighbours algorithm |
| <i>Abstract</i> | <p>On-scene analysis of explosives is desired to assist decision-making already on the scene. Traditionally, colorimetric presumptive tests are done. However, they lack specificity and are not reliable. Raman and infrared (IR) spectroscopy have also been proposed, but Raman presents problems with fluorescent samples and IR is an invasive technique. Near infrared (NIR) spectroscopy can overcome the drawbacks of other techniques and, together with chemometric tools, is selective enough to be applied to a large set of compounds. This worked aimed to study the applicability of a portable NIR sensor to classify bulk explosives. This study presents a NIR sensor that works in the 1350 -2550 nm spectral range able to produce fast, reproducible, and selective data. Together with a k-nearest neighbours (kNN) algorithm, the sensor is able to accurately classify a set of 17 explosives encountered in casework, including organic and inorganic compounds as well as mixtures of them. A limitation of the applicability of the sensor is that it is not able to analyse black and metallic-coloured samples. The model was successfully applied to casework explosive samples with 97.8% correct classification. Our approach has the potential to be used by officers on-scene to conduct explosive identification in a fast, accurate manner. Eventually, the results from the proposed NIR procedure, together with an orthogonal on-scene technique, could be of use in Court without the need of laboratory analyses, assisting in making forensic identification of explosives more efficient.</p> |

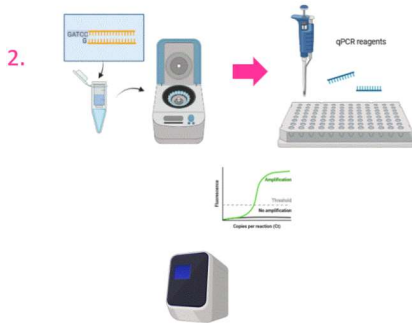
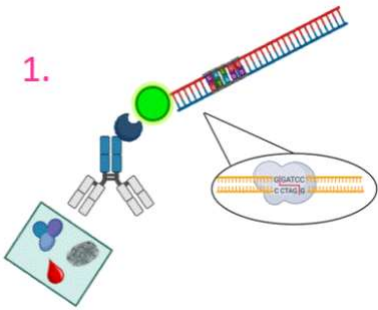
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| Student | Meike Kerklaan |
| <i>Research carried out at</i> | TNO |
| <i>Supervisor</i> | Mirjam de Bruin - Hoegee |
| <i>Title thesis</i> | Impurity profiling of fentanyl analogues with LC-MS/MS |
| <i>Abstract</i> | <p>The number of chemical threat agents which have entered the illicit drug market has increased majorly over the past few decades. The fentanyl analogues sufentanil, carfentanil and remifentanil are included as well. These opioids are very addictive and are responsible for a lot of overdoses resulting in deaths in the USA. To address this problem more information about the origin of these compounds is required. Chemical profiling is a technique which can establish a link between material found at the crime scene and the geographical origin, synthetic route or precursors of the synthetic route. In this study identification of the fentanyl analogues and the intermediates is obtained with LC-MS/MS. Subsequently these results are analysed with Compound Discoverer to obtain a list with possible impurities. The impurities found are then addressed to investigate if they are discriminating to be set as marker compound for a specific synthesis route. For sufentanil four intermediates are identified as impurities. For carfentanil this was one intermediate and for remifentanil two intermediates. Carfentanil was also synthesized via an Ugi reaction resulting in no intermediates identified as impurity. In the case of the Ugi reaction two precursors were identified as impurities. These results were based on only one batch of the final product and before a marker compound can be identified multiple batches should be analysed. Further research should investigate if the found impurities could be set as marker compound for the synthesis routes investigated. Next to that for this research to be applicable in the forensic field multiple synthesis routes for the same fentanyl analogue should be analysed. This way statistics can add value to the findings of this study.</p> |

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| Student | Esmee Schoonderwoerd |
| <i>Research carried out at</i> | UvA |
| <i>Supervisor</i> | ing. Tom Aalbers |
| <i>Title thesis</i> | Optimization of a GC-MS method for the identification of illicit drugs |
| <i>Abstract</i> | <p>In recent years, the number of newly identified New Psychoactive Substances (NPS) has increased tremendously. Often NPS are changed slightly in chemical structure, often isomers of illicit drugs are synthesized with the purpose of falling outside of the legislation. NPS pose a risk to public health and it is therefore of importance that these substances are regulated by law. Controlling NPS brings about some analytical challenges. Since they are highly similar to their analogues, traditional GC-MS methods struggle to differentiate between these compounds. Optimization of the traditional GC-MS methods can aid in the differentiation of isomeric structures. During this project an optimized GC-MS method was developed for the analysis of drugs of abuse, and retention indices were introduced as a means of identification. Optimization parameters included the flow rate and temperature program. Retention indices were determined for 16 substances, including common drugs of abuse and NPS. With the combination of a mass spectrum and retention index it is possible to differentiate between isomeric compounds, such as 2-FA, 3-FA and 4-FA. This GC-MS methodology offers an additional means of identification in complex mixtures of common psychoactive substances and is able to distinguish between positional isomers.</p> |

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| Student | Selma Wagemakers |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | Annemieke Hulsbergen - van den Berg |
| <i>Title thesis</i> | Background, Transfer, Persistence, and Recovery of Flash Powder Contaminated (Biological) Traces |
| <i>Abstract</i> | <p>The European INHERIT project aims to disrupt or prevent home-made explosive production. Its multifaceted approach encompasses rendering precursors and their explosive end products inert, more readily detectable and capable of yielding greater forensic value. This report focuses on enhancing the investigation of clandestine explosive laboratories by gaining activity-level knowledge on flash powder. One part entails increasing sampling efficiency by predicting the most valuable sampling locations. Alternatively, the other part intends to tie a perpetrator to the crime in its preparatory phase by exploring flash powder contaminated biological traces. First, background levels of perchlorate were determined on utilized equipment and a range of relevant materials. To determine transfer properties, multiple series of twenty successive glove- and fingerprints were placed on microscope glass slides, as well as on several other materials. These series were analyzed semi-quantitatively with μ-XRF and quantitatively with IC-MS. In addition, fingerprints were further visualized with MA-XRF and a hyperspectral camera, including various types of forensic light and wavelength ranges. To evaluate transfer by airborne flash powder, common clandestine laboratory objects of various materials were placed in proximity of an explosive disassembly site and analyzed quantitatively by IC-MS. Moreover, experiments were conducted concerning the transfer and persistence of airborne flash powder onto head hair. Moisture conditions, wind power, flash powder composition and particle size were varied. The resulting hair samples were analyzed qualitatively by SEM-EDX.</p> |

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| Student | Nicole Dolot |
| <i>Research carried out at</i> | KWR Water Research Institute |
| <i>Supervisor</i> | dr. Thomas ter Laan |
| <i>Title thesis</i> | Mapping Dutch Illicit Drug Consumption through Wastewater Analysis |
| <i>Abstract</i> | <p>Illicit drug abuse is an international problem that takes a great toll on society. For governments and law enforcement to effectively control drug abuse and help those affected by it, they need accurate information on consumption trends and the size of the drug market. A tool that can provide these insights is wastewater analysis. This method relies on estimating the drug consumption of a certain population from the drug residues in municipal wastewater. This study poses two questions: "What geographical and temporal trends for drug consumption in the Netherlands can be derived through wastewater analysis?" and "How can wastewater data be used to estimate the size of the drug market in the Netherlands?". Five drugs were studied, namely: cannabis, cocaine, amphetamine, methamphetamine, and MDMA. Wastewater was sampled over a period of 12 years (2010-2021) at 27 sewage treatment plants across the country. Three of these were sampled yearly for the entire period (Amsterdam-West, Utrecht and Eindhoven). Consumption values expressed as mg of pure drug/day/1000 people were back-calculated according to the SCORE guidelines and were then used to answer the research questions. Concerning long-term trends, linear regression analysis showed that amphetamine consumption increased in Utrecht and Amsterdam, while cocaine consumption increased in Amsterdam and Eindhoven. While methamphetamine consumption increased significantly for all three plants, no linear trends could be found for MDMA consumption. Regarding weekly consumption, two-tailed T-tests revealed that MDMA and cocaine are consumed significantly more during weekends than weekdays. As for the geographical trends, linear regression analysis showed a positive correlation between the level of urbanization and cocaine, methamphetamine and MDMA consumption. Monetary estimations were performed by combining the back-calculated consumption values with the average drug purities and prices and then extrapolating the results to the entire population of the Netherlands. The THC retail market was estimated at 2.5 billion euros (41 tonnes), accounting for 22% of the EU market, followed by cocaine at 1.2 billion euros (71 tonnes), representing 13% of the EU market, MDMA at 120 million euros (5 tonnes)-24% of the EU market and amphetamine-32 million euros (2 tonnes)-3% of the EU market.</p> |

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| Student | Mireia Perez Orts |
| <i>Research carried out at</i> | AUMC |
| <i>Supervisor</i> | dr. Annemieke van Dam |
| <i>Title thesis</i> | Towards the development of an Immuno-PCR assay to retrieve donor profiling information from fingerprints |
| <i>Abstract</i> | <p>The chemical components present within the fingerprint residue can be crucial when the sample fingerprint cannot be matched to stored fingerprints in police databases, but even if a match is found, they can provide additional information that could be used for confirmation purposes. These components serve as biomarkers that indicate certain attributes that the donor of the trace must possess (i.e., sex or blood type). Current methods available for the study of the chemical composition for donor profiling applications present a series of limitations that hinder their applicability in forensic practice. To bridge the gap between forensic research and practice, this project aimed to design an alternative method, an immuno-PCR (iPCR) assay for the detection of human serum albumin (HSA), previously detected in the fingerprint residue as a proof-of-concept study. Immuno-PCR makes use of an amplifiable DNA template that is conjugated to an antibody for exponential signal generation enabling also quantification of the antigen present within the sample. The non-covalent streptavidin-biotin interaction was selected for the functionalization of a synthetic novel DNA label and specific anti-HSA antibody. Dot blotting confirmed the generation of a dsDNA biotinylated reporter obtained through PCR amplification with a biotinylated primer. This DNA label proved to be specifically amplified in real-time PCR by the designed primers in cross-reaction studies. A linear relationship was established between concentration of DNA label and crossing-point values (Cp) and the sensitivity in detection was established at a 1:100 000 dilution. On the other hand, FPLC chromatography showed conjugation of the antibody to streptavidin, even if excess free-reagents were also present. The in situ assembly of the immunocomplex in the immuno-PCR assay developed generated a high background signal and non-specific binding of the DNA label to the nitrocellulose membrane, meaning that signal generation was antigen independent and quantification was not feasible. This research highlighted the need of a thorough optimization process to set up a functional iPCR method which involves the pre-conjugation of the immunocomplex controlling molar stoichiometries of assay components, additional purification steps to remove excess reagents and optimization of blocking and washing solutions to reduce noise-to-signal ratio.</p> |




Forensic Medicine

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| Student | Parnia Schariatmadary |
| <i>Research carried out at</i> | AUMC |
| <i>Supervisor</i> | Tristan Trap MSc |
| <i>Title thesis</i> | Using Alternate Light Sources for the Analysis of Burned Human Remains in Fire Scene Investigations |
| <i>Abstract</i> | <p>Burned human bone has shown to have luminescent properties when excited with alternate light sources (ALS). During this research, ALS were used to investigate visualization of latent details relevant for forensic investigations at fire scenes. As fire is a destructive force, it induces a vast variety of physical and chemical alterations to all components of the bone, making the subsequent analysis and interpretation of burned human remains challenging. The bone loses its viscoelastic and mechanical properties and becomes more prone to fracturing during and after fire exposure. Hence differentiating between heat-induced bone fractures and pre-fire fractures becomes challenging. By analysing these two different fracture types on a set of burned human remains, it was shown that ALS can visualize differences in the ratio of carbonized and calcined bone in pre-fire and heat-induced fractures more clearly through differences in observed luminescence intensity. Moreover, it was tested whether ALS can visualize latent heat border lines (HBL). Receding soft tissue or falling fire debris can shield one part of the bone from fire, resulting in a typical HBL, demarcating unburned, charred and then calcined bone. Visible HBLs disappear once the bones are calcined, but it is hypothesized that latent HBLs remain due to a difference in temperature and exposure. By burning human bones at 700°C and 900°C, a shift from green to red luminescence was detected using ALS. A calcined bone that shows a general green luminescence can show a small patch of absent luminescence on the same segment, caused by an increase of temperature and exposure on that specific area. This is only visible using ALS and therefore seen as a latent HBL. Understanding this phenomenon can help forensic anthropologists in estimating flame exposure and the temperature of the fire. The presented research on using ALS on heat fractures and HBLs shows that implementing ALS in the analysis of thermally altered human bones can improve interpretation of burned remains and reconstruction of the fire scene.</p> |

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| Student | Willemijn Lolcama |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | dr. Wouter Karst |
| <i>Title thesis</i> | The value of physical examination and forensic evidence collection in acute cases of suspected child sexual abuse |
| <i>Abstract</i> | <p>Objective: To analyse all acute cases of suspected child sexual abuse where the child has been examined by forensic physicians of the Netherlands Forensic Institute (NFI) between August 2016 and July 2021. An epidemiological overview of the sample was created to visualize all characteristics of the cases examined. The association of factors with successful forensic evidence collection were investigated. Methods: Based on the registration forms that were filled in during Acute Forensic Medical Examinations (AFMEs) and DNA reports, a dataset was constructed containing all information about the alleged abuse such as abuse history, child and suspect information, and DNA results. Using Microsoft Excel and IBM SPSS statistics, the characteristic of each case were processed. The factors associated with successful forensic evidence collection, such as injuries and DNA, were assessed using logistic regression. All relevant factors were analysed individually using bivariable logistic regression. Next, all significant (p-value <0.05) factors were used in multivariable logistic regression to find the best fitting model. Results: In total 652 cases were included in this study. In 596 cases the forensic evidence collection kit was used to sample the body of the children of which 39% were sent in for DNA analysis. Out of the sent in kits of prepubertal children (n=147) 33% were positive for non-self DNA and 12% were positive for suspect DNA. The DNA analysis regarding pubertal children (n=85) showed that non-self DNA was found in 59% of the kits and suspect DNA was found in 40% of the kits. In total 22% of the kits subjected to DNA analysis showed the presence of suspect DNA. Showering after the incident, increase of the days elapsed since the incident and multiple incidents had a negative association with detecting DNA. Furthermore, ejaculation without a condom and an abuse history of oral-oral contact had a positive association with detecting DNA. Most DNA was found in examinations within the first 24 hours after the incident, however, examinations with a longer time interval since the incident also yielded DNA. Conclusions: The best results of successful DNA recovery were when the examination was done within the first 24 hours after the incident and when the child did not shower. However, if a longer time period elapsed and/ or if the child showered, an AFME should still be done up to 7 days after the incident, especially in cases with pubertal children, since DNA can have a long persistence on the body, especially inside the vagina or anus, and discovery of these DNA traces can help to convict the perpetrator.</p> |

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| Student | Yolanda Pressler |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | Mike Groen |
| <i>Title thesis</i> | Precision and validation accuracy test of an ISO-9001 certified tooth cementum annulation protocol for age-at-death estimation in a forensic context |
| <i>Abstract</i> | <p>The aim of this study is to test the ISO-9001 certified tooth cementum annulation (TCA) protocol by Colard et al. (2018) for age-at-death estimation based on TCA. This method, as described in literature shows huge forensic relevance, as it seems to allow more precise age-at-death estimations, compared to the currently used morphological methods. Further error sources, like the calculations TCA is based on and underlying assumptions that should be revisited, will be pointed out and discussed. Finally, it will be assessed whether the protocol can be validated for casework at the Netherlands Forensic Institute. The protocol could be replicated with minor adjustments. The Intraclass correlation for rater agreement shows high reliability. Most aged individuals were underestimated, with few exceptions that are overestimated which are discussed more thoroughly. The overall correlation of true age and estimated age-at-death is lower than proposed by Colard et al. (2018), but for younger individuals (<60 years) a comparable result can be reached by one observer. We found that the ISO9001 certification only applies to companies, not protocols. This would have possibly impacted our decision to choose this protocol for this study. Under certain preconditions the TCA method can be used and qualifies for validation at the Netherlands Forensic Institute. To apply in forensic case work it should, ideally, only be used in combination with other morphological methods for age-at-death estimation and only for individuals younger than 60 years. Furthermore, the observers will have to undergo a training before applying the method.</p> |

| Student | Shanti Bolt |
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| Research carried out at | Emma Childrens Hospital |
| Supervisor | drs. Kirsten van Dam |
| Title thesis | The inter- and intra-rater reliability of the Sexual Knowledge Picture Instrument (SKPI) - a tool to detect verbal and non-verbal signs of child sexual abuse |
| <p data-bbox="228 373 341 405"><i>Abstract</i></p>  | <p data-bbox="699 373 1385 1650">Child sexual abuse (CSA) is a worldwide problem with potentially devastating consequences for victims. To date, no validated test or instrument is available for medical, psychological and forensic professionals to confirm or reject suspicions of CSA. An illustrated child-friendly book called the Sexual Knowledge Picture Instrument (SKPI) is routinely used at the Emma Children's Hospital (Amsterdam), where it is considered to be particularly valuable in confirming or rejecting suspicions of CSA in children aged three to eight years. The SKPI contains fifteen pictures on family routines, gender differences and normal intimacy. Because of the open, non-suggestive character of the semi-structured SKPI interview method, it is potentially a suitable tool for forensic, medical and psychological professionals to confirm or reject suspicions of CSA. We aimed to determine the inter- and intra-rater reliability of the SKPI as a diagnostic instrument for CSA. Video-recorded SKPI interviews with children aged three to eight years with and without suspicion of CSA were observed by two independent raters, who scored verbal and non-verbal signs of CSA using standardized scoring forms. Inter- and intra-rater reliability of the scoring data was evaluated by Cohen's kappa and percentage of agreement (POA). A total of 78 subjects participated in this study, of which 39 with CSA-suspicion and 39 without. The intra-rater reliability on both the verbal (Cohen's kappa 0.931, POA 97.4) and non-verbal (Cohen's kappa 0.902, POA 100.0) scoring data was almost perfect. The inter-rater reliability on the verbal scoring form was overall substantial (Cohen's kappa 0.673, POA 89.7). The overall inter-rater agreement on the non-verbal scoring form was fair (Cohen's kappa 0.360), and thereby substantially lower than on the verbal scoring form, although the POA was remarkably higher (97.4). The reliability of the SKPI was evaluated as sufficient for further validation. The verbal scoring method as a whole showed satisfactory inter- and intra-rater agreement and thereby proved to be reliable. However, the non-verbal scoring method suffered from substandard inter-rater reliability when evaluating the aggregate of the scoring items. This may be remedied by removing the apparently unreliable items from the scoring form.</p> |


Forensic Physics

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| Student | Britt Meijer |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | ir. Koen Herlaar |
| <i>Title thesis</i> | Virtualisation of striation patterns caused by knife stabbings |
| <i>Abstract</i> | <p>As the amount of stabbing incident has increased, so has the forensic interest in creating a database for profiles of striation patterns caused by knife stabbings. In order to calculate likelihood ratios for criminal cases involving these incidents, it is necessary to estimate the probability the crime scene profile can be created using the suspected knife as well as the probability this profile can be created with an arbitrary other knife. For the first estimation, current methodology is not time nor labour efficient and the latter is an educated estimation. In order to compare the crime scene profile to the suspected knife, the knife is used to stab into material similar to human cartilage (dippak) to visualise the profile caused by the knife. This is done under various angles of attack, as the profile alters based on this variable. These profiles can then be compared to the profile found on the victim. To increase efficiency, objectivity and precision for this process this research aims to create a computer model which can virtualise profiles based on a single profile at one angle of attack. Together with the angle of attack, the curve of the knife will be taken as the parameters of the computer model. The model creates a polynomial to represent the curve of the knife and uses its geometry to create a new distribution for the profile at other angles of attack. Physical test-stabs were produced to test and compare to the virtualised data using Pearson's cross correlation. The results of the scaling of the profiles appear promising, but only at corrected angles, which are not near the original angles. The linear scaling appears successful but the non-linear scaling could use improvement. Virtualising a scaled profile to a profile corresponding to its original stab shows relatively high cross-correlations. When comparing the final virtualised profile to their corresponding physical profile the cross-correlations are expected to be low. The low cross-correlations are due to either faults in the model itself or the written algorithm.</p> |

Human Factor

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| Student | Joyce Cuijpers |
| <i>Research carried out at</i> | GGD |
| <i>Supervisor</i> | Maartje Goudswaard |
| <i>Title thesis</i> | The availability and use of (forensic) medical information on physical injury in criminal cases. The perspective of public prosecutors. |
| <i>Abstract</i> | <p>The purpose of this research was to (i) determine the availability and use of medical information in the more serious criminal indictments, (ii) identify regional differences between courts across the Netherlands, and (iii) gain better understanding of the criteria for requesting and deploying forensic medical expertise in criminal cases by the public prosecutor – with special focus on injury dating. Both a quantitative criminal case law study with online information on rechtspraak.nl and qualitative analysis of questionnaires held with public prosecutors specialized in criminal cases involving injury were conducted nationwide. Medical information on physical injury was present for 72.3% of the victims in the investigated case law of the more serious indictments. Significant regional differences in the presence of forensic medical information were also identified in the investigated case law between district courts in the Netherlands. The questionnaires revealed that public prosecutors consider forensic medical expertise to be most useful in cases of the more serious indictments or violence by providing elaborate information on the type, location, and nature of the injury, the estimated time of recovery, the severity and fatality of the injury, whether the injury has permanent negative implications for the victim, and whether the reported scenario matches the visible injury. The public prosecutors also indicated that injury dating would especially be of added value in cases of child abuse, domestic violence, and where different scenarios of the incident are proposed. Additionally, recommendations were provided to improve the availability of medical information and raise awareness about the possibilities of forensic medical examinations and reporting in criminal cases.</p> |

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| Student | Perle Russel |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | dr. Bart Aarts |
| <i>Title thesis</i> | The influence of human factors in the examination of underwear for biological traces |
| <i>Abstract</i> | <p>Although often perceived as objective, the investigation of human biological traces and DNA-analysis involves subjective decision-making by the forensic practitioners involved. This raises the question what the influence is of the human factor in the outcome of the forensic investigation of biological traces. To answer this question, this study examined if human factors influence the investigation. And if so, if this has a significant impact on the examination strategy of underwear in an alleged sexual assault case examination. To investigate this, two lines of investigation were chosen: a retrospective study and a reexamination of cases. In the retrospective study, 68 sexual assault cases with underwear from a victim were analyzed on whether they contained possibly influencing human factors. These factors were compared to decisions made in the examination strategy, the trace examination, and the reported results. Differences between the 68 cases were observed in the chosen examination strategy. Additionally, the strategy was often adjusted following the initial inspection of the underwear by the trace examiners. The differences were examined to determine if the cause was case-specific, investigation-specific or personal. Argumentation that might explain the differences was often missing. In the reexamination of cases, 18 experts and 8 trace examiners were asked to describe their decisions and underlying argumentations when investigating underwear in five alleged sexual assault cases. These decisions consisted of whether they would examine the underwear for semen, saliva and/or latent biological traces. In some cases a common examination strategy was observed with some deviations, while in other cases there was more variation between the experts and trace examiners. The reexamination provided clarity as to why some individuals would examine for semen and saliva, while others would not. The reexamination made it explicit why certain decisions were made, possibly due to a different approach to context information, however the reexamination did not provide a definite human factor explaining the variation. To minimize this influence of human factors, it is recommended to standardize the procedure of the examination of underwear in sexual assault cases by, for example, implementing a standard operation procedure and/or having the experts decide together which justification is better in which circumstances.</p> |

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| Student | Anna Knes |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | Madeleine de Gruijter |
| <i>Title thesis</i> | CSI-CSI: Comparing Several International Approaches Towards Crime Scene Improvement |
| <i>Abstract</i> |  <p>Over the past decade, interest in crime scene investigation research has increased due a greater awareness and fear of cognitive bias during complex decision-making. Crime scene investigations are highly complex environments. Not only do they entail extensive communication and collaboration between multiple professionals (first responders, police, crime scene investigators (CSIs), prosecutors), but they also require a high degree of decision-making on behalf of the CSI. Serious violent high-volume crimes (HVCs) are characterized by having many different types of ambiguous traces (e.g., DNA, fingerprints, shoe marks, fibers, glass, blood, etc.). CSIs must rely on personal experience as well as context information to both find and correctly interpret these ambiguous traces and accurately reconstruct a scene. Unfortunately, CSI decision-making has been neglected, while it is critical to understand how investigations are conducted given its crucial role in forensic investigation. The aim of this study is to investigate what different approaches CSIs from ten countries around the world implement to conduct an effective crime scene investigation. This project was guided by sub-questions relating to understanding the type of training CSIs received, their choice to incorporate contextual information into their investigations, and their communication styles with other key actors in the criminal justice system. In the present study, 9 researchers and 25 CSIs from ten different countries (representing sixteen different regions) were interviewed to determine how crime scene investigation approaches differ around the world. Firstly, CSI training differed for each country and was therefore difficult to directly compare. While countries like Australia utilized a national standardized training curriculum, others were less regulated. Secondly, this study observed that a variety of investigation approaches have been adopted by CSIs, and the diversity that exists is likely the result of insufficient (or nonexistent) guidelines for crime scene investigations. How CSIs gather and incorporate context information before and during an investigation is largely dependent on each CSI's personal preferences. Moreover, the CSI's use of information and personal experience can have a large impact as they both influence which scenarios are considered and whether a trace is perceived as relevant. Lastly, this study found that communication with the CSI needs improvement as many CSIs feel misunderstood and excluded by their police colleagues. Together, these results highlight the need for future studies to examine how researchers and forensic practitioners can best guide CSIs during investigations. To do this, researchers must start with identifying what information is needed and when it should be provided to reduce interference with the investigation and minimize cognitive bias.</p> |

Other

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| Student | Maurice Dunne |
| <i>Research carried out at</i> | NFI |
| <i>Supervisor</i> | dr. Mike Groen |
| <i>Title thesis</i> | Determining prior probabilities in forensic archaeology using spatial statistics and radiocarbon dating. |
| <i>Abstract</i> | <p>The purpose of this research is to breakdown and analyse the caseload concerning the stray finds of human skeletal elements for the Forensic Anthropology and Archaeology (FAA) unit of the Netherlands Forensic Institute (NFI), which was composed of cases throughout the Netherlands, including finds recovered from the North Sea. The aim was to determine if details and statistics from previous cases could be used as background information to determine prior probabilities for newly recovered skeletal elements. The idea is to use prior probabilities in the investigative phase of an FAA investigation when determining the age of a recovered skeletal element with an undatable or unknown context. This age estimation would be determined in conjunction with radiocarbon dating, also known as carbon-14 dating. The determination of prior probabilities for the age of newly found stray skeletal elements could quickly be carried out in the investigative phase before radiocarbon dating is carried out, by comparing the new case to previous cases from the caseload. Spatial analysis and spatial statistics were other components of this research. The spatial distribution of stray finds of skeletal elements throughout the Netherlands was also determined to see where cases are occurring and where bones are recovered from, using the ArcGIS geographic information system (ArcMap 10.8). This spatial overview of the previous cases provides insight for the forensic archaeologist and gives a better overview of where stray skeletal elements are being recovered, and what periods they date from. Stray skeletal elements and their recovery locations in the Netherlands are clustered and not randomly distributed. There were municipalities where stray skeletal elements are more commonly found. For example, coastal municipalities had more recoveries of skeletal elements due to archaeological sites, now reclaimed by the North Sea. Thus, many archaeological bones are washed up and found on beaches in these municipalities. The North Sea and the municipalities along the coast also showed much more finds, compared to inland municipalities. However, municipalities with high populations and population densities, such as The Hague and Amsterdam also had more recoveries. It was determined that when analysing the FAA caseload of the Netherlands, spatial information and prior probabilities from similar cases can be used as background information in the investigatory phase of an FAA investigation, in conjunction with known radiocarbon age estimation of the previously recovered stray skeletal elements.</p> |