**Combinatorial Methods for Artificial Intelligence**

Dimitris E. Simos, Bernhard Garn, Dominik-Philip Schreiber, Ludwig Kampel, Rick Kuhn, Raghu Kacker

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**Combinatorial Methods for Explainable Artificial Intelligence (XAI)**

Today

- Only reptiles have these 3-way combinations of features:
  - not aquatic AND not toothed AND four legs
  - egg-laying AND not aquatic AND four legs
  - not hairy AND four legs AND cat size
  - not milk-producing AND not aquatic AND four legs
  - not milk-producing AND four legs AND cat size
  - not predator AND not toothed AND four legs

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**Intelligent Virtual Assistants (IVAs)**

- Vulnerabilities and exploits demonstrated against available IVA platforms.
- Exhibit large new attack surface due to functionality.
- Need all-embracing novel security and reliability testing (e.g., explainable AI).

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**Automotive Vehicles**

- Connected, intelligent, and autonomous vehicles pose new safety and security challenges.
- Systematic and holistic safety and security approach required to test networked computers on wheels.
- Guaranteeing the reliability and robustness is a major challenge.

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**Generative Adversarial Networks (GANs)**

- Combinatorial methods to reduce number of queries to targeted classifier.
- Generating inputs that get misclassified by different classification networks.

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**AI-based Combinatorial Computer Virology**

- Most anti-virus scan patterns can easily be extracted from anti-virus software.
- Using balanced incomplete block designs and AI to generate effective subsets of malware patterns.
- Prevent black-box analysis by only using specific subset per user for malware detection.
- Single user cannot learn full detection pattern.

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