Tutorial Proposal for FLINS-ISKE2026 Conference

Title: Standard Contradiction Based Automated Theorem Generation (ATG): Methods, Tools and Applications

Duration: 3 Hours

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1. Tutorial Overview

Automated Theorem Generation (ATG) is a fundamental topic in symbolic reasoning, logic engineering, and intelligent systems. In recent years, a new class of NP problems, referred to as *standard contradictions*, has been proposed, together with a special and practically effective structure known as the triangle standard contradiction. These concepts provide a novel theoretical foundation for constructing automated theorem provers and automated theorem generators capable of producing large-scale logical symbol theorems in a systematic and computable manner.

This tutorial presents a comprehensive introduction to *standard contradiction–based automated theorem generation*, with particular emphasis on methods and tools derived from triangle standard contradictions. The tutorial will review recent research progress in automated theorem provers and automated theorem generators built upon this framework, and will demonstrate how these systems can efficiently generate massive quantities of formally structured logical theorems.

Beyond symbolic generation, this tutorial highlights a **bidirectional integration between automated theorem generation and Large Language Models (LLMs)**. On the one hand, LLMs can be used to interpret the symbolically generated theorems produced by ATGs, translating formal logical expressions into human-readable and domain-specific theorems across mathematics, science, and engineering. On the other hand, LLMs can assist in transforming objective facts and domain knowledge expressed in natural language into symbolic representations, which can then be

systematically processed by contradiction-based ATGs to produce targeted logical theorems for specific application domains.

Through this two-way interaction, automated theorem generation and LLMs together enable a new paradigm for large-scale theorem discovery, explanation, and application. In particular, the massive collections of logical symbol theorems generated by triangle standard contradiction–based ATG systems can serve as high-quality training and evaluation data for improving the logical reasoning capabilities of LLMs. This tutorial therefore positions standard contradiction–based ATG not only as a theoretical and computational logic framework, but also as a valuable bridge between symbolic reasoning and data-driven artificial intelligence.

2. Objectives and Motivation

The tutorial aims to:

- Present the **theoretical basis** of standard contradictions and triangle standard contradictions.
- Review **research progress** in automated theorem provers and generators that use these structures.
- Introduce practical **software tools and repositories** for ATG.
- Explore how LLMs can interpret automatically generated logical theorems or be trained using them.
- Demonstrate **applications and future directions** of ATG in logic reasoning, AI, and computational mathematics.

Participants will gain a comprehensive understanding of both foundational principles and practical tools in state-of-the-art automated theorem generation.

3. Tutorial Structure and Content

Part I — Standard Contradictions and Triangle Standard Contradictions

- Definition and formalization of **standard contradictions**.
- Complexity considerations: Why standard contradictions are a new NP class problem.
- Introduction to **triangle standard contradictions** and their significance in logic systems.
- Examples and illustrative explanation.

Key outcome: Participants will understand the mathematical logic foundations and complexity attributes of these contradiction frameworks.

Part II — Automated Theorem Provers Based on Triangle Standard Contradictions

- Overview of ATProver design grounded in triangle standard contradiction theory.
- Survey of research progress and key results.
- Strengths and limits of existing provers using this approach.
- Demonstration of theorem proving workflows.

Key outcome: Participants will learn how triangle standard contradictions underpin effective automated theorem proving.

Part III — Automated Theorem Generation: Methods, Tools and Repositories

This part focuses on the theory and practice of **automated theorem generators (ATGs)** designed with triangle standard contradiction structures.

Key points covered:

- Fundamental algorithms and logic construction methods.
- Automated generation of logical symbol theorems.
- Techniques for managing large-scale theorem databases.

Open Source Tools and Repositories:

Participants will be introduced to and shown how to access and explore the following publicly available projects:

- **Automated_Theorem_Generator**
  https://github.com/SWJTU-math/Automated_Theorem_Generator
- **Automated-Theorem-Generator-2**
  https://github.com/SWJTU-math/Automated-Theorem-Generator-2
- **Automated-Theorem-Generator-3**
  https://github.com/SWJTU-math/Automated-Theorem-Generator-3
- **Automated-Theorem-Generator-4**
  https://github.com/SWJTU-math/Automated-Theorem-Generator-4

Key outcome: Participants will gain practical exposure to state-of-the-art code and tools for generating automated theorems based on contradiction frameworks.

Part IV — Symbolic–LLM Integration: Interpretation, Guided Generation, and Reasoning Enhancement

ATGs based on triangle standard contradictions are capable of producing large-scale collections of formally valid logical symbol theorems. While these theorems are powerful in a symbolic sense, their practical impact depends on effective interaction with human understanding and application domains. This section presents a bidirectional integration framework between contradiction-based automated theorem

generation and Large Language Models (LLMs), unifying symbolic reasoning with data-driven intelligence.

Part IV1 — LLM-Assisted Interpretation and Domain-Level Application of Generated Theorems

ATGs based on triangle standard contradictions are capable of producing massive volumes of formally correct logical symbol theorems. However, these theorems are typically expressed in highly abstract symbolic forms, which limits their direct usability by human researchers and domain experts. This section focuses on how Large Language Models (LLMs) can be employed to bridge this gap by interpreting, explaining, and contextualizing automatically generated symbolic theorems. It will cover:

- Challenges of interpreting machine-generated logical symbol theorems with LLMs.
- Techniques for explaining logical expressions in natural language.
- Opportunities for LLM application domains, including:
    - Symbolic reasoning
    - Knowledge extraction and verification
    - Automated theory discovery in science and mathematics
    - Logic-driven decision support

Key outcome: Participants will learn how LLMs can augment or interact with symbolic logic outputs.

Part IV2 — Training LLMs with Generated Theorem Data

One of the major potentials of ATG systems is their ability to generate massive volumes of structured logical symbol theorems. This section emphasizes that the massive quantities of logical symbol theorems generated by triangle standard contradiction–based ATG systems constitute a unique and high-quality source of structured reasoning data. These automatically generated theorems can be used as training, fine-tuning, or evaluation datasets for LLMs, with the goal of enhancing their formal reasoning, logical consistency, and symbolic inference capabilities. This curated dataset:

- Provides rich, high-quality *reasoning and proof-oriented material*.
- Can serve as training or fine-tuning input to improve LLM logical reasoning capabilities.
- Supports scientific research on AI reasoning, interpretability, and symbolic-neural integration.

Key outcome: Attendees will understand how automatically generated theorems can become valuable training data for enhancing LLM logic performance.

4. Teaching Methods

The tutorial will combine:

- **Lectures** for theoretical foundations.
- **Live demonstrations** of tools and codebases.
- **Interactive Q&A** to engage participants.
- **Guided discussions** on research implications and future pathways.

Slides and supplementary materials will be provided.

5. Target Audience

This tutorial is appropriate for:

- Researchers and graduate students in logic, AI, and nonlinear systems.
- Practitioners interested in symbolic computation, automated reasoning, and deep learning.
- Anyone curious about the interface between symbolic logic generation and large-scale language models.

No prior experience with automated theorem generation is required.

6. Expected Outcomes for Participants

After attending this tutorial, participants will be able to:

- Explain the theory of standard contradictions and triangle standard contradictions.
- Describe current progress in automated theorem proving and generation.
- Use open-source generators to experiment with theorem production.
- Understand how LLMs can be applied to interpret or leverage logical theorem data.
- Appreciate the role of symbolic theorem datasets in improving AI reasoning.

7. Technical Requirements

- Projector and screen
- Internet connection (for live code repository demos)
- Optional: access to laptop for hands-on exploration