# Attack Tree Visualiser

GitHub Repo: https://github.com/craigbourne/infosec-assignment-2

> Visual risk assessment tool for business decision-making

The Attack Tree Visualiser is a Python application that transforms attack trees into quantified business risk assessments, allowing business stakeholders to visualise security threats through monetary impact. This was developed to address Pampered Pets' digitalisation concerns following an initial risk identification report submitted for Assignment 1.

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## Overview

The Attack Tree Visualiser serves as an "unconventional executive summary" for risk assessment, transforming attack scenarios into visual representations with monetary impacts. Following the initial Assignment 1 risk identification report, this application addresses the request from Pampered Pets' shop manager for a more accessible way to understand the implications of Pampered Pets' digitalisation.

**The Problem**: Traditional risk assessments can fail to communicate business impact, relying on technical severity ratings that do not reflect real business risk exposure. As Spring et al. (2021) demonstrate, "CVSS is designed to identify the technical severity of a vulnerability" whilst "what people seem to want to know, instead, is the risk a vulnerability or flaw poses to them" Hubbard (2020) found that popular methods employ "high, medium, low evaluation of likelihood and impact" without proper quantitative foundation.

**The Solution**: The application converts the attack trees and risk scenarios from Assignment 1 into quantified business impacts, enabling data-driven digitalisation decisions through visual analysis.

**Methodological Foundation**: Following the Threat Modelling Manifesto framework (Threat Modeling Manifesto Working Group, 2020) and implementing Tarandach & Coles' (2020) attack tree methodology, the application converts abstract security threats into quantified business risks.

## Features

- **Attack Tree Management**: Load JSON attack trees representing current and post-digitalisation business scenarios
- **Interactive Risk Assessment**: Input monetary values for individual attack methods
- **Transparent Risk Aggregation**: OR/AND gate logic providing business-focused risk calculations

- **Scenario Comparison**: Pre/post digitalisation analysis validating Assignment 1 recommendations
- **Executive Visualisation**: Colour-coded diagrams with risk values and business summaries

## Installation

### System Requirements

- Python 3.9 or higher
- pip package management
- Modern web browser
- Minimum 4GB RAM for attack tree processing

**Dependencies and Requirements** The application requires three core Python libraries as specified in requirements.txt:

```
networkx>=3.0
matplotlib>=3.7.0
numpy>=1.24.0
```

NetworkX provides graph algorithms for attack tree representation (NetworkX Developers, 2024), Matplotlib generates static, animated and interactive diagrams (Matplotlib Development Team et al., 2024) and NumPy provides numerical operations for risk calculations (NumPy Developers, 2024).

### Installation Steps

```
# Verify Python version
python --version

# Clone repository
git clone https://github.com/craigbourne/infosec-assignment-2.git
cd infosec-assignment-2

# Create and activate virtual environment
python -m venv venv
source venv/bin/activate  # macOS/Linux

# or on Windows
venv\Scripts\activate

# Install dependencies
pip install -r requirements.txt
```

## Usage

### Launch Application

```
python src/attack_tree.py
```

### Menu Options

The application provides six analysis scenarios based on the original Assignment 1 risk assessment:

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL    PORTS
craigbourne@Mac infosec-assignment-2 % python3 src/attack_tree.py
============================================================
PAMPERED PETS RISK ASSESSMENT TOOL
============================================================
Compare risks before and after digitalisation:

CURRENT BUSINESS (Pre-Digitalisation):
1. Payment System Risks (Current)
2. Supply Chain Risks (Current)

AFTER DIGITALISATION (Post-Implementation):
3. Payment System Risks (Digitalised)
4. Supply Chain Risks (Digitalised)

COMPARISON MODES:
5. Compare Payment Systems (Current vs Digitalised)
6. Compare Supply Chains (Current vs Digitalised)
============================================================
Enter choice (1-6): 
```

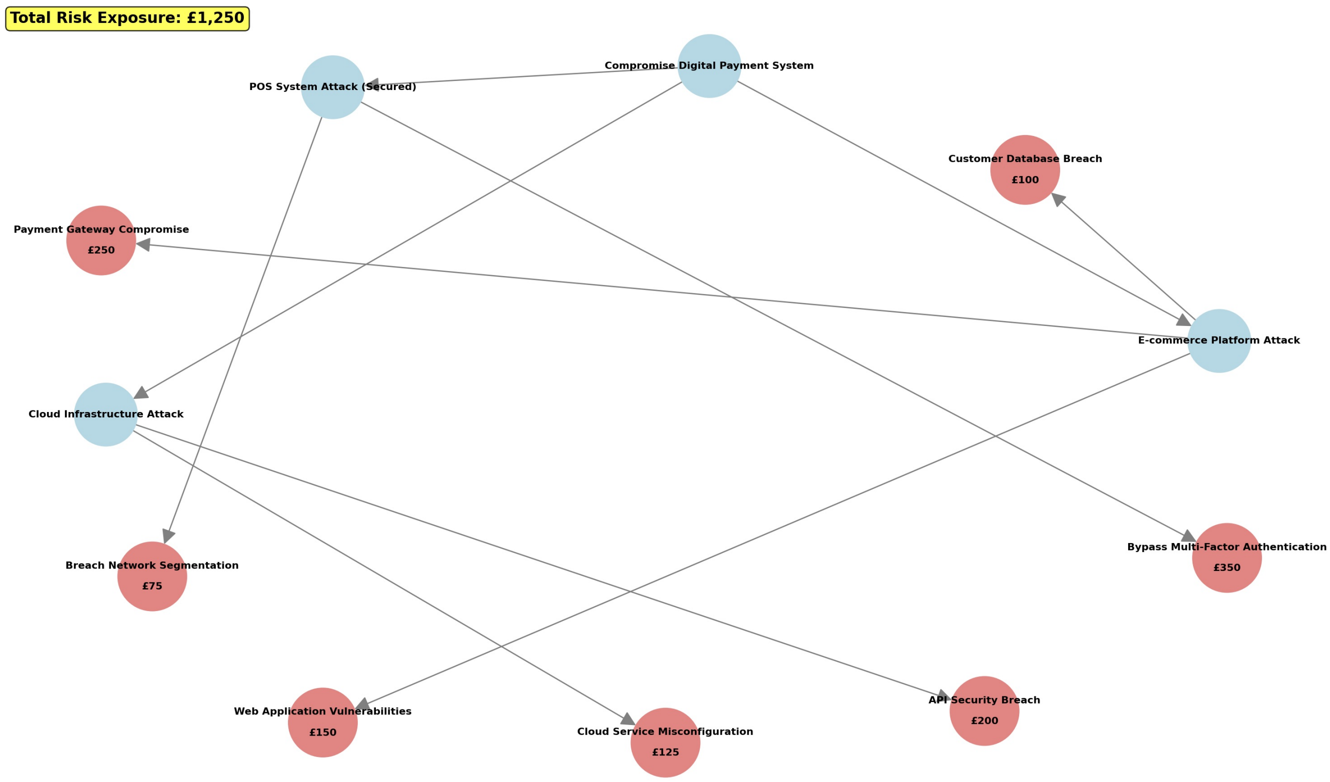
1. **Payment System Risks (Current)** - Pre-digitalisation baseline outlined in Assignment 1
2. **Supply Chain Risks (Current)** - Current local supplier model with 10-minute proximity advantage
3. **Payment System Risks (Digitalised)** - Post-implementation risks following digitalisation recommendations
4. **Supply Chain Risks (Digitalised)** - Demonstrates why local suppliers were recommended over international 24% cost savings
5. **Payment Systems Comparison** - Pre/post-digitalisation supporting the 50% growth opportunity analysis
6. **Supply Chains Comparison** - Local vs international supplier analysis validating Assignment 1 recommendations

### Risk Input Process

1. Select analysis scenario from the menu
2. Users are then guided through entering costs for each attack method:
    - Prompts appear for each leaf node in the attack tree
    - Current values displayed, can be skipped or updated
    - Input validation ensures positive numbers or zero

```
Enter choice (1-6): 3

Analysing: Payment System (Digitalised)
------------------------------------------------------------
✓ Loaded attack tree: Payment System Attack (Post-Digitalisation)
✓ Built graph with 11 nodes
============================================================
RISK VALUE INPUT
============================================================
Enter the cost impact (in £) if each attack succeeds:
(Press Enter to skip, or enter 0 for no impact)

Web Application Vulnerabilities (current: £0.00): £150
✓ Updated Web Application Vulnerabilities = £150.00
Payment Gateway Compromise (current: £0.00): £250
✓ Updated Payment Gateway Compromise = £250.00
Customer Database Breach (current: £0.00): £100
✓ Updated Customer Database Breach = £100.00
Bypass Multi-Factor Authentication (current: £0.00): £350
✓ Updated Bypass Multi-Factor Authentication = £350.00
Breach Network Segmentation (current: £0.00): £75
✓ Updated Breach Network Segmentation = £75.00
Cloud Service Misconfiguration (current: £0.00): £125
✓ Updated Cloud Service Misconfiguration = £125.00
API Security Breach (current: £0.00): £200
✓ Updated API Security Breach = £200.00

✓ All values updated!

--------------------------------------------------
DETAILED RISK BREAKDOWN
--------------------------------------------------
Web Application Vulnerabilities: £150.00
Payment Gateway Compromise: £250.00
Customer Database Breach: £100.00
Bypass Multi-Factor Authentication: £350.00
Breach Network Segmentation: £75.00
Cloud Service Misconfiguration: £125.00
API Security Breach: £200.00

============================================================
RISK ASSESSMENT SUMMARY
============================================================
Total Business Risk Exposure: £425.00
============================================================

Sum of individual attacks: £1,250.00
Calculated overall risk: £425.00
(Lower overall risk due to OR-gate logic - not all attacks likely)
```

3. **Risk breakdown analysis**: System provides detailed breakdown showing:
    - Individual attack costs
    - Sum of all individual attacks
    - Calculated overall risk using OR/AND gate logic
    - Explanation of logic differences
4. **Visual representation**: Attack tree diagram displays with:
    - Colour-coded nodes (red for attacks, blue for logic gates)
    - Monetary values prominently shown on nodes
    - Total risk exposure in summary box
    - Clear hierarchical structure

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5. **Business recommendations**: Analysis provides contextual guidance based on risk differentials and Assignment 1 findings

**Example: Payment System Analysis** When selecting option 1 (Payment System Current), the application guides users through risk value input for threats including:

- Malware installation on POS systems
- Physical access to payment terminals
- WiFi interception of transaction data
- Credential theft from unsecured systems

```
Enter choice (1-6): 1

Analysing: Payment System (Current)
------------------------------------------------------------
✓ Loaded attack tree: Payment System Attack
✓ Built graph with 7 nodes
============================================================
RISK VALUE INPUT
============================================================
Enter the cost impact (in £) if each attack succeeds:
(Press Enter to skip, or enter 0 for no impact)

Install Malware (current: £0.00): £250
✓ Updated Install Malware = £250.00
Physical Access to POS (current: £0.00): £100
✓ Updated Physical Access to POS = £100.00
Intercept WiFi (current: £0.00): £75
✓ Updated Intercept WiFi = £75.00
Steal Credentials (current: £0.00): £50
✓ Updated Steal Credentials = £50.00

✓ All values updated!

--------------------------------------------------
DETAILED RISK BREAKDOWN
--------------------------------------------------
Install Malware: £250.00
Physical Access to POS: £100.00
Intercept WiFi: £75.00
Steal Credentials: £50.00

============================================================
RISK ASSESSMENT SUMMARY
============================================================
Total Business Risk Exposure: £250.00
============================================================

Sum of individual attacks: £475.00
Calculated overall risk: £250.00
(Lower overall risk due to OR-gate logic - not all attacks likely)
```

**Attack Tree Logic Implementation** The application implements attack tree logic following Tarandach & Coles (2020):

- **OR gates represent alternative attack paths**: Attackers will choose the most feasible route, so the system takes the maximum risk value from child nodes
- **AND gates represent required attack sequences**: All steps must succeed for the attack to work, so risks are cumulative (summed)
- **Leaf nodes**: Individual attack methods with business impact values input by the user
- **Overall risk calculation**: Reflects realistic business exposure rather than theoretical maximum, using transparent logical aggregation

This methodology addresses the "Risk = Threat Capability × Vulnerability × Impact" framework established in FAIR model literature, focusing on impact assessment with transparent logical aggregation.

## File Structure

```
infosec-assignment-2/
├── src/
│   ├── __init__.py             # Package initialisation
│   └── attack_tree.py          # Main application logic
├── data/
│   └── attack_trees/
│       ├── payment_system_current.json      # Pre-digitalisation payment risks
│       ├── payment_system_digitalised.json  # Post-digitalisation payment risks
│       ├── supply_chain_current.json        # Current local supply chain model
│       └── supply_chain_digitalised.json    # International supply chain comparison
├── tests/
│   └── tests.py                # Logic validation tests
├── requirements.txt            # Python dependencies
└── README.md                  # This documentation
```

## Assignment 1 Validation and Business Impact

The application validates the three critical business questions from Assignment 1. It shows that the original selective digitalisation approach is financially justified whilst giving the shop manager the clear, visual risk information they require.

**Methodology**: The application employs attack tree analysis with OR/AND gate logic to convert security threats into monetary impact assessments, enabling comparison of digitalisation scenarios. This approach addresses the limitations of traditional risk assessment methods identified by Hubbard (2020) and Spring et al. (2021), replacing subjective "high, medium, low" ratings with transparent, business-focused risk calculations.

**Q1: Could online presence grow the business by 50%?** Digitalisation introduces risks, including malware attacks and payment fraud. However, implementing security controls (WPA3 encryption, role-based access, daily backups) mitigates these risks whilst preserving growth opportunities. Following Fowler's (2023) framework for developing effective risk analysis validates the Assignment 1 recommendation to pursue selective digitalisation with appropriate security investment.

**Q2: Could international supply chain changes reduce costs by 24%?** The supply chain comparison provides clear evidence for why the international option is less desirable. Using Kovaitė & Stankevičienė's (2019) RADi framework for digitalisation risks alongside Luo's (2021) framework for international business digitisation, the analysis quantifies how quality control loss,regulatory complexity and expanded attack surfaces create costs that exceed the 24% savings. This validates the Assignment 1 recommendation to maintain local supplier relationships.

**Q3: Could lack of digital features result in 33% customer loss?** The scenario comparison analysis (options 5 and 6) indicates that inaction poses the greatest threat to business sustainability. By comparing current operations against digitalised alternatives, the risk of losing customers by remaining offline significantly outweighs the security risks of digital transformation, provided appropriate controls are implemented. This supports the Assignment 1 recommendation for phased digital implementation, building on Sørensen's (2018) recognition that digitalisation creates "massive opportunity" when risks are properly managed.

**Business Impact Summary**:

This application validates that Assignment 1's risk-based approach to digitalisation was methodologically sound and financially justified. Three key outcomes are demonstrated:

**Risk Quantification**: Converting security threats into monetary impacts enables evidence-based decision-making, addressing Hubbard's (2020) critique of qualitative risk assessment methods.

**Strategic Validation**: The selective digitalisation approach balances growth opportunities against security investments, with local supply chain advantages outweighing international cost saving benefits.

**Practical Implementation**: Security risks can be managed and mitigated through appropriate controls whilst business transformation proceeds, providing the "unconventional executive summary" that bridges technical assessment and business strategy.

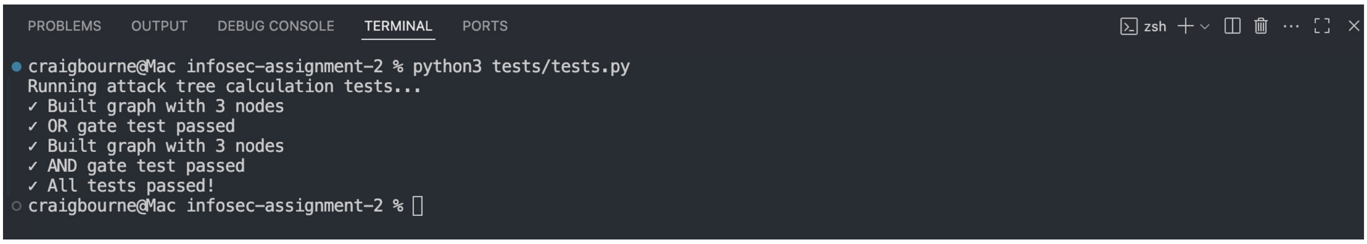
The application successfully transforms complex information security analysis into business intelligence, enabling informed strategic decisions for small enterprises navigating digital transformation challenges.

# Testing and Validation

### Running Tests

```
python tests/test_calculations.py
```

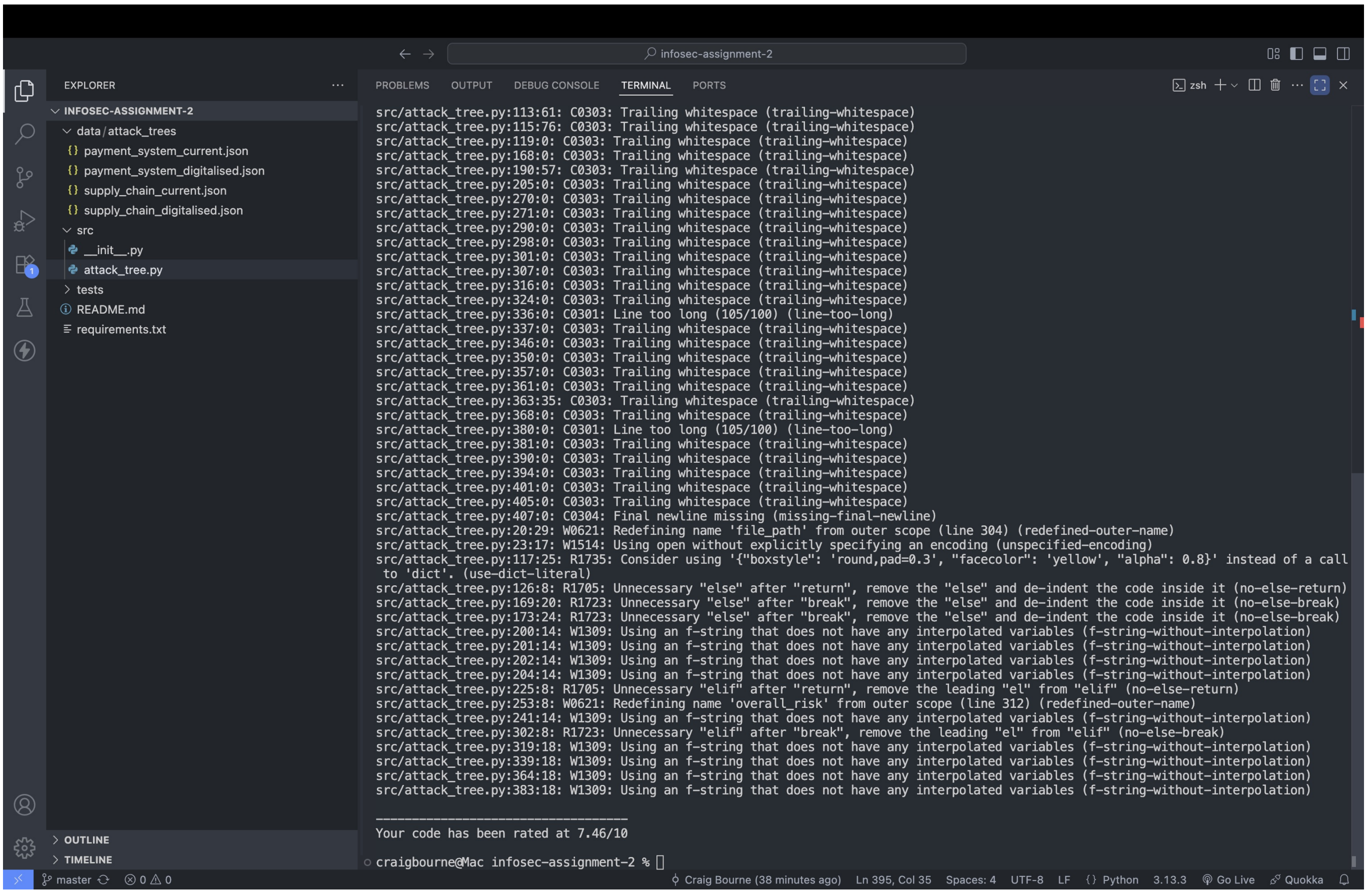
The test suite validates core attack tree calculation logic:




**Code Quality Assessment** The application underwent systematic code quality improvement using pylint analysis:

### Pre-Remediation Results

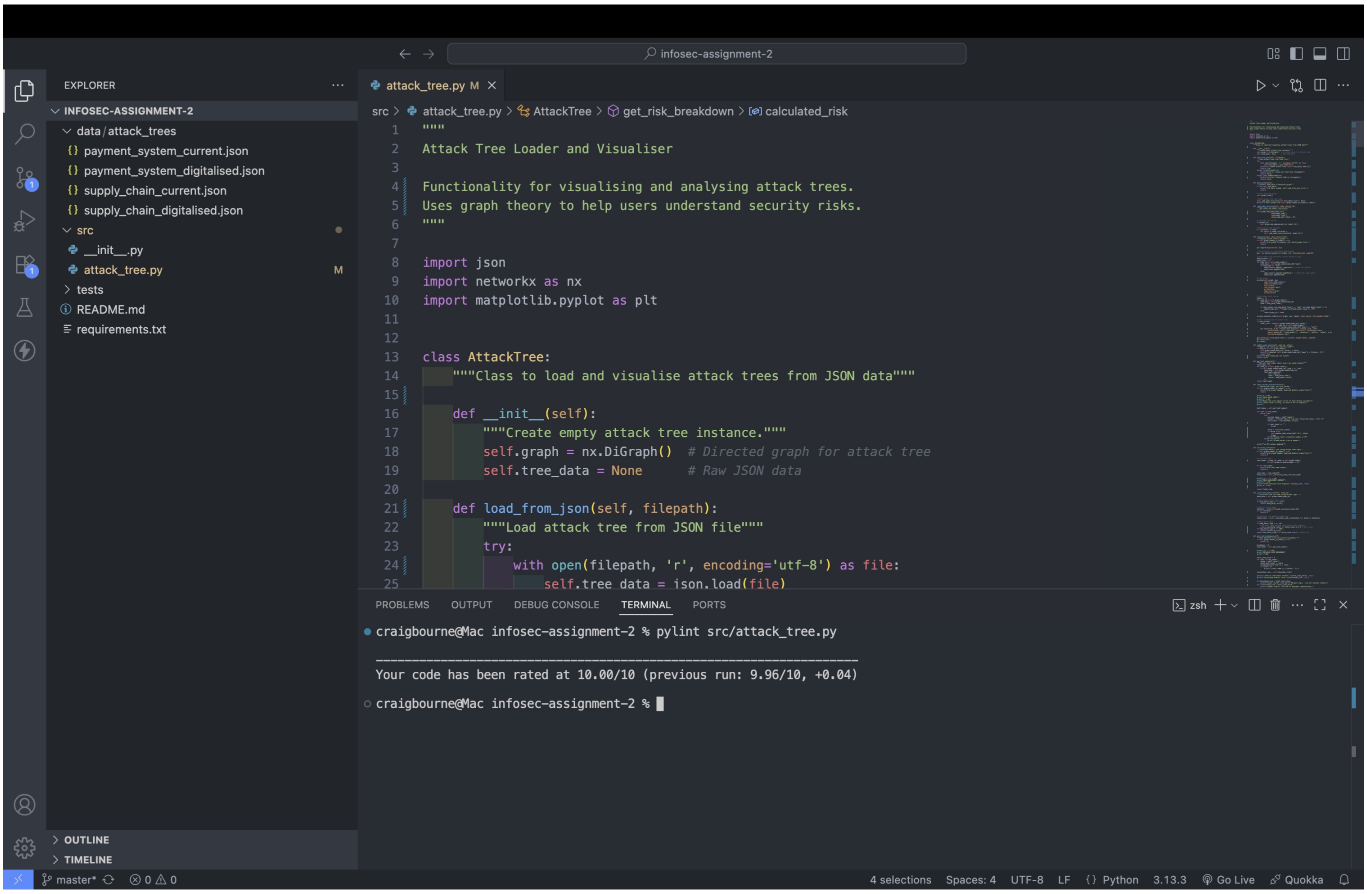
- Various style and structural issues identified
- Inconsistent naming conventions
- Code complexity concerns




### Post-Remediation Results

- Achieved professional standards with **10.00/10.00 pylint score**

- Comprehensive docstring documentation
- Consistent PEP 8 compliance
- Modular, maintainable code structure




**Validation Results** Testing confirms correct implementation:

- **OR gate logic**: ✓ Correctly implements maximum risk selection reflecting attacker behaviour (choosing easiest path)
- **AND gate logic**: ✓ Accurately sums cumulative risks for sequential attack requirements (all steps must succeed)
- **Graph structure**: ✓ Maintains hierarchical relationships ensuring logical attack tree progression
- **Risk calculations**: ✓ Produces consistent, reproducible results supporting business decision-making
- **JSON loading**: ✓ Handles all four attack tree scenarios without errors
- **User input validation**: ✓ Handles edge cases including invalid inputs and empty values

## References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