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Devising optimal integration test orders using cost–benefit analyses

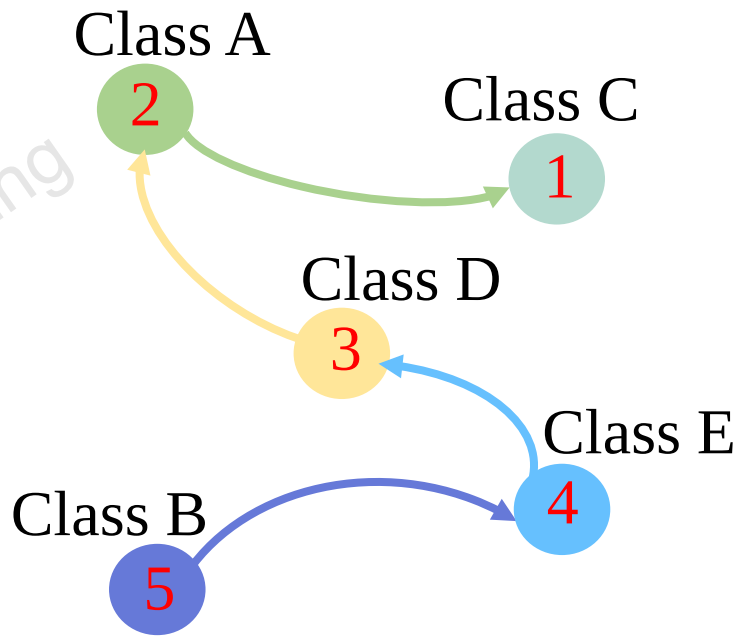
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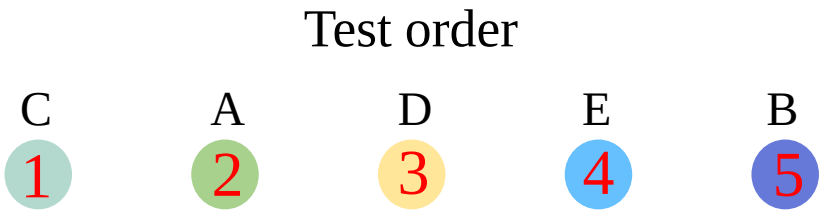
Key words: Integration test order; Cost–benefit analysis; Probabilistic risk analysis; Complex network

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Motivation

- It is challenging to determine the order in which classes are integrated and tested in inter-class testing.
- Class integration test order affects the sequence in which classes are developed and inter-class bugs are detected, and the construction of test stubs.
- Integration test orders are generated by a reverse sorting of the classes if there are no cyclical dependencies between them.





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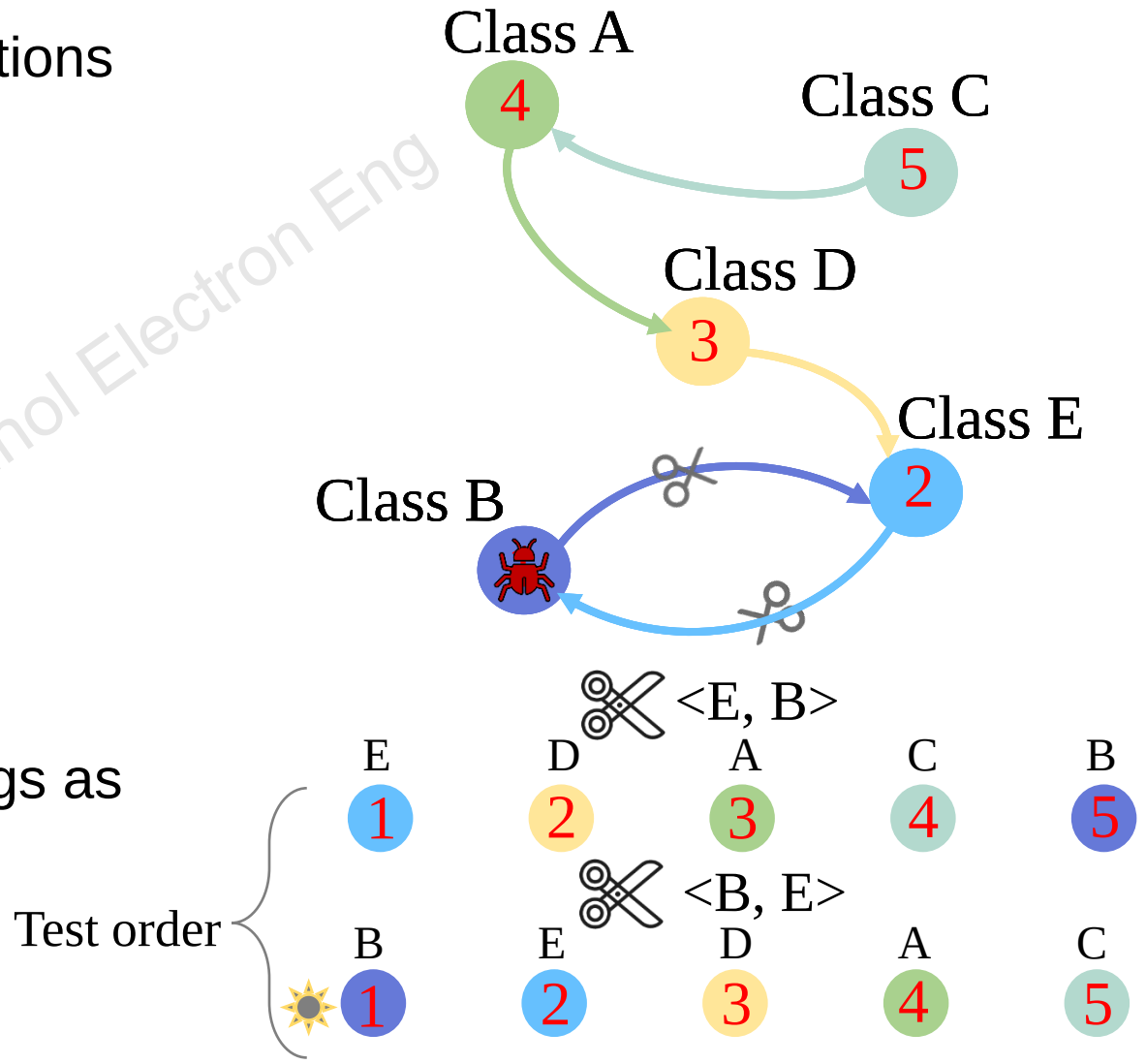
Motivation

Testers must perform the break cycle operations when test stubs are introduced.

Existing strategies focus on two aspects:

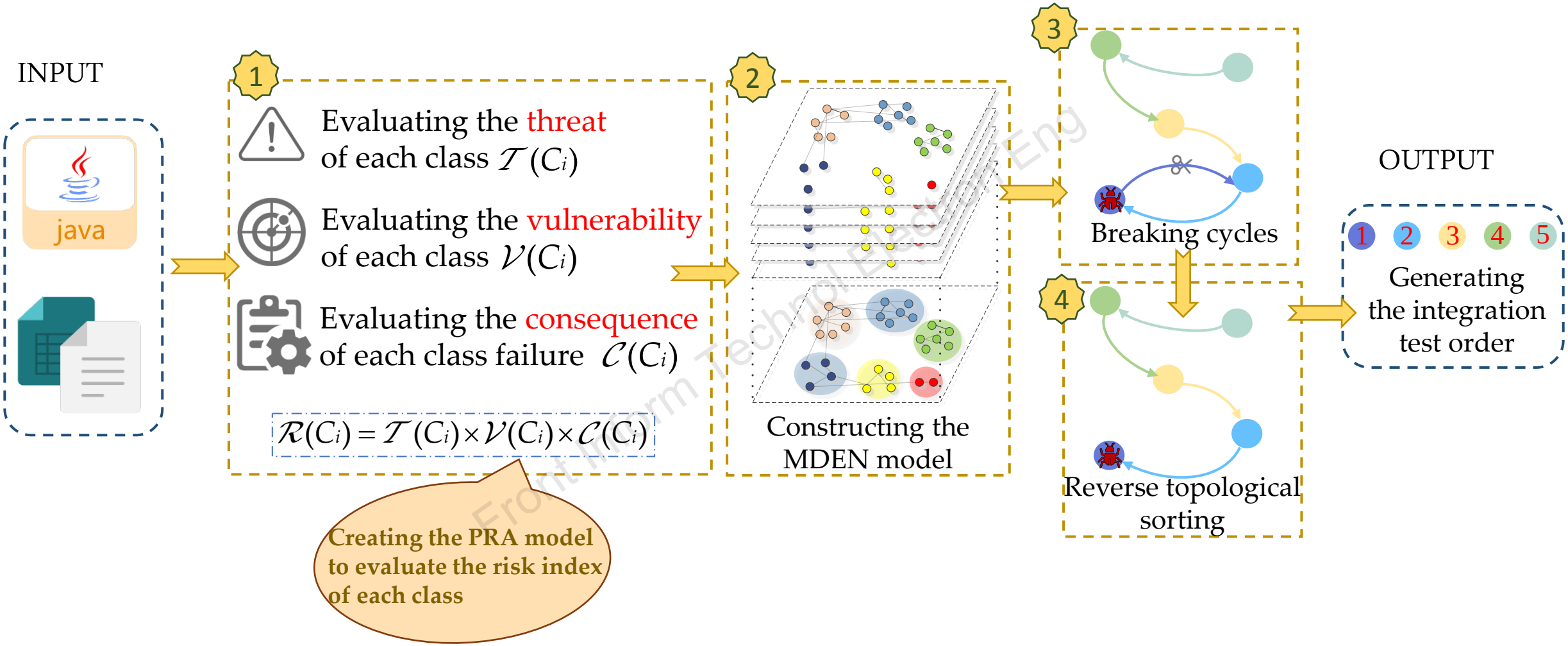
- reducing the number of test stubs
- minimizing their total complexity

Such strategies cannot expose software bugs as soon as possible, thus affecting the test efficiency.



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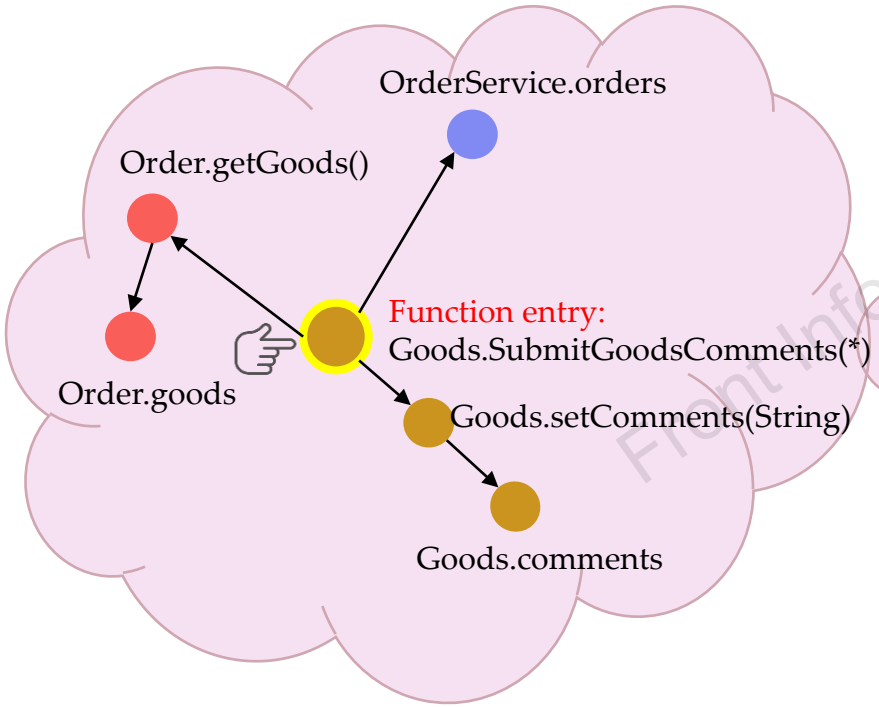
Methodology

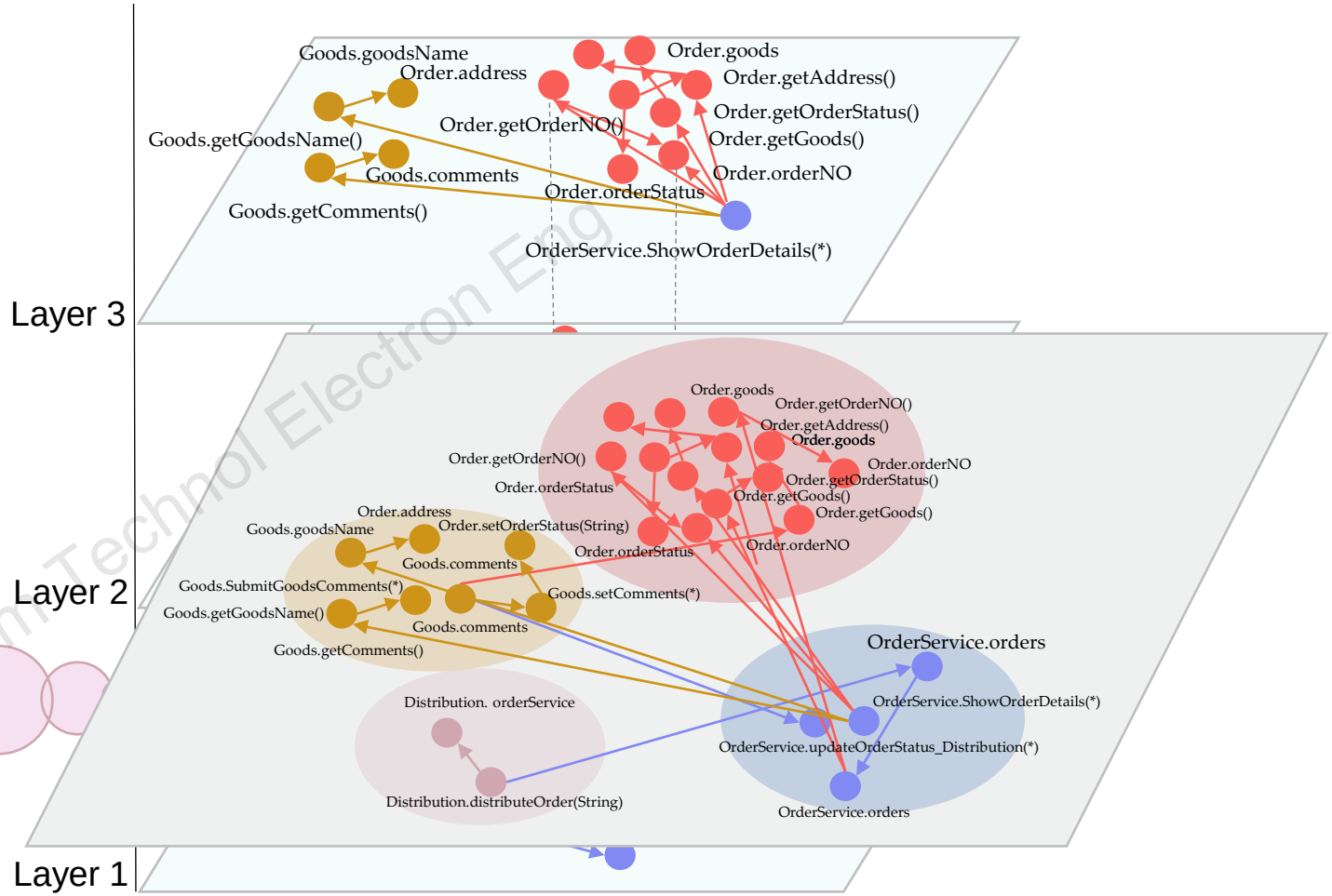


Methodology: MDEN model construction

$$\mathcal{R}(C_i) = \mathcal{T}(C_i) \times \mathcal{V}(C_i) \times \mathcal{C}(C_i)$$

$$\mathcal{V}(C_k) = \sum_{i=1}^{N_k} \mu(m_i) \Big/ |M_k|$$





Overlay network

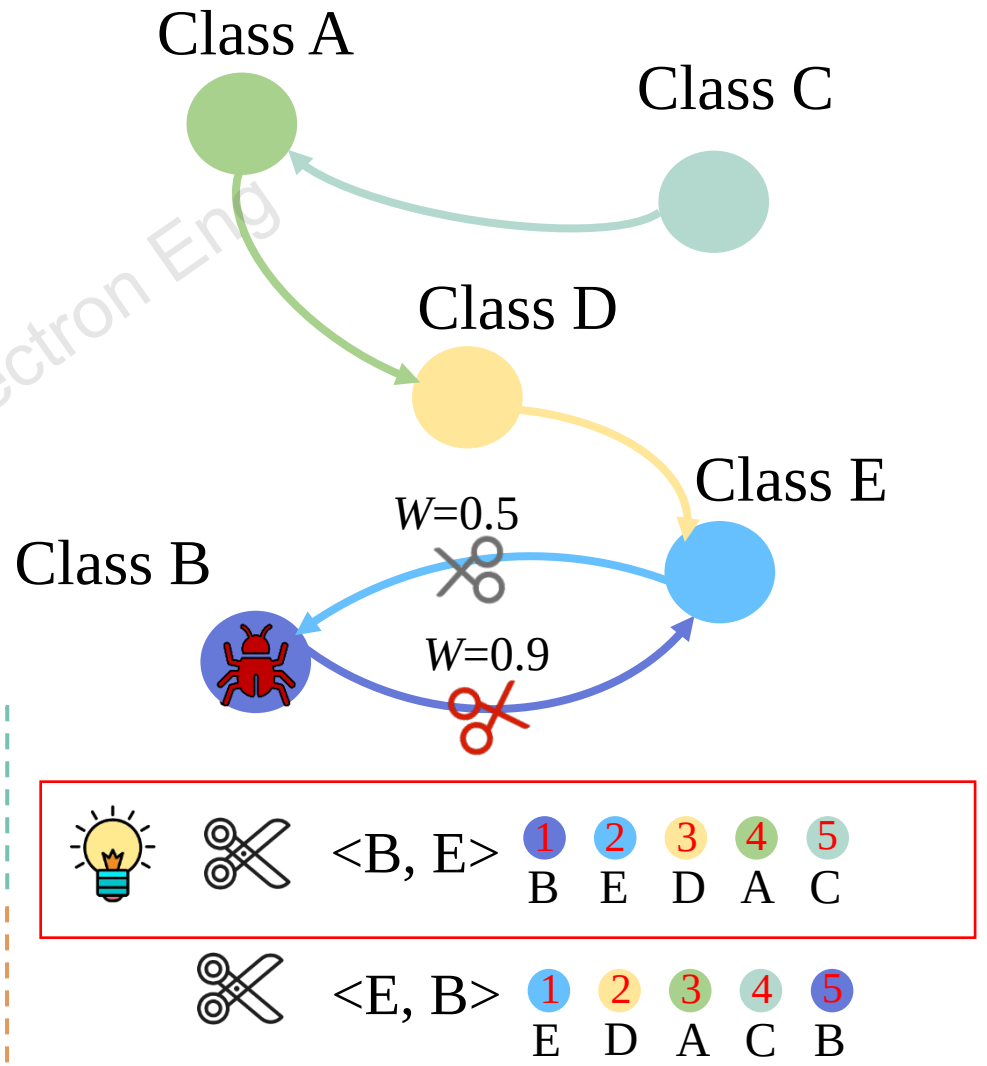
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Methodology: breaking cycles

- Providing a higher priority to critical classes with higher risk indices
- Minimizing the total complexity of the test stubs
- The cost-benefit rate: $\mathrm{Bf}_{ij}^{t} = \dfrac{\mathrm{PR}_t}{\mathrm{SCplx}(C_i, C_j)}$

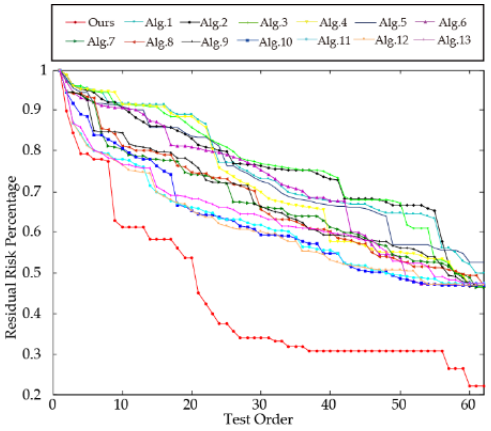
$$\mathrm{PR}_t = \sum_{k=1}^{r_t} \left(\frac{2(r_t - k + 1)\mathcal{R}_k^{O_t}}{r_t(r_t+1)} \Big/ \sum_{n=1}^{r_t} \frac{2(r_t - k + 1)\mathcal{R}_n^{O_t'}}{r_t(r_t+1)} \right)$$

$$\mathrm{SCplx}(C_i, C_j) = (\alpha \cdot \overline{\mathrm{ZA}(C_i, C_j)}^2 + \beta \cdot \overline{\mathrm{ZM}(C_i, C_j)}^2)^{1/2}$$

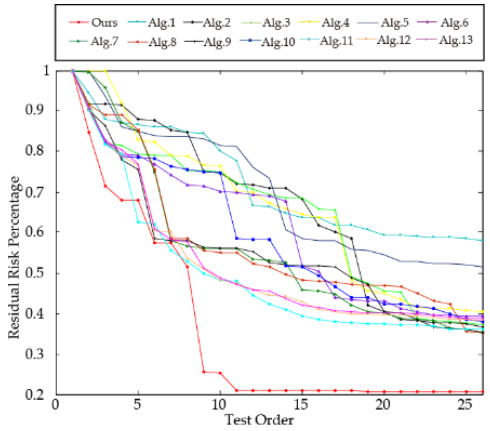


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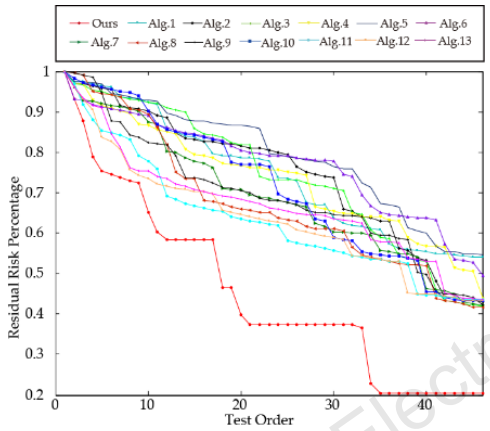
Major results



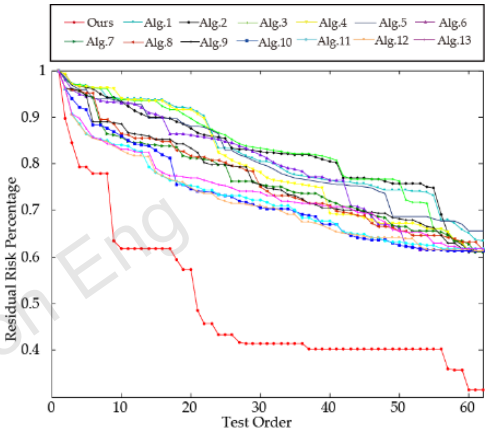
Reduction in total risk of DNS
(θ = 80%)



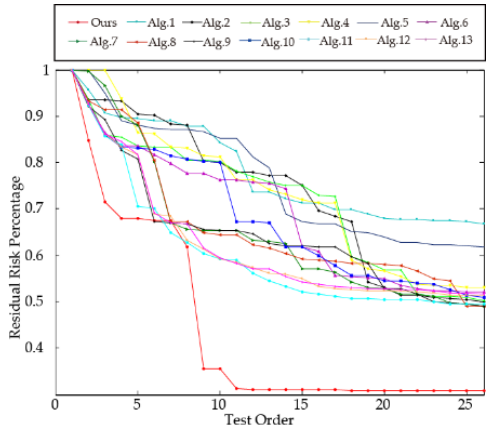
Reduction in total risk of ANT
(θ = 80%)



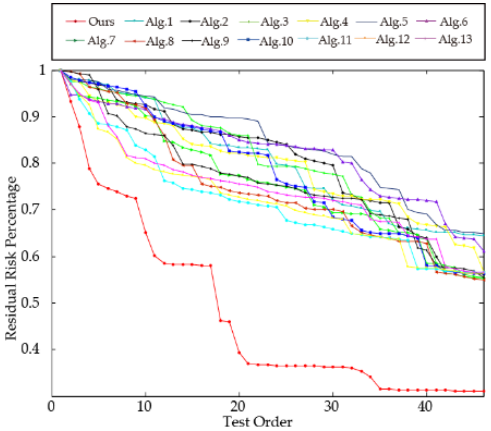
Reduction in total risk of BCEL
(θ = 80%)



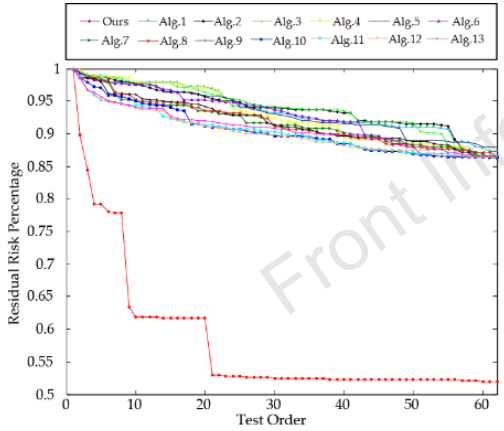
Reduction in total risk of DNS
(θ = 50%)



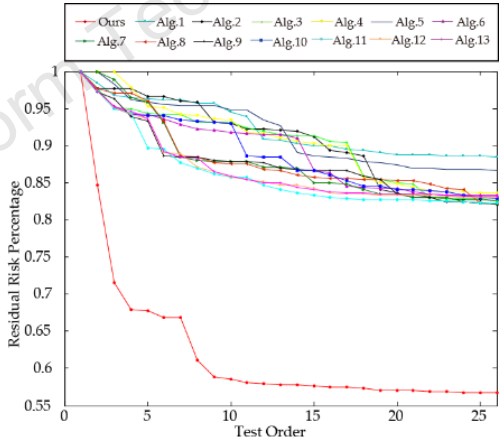
Reduction in total risk of ANT
(θ = 50%)



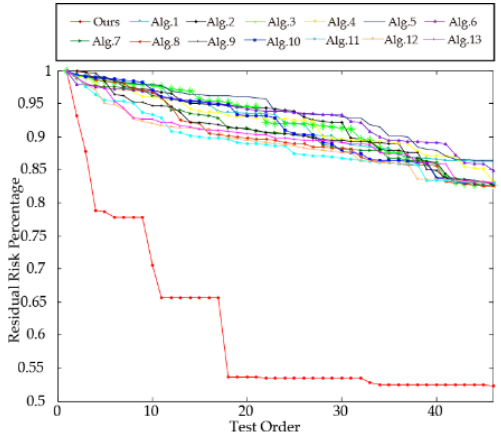
Reduction in total risk of BCEL
(θ = 50%)



Reduction in total risk of DNS
(θ = 20%)



Reduction in total risk of ANT
(θ = 20%)



Reduction in total risk of BCEL
(θ = 20%)



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Summary

- Integration test priority measurements
- Principles encoded in breaking cycle operations
- An evaluation scheme for class integration test orders
- A publicly available tool and dataset



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