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Devising optimal integration test orders using cost–benefit analyses

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

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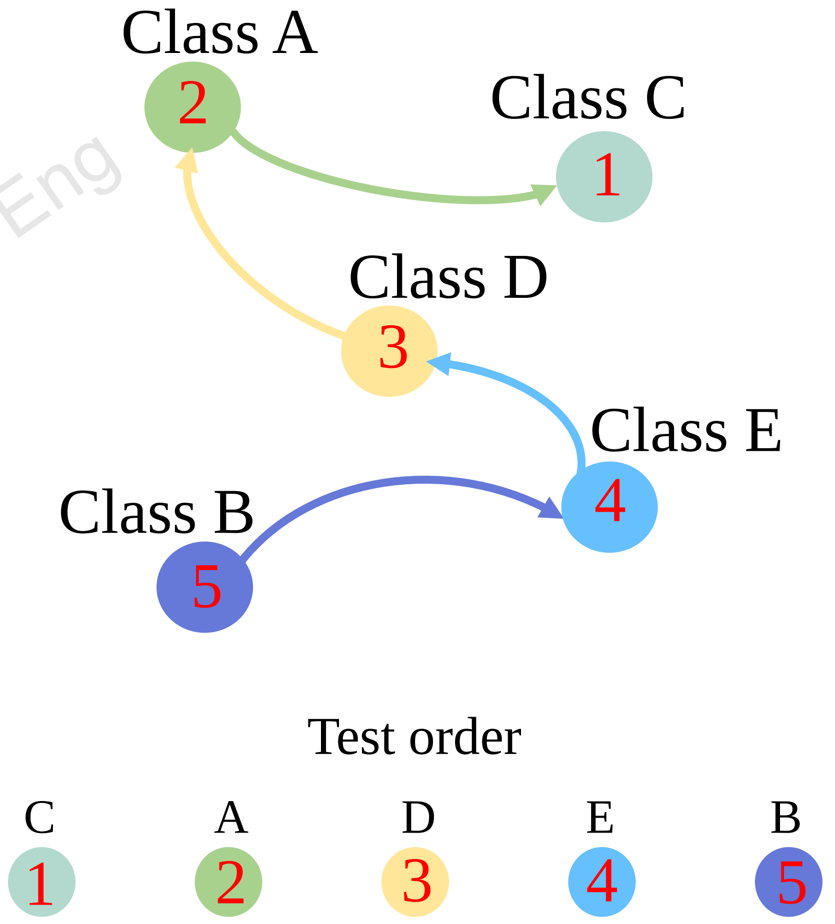
Motivation

- 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.



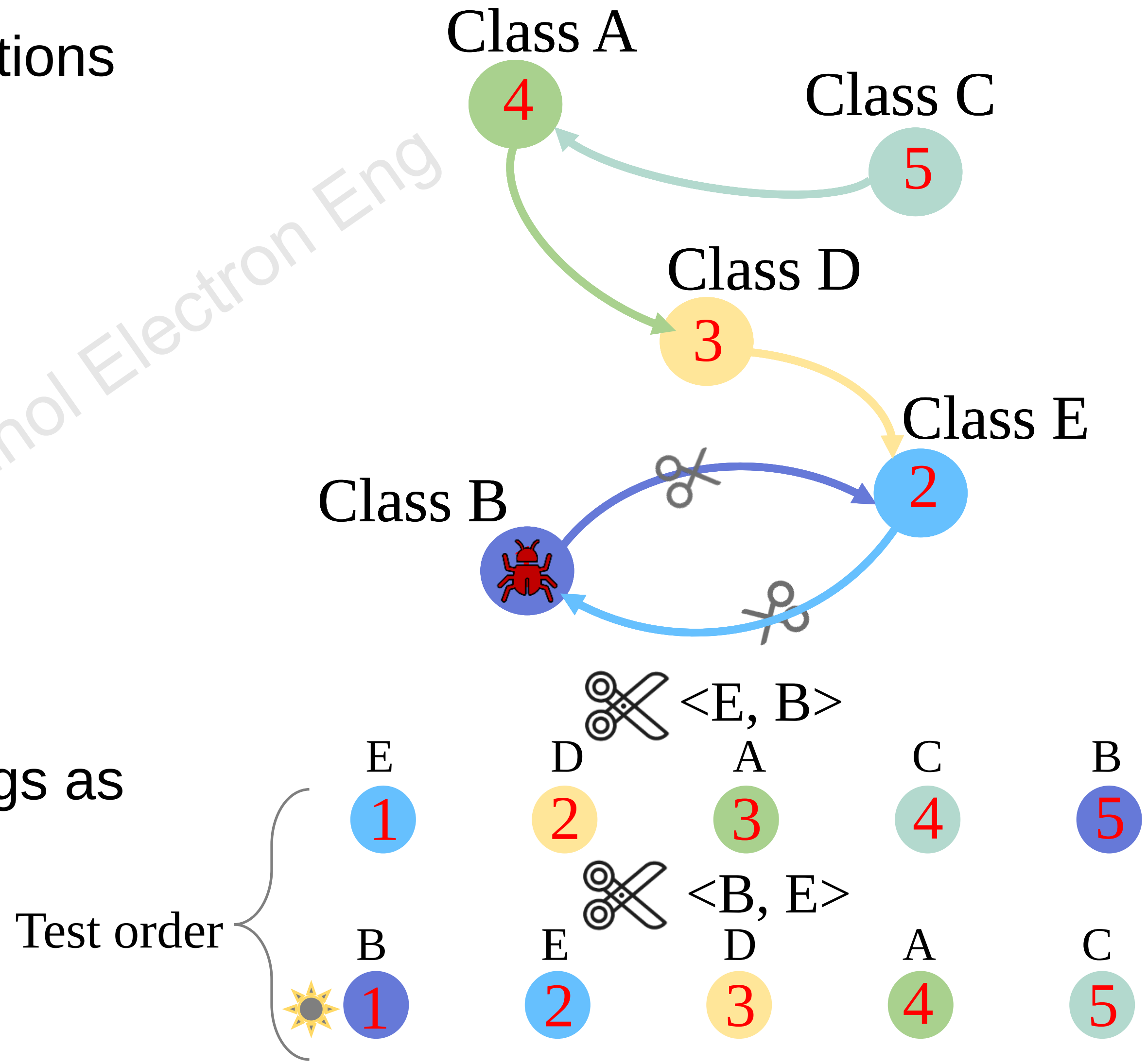
Motivation

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

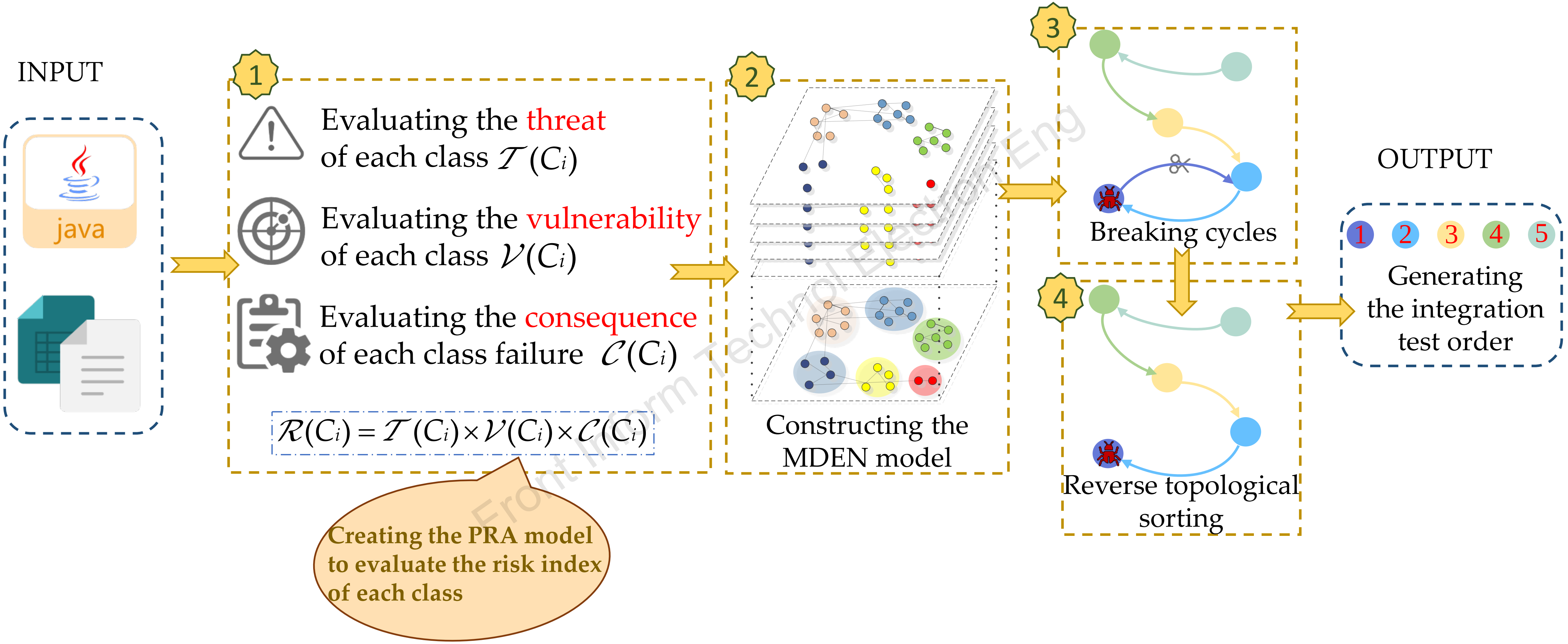
Existing strategies focus on two aspects:

- 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.



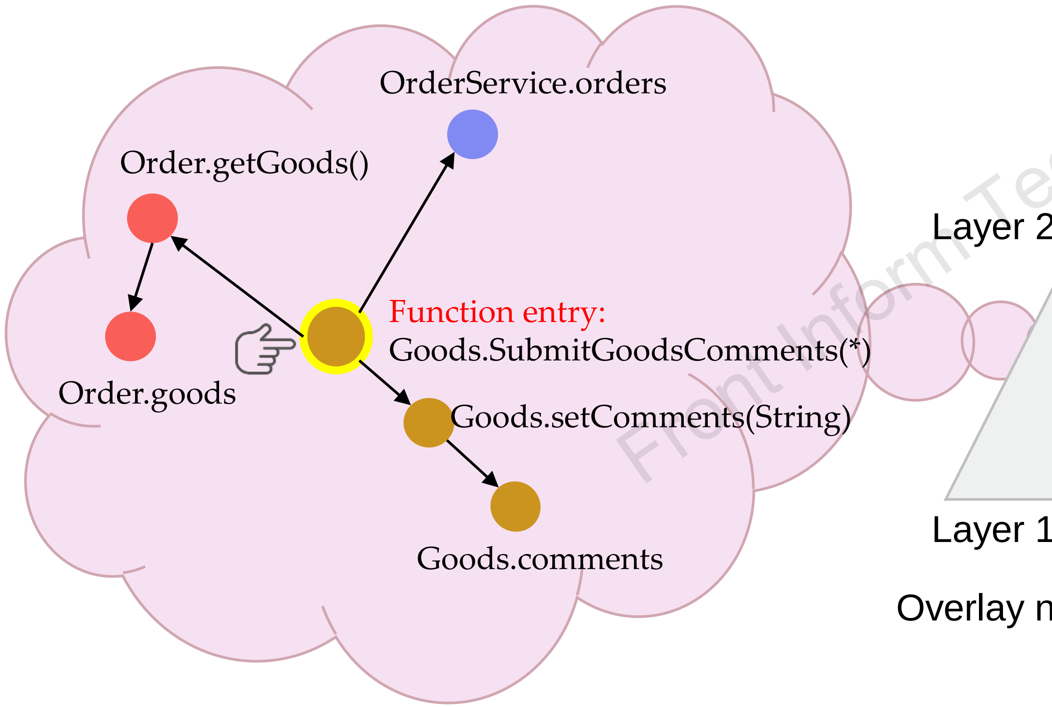
Methodology

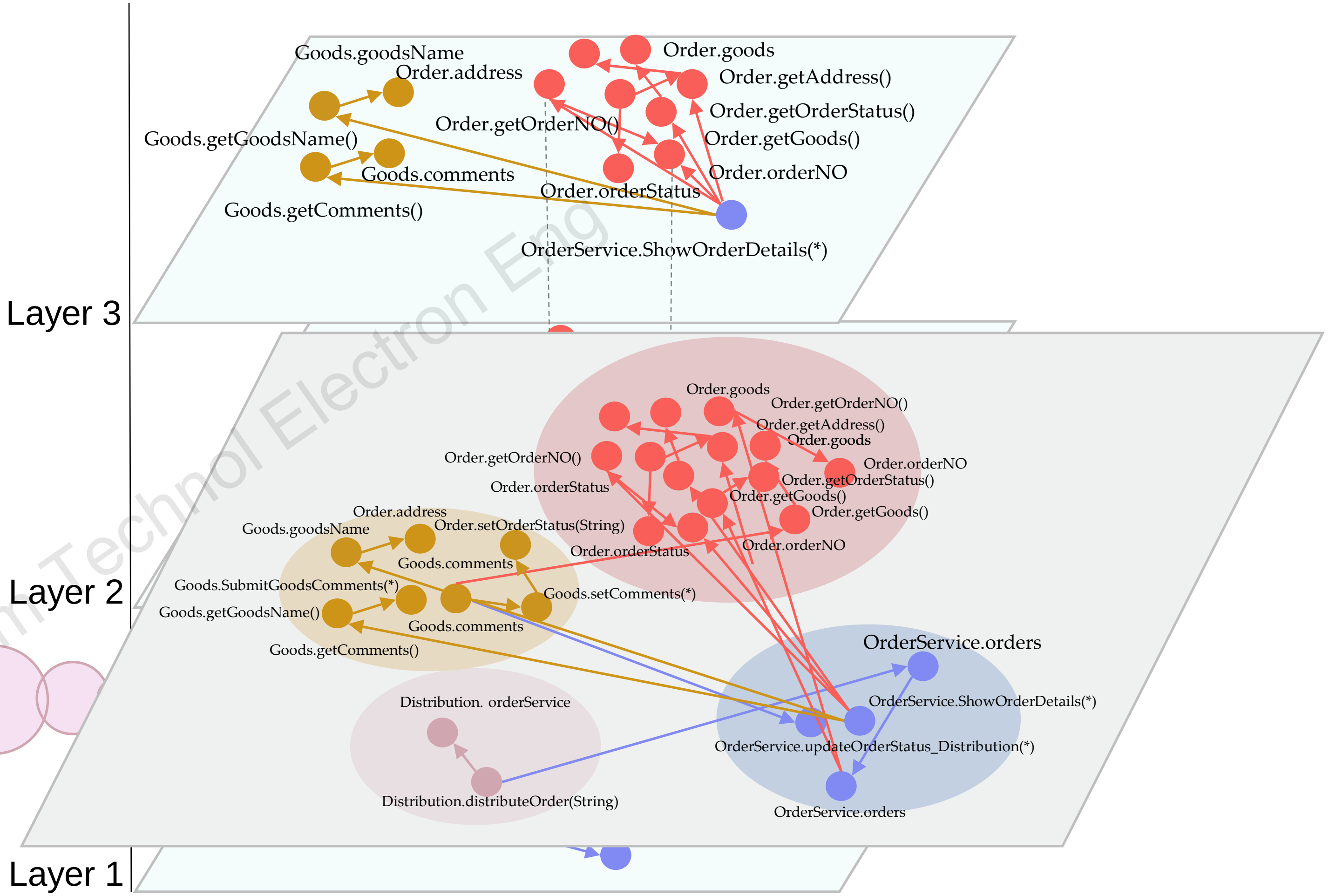


Methodology: MDEN model construction

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

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





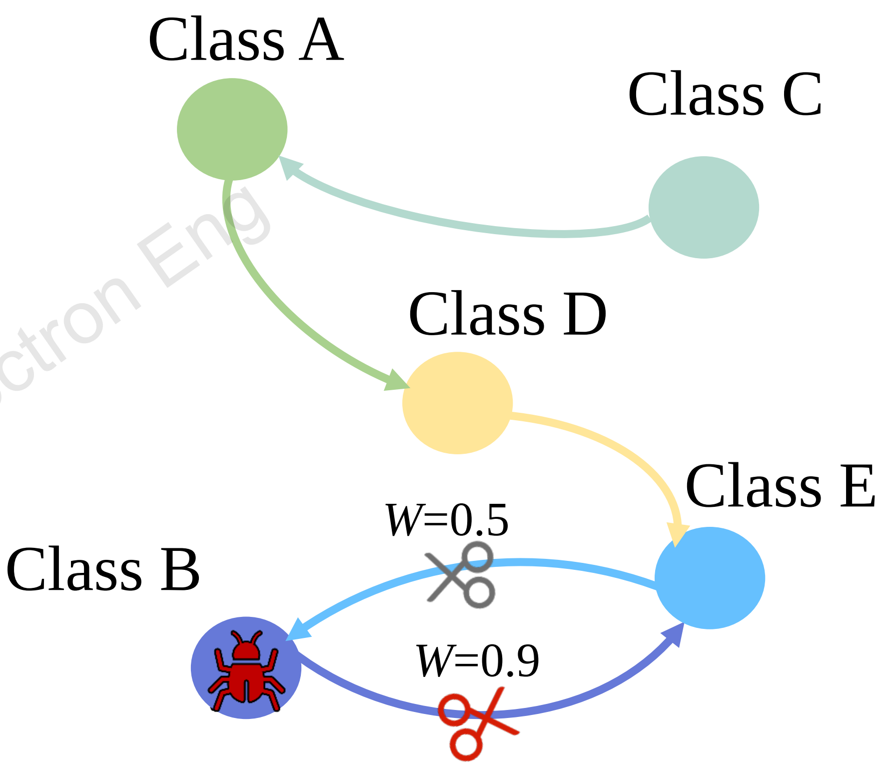
Overlay network

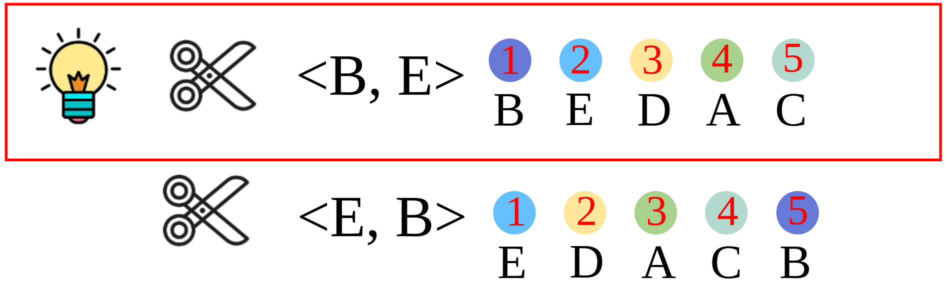
Methodology: breaking cycles

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

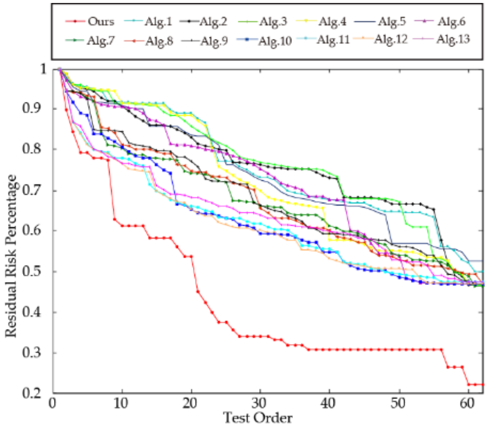
$$\mathrm{PR}_t = \sum_{k=1}^{r_t}\left(\frac{2(r_t - k + 1)\mathcal{R}_k^{O_t}}{r_t(r_t+1)} \Big/ \sum_{n=1}^{r_t}\frac{2(r_t - k + 1)\mathcal{R}_n^{O_t'}}{r_t(r_t+1)}\right)$$

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

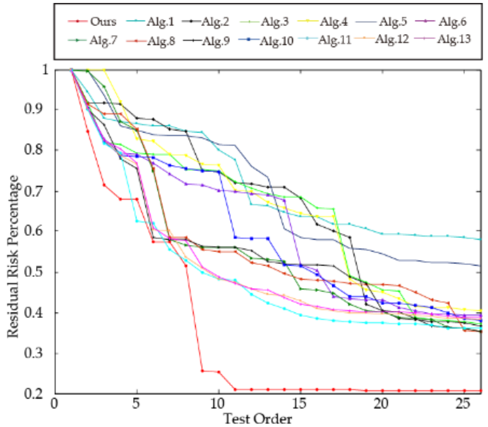




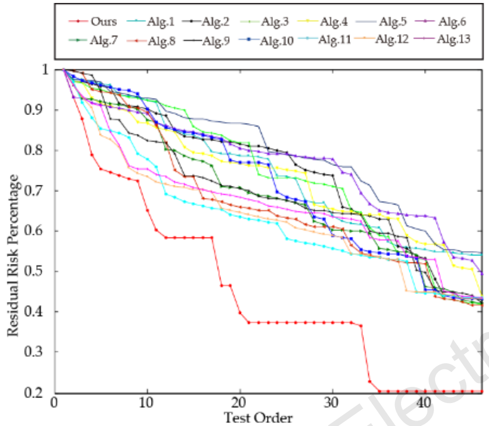
Major results



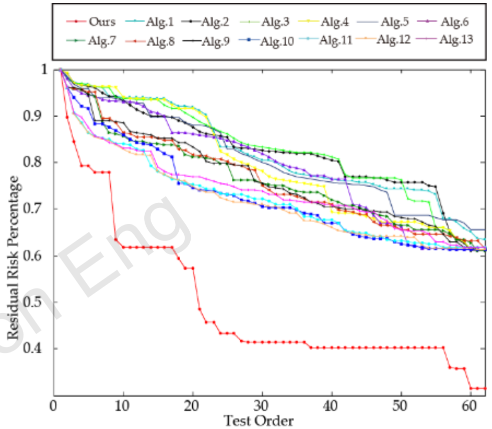
Reduction in total risk of DNS ($\theta = 80\%$)



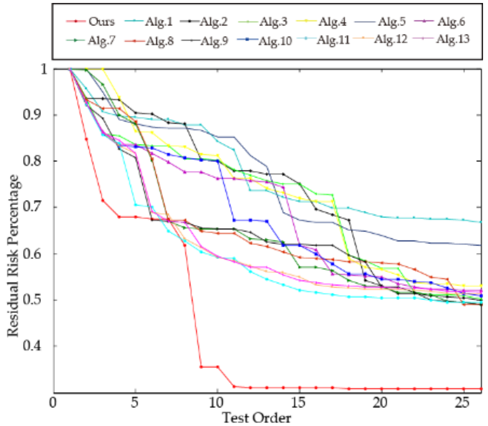
Reduction in total risk of ANT ($\theta = 80\%$)



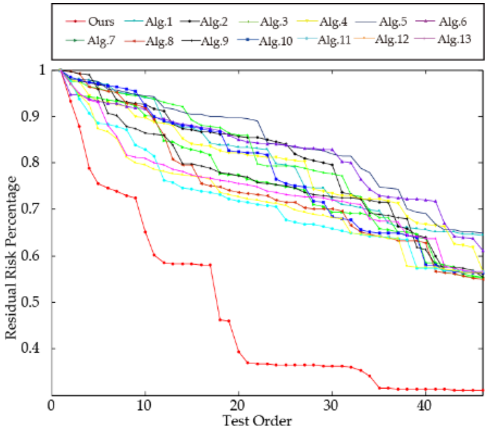
Reduction in total risk of BCEL ($\theta = 80\%$)



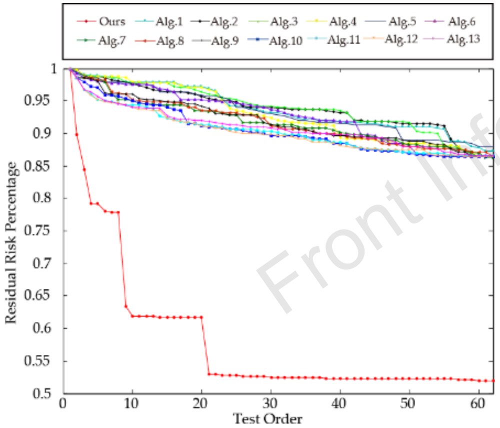
Reduction in total risk of DNS ($\theta = 50\%$)



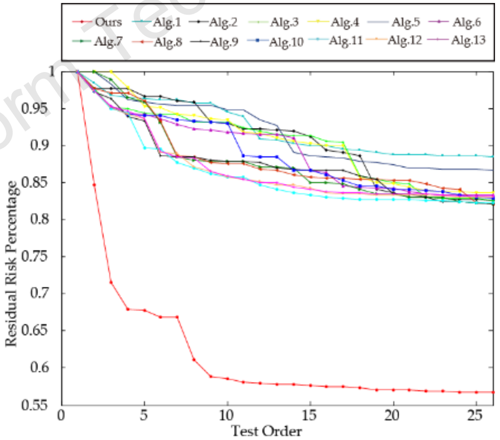
Reduction in total risk of ANT ($\theta = 50\%$)



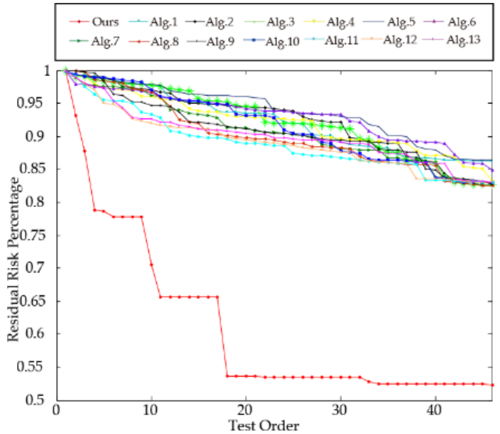
Reduction in total risk of BCEL ($\theta = 50\%$)



Reduction in total risk of DNS ($\theta = 20\%$)



Reduction in total risk of ANT ($\theta = 20\%$)



Reduction in total risk of BCEL ($\theta = 20\%$)

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