Project Scheduling with Alternative Technologies: Incorporating Varying Activity Duration Variability

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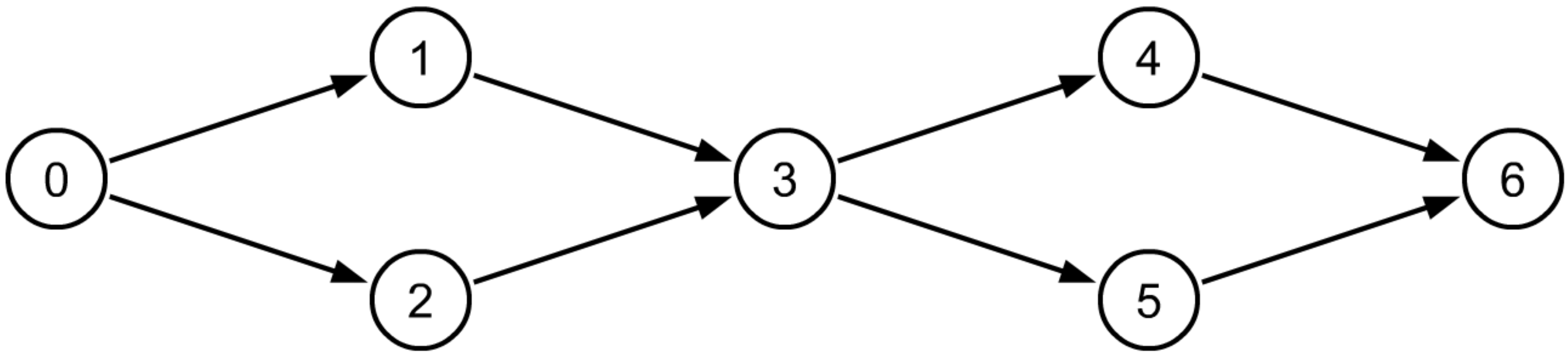
Introduction

- A project is a set of precedence-related activities that need to be completed in order to achieve a specific target
- Our objective is to schedule the activities of a project such that its value is maximized
- We examine how to incorporate the following characteristics:
  - Activity failure
  - Modular completion structure of the project
  - Different levels of variability in the durations of the activities
- Relevant especially for R&D and NPD but also in other sectors: pharmaceuticals, software development, …

PROBLEM SETTING: DEFINITIONS



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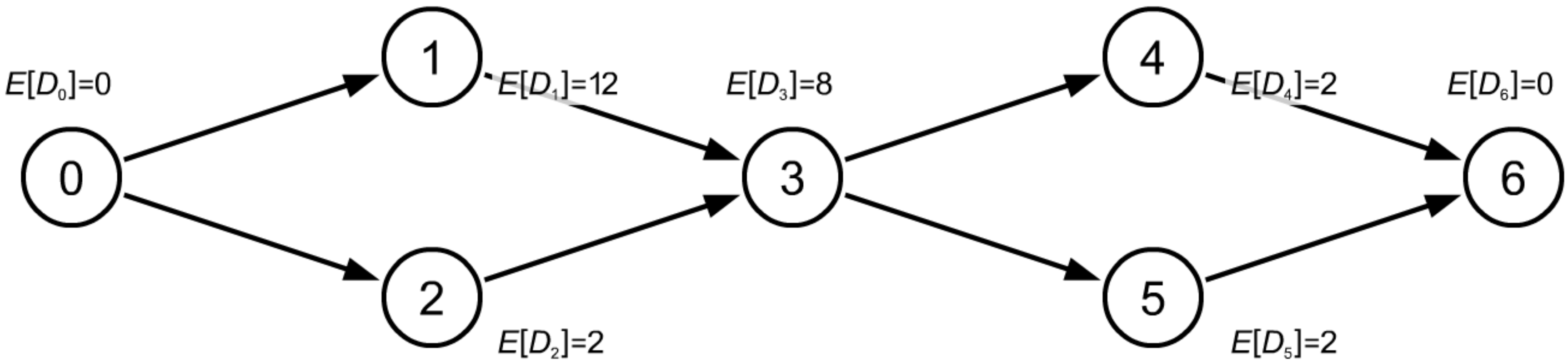

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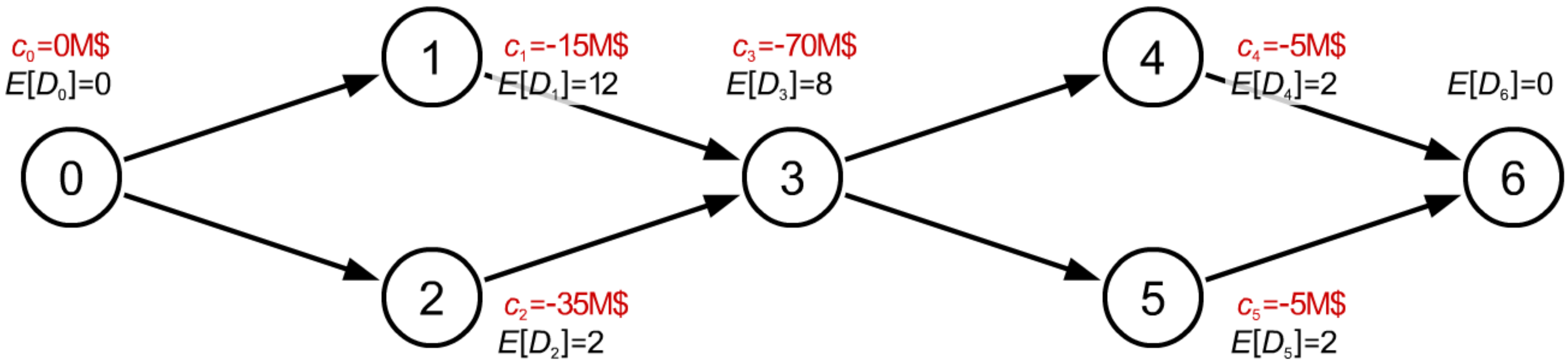

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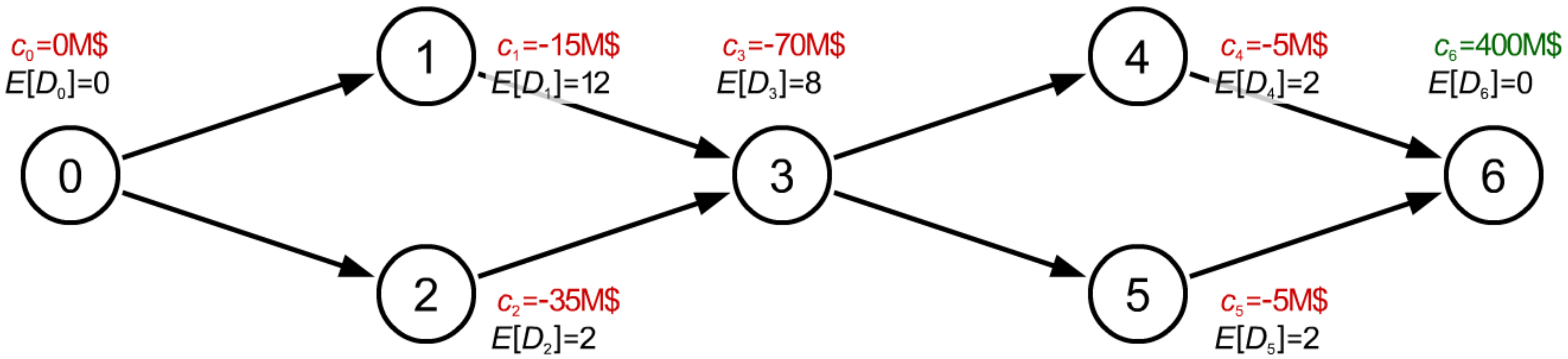

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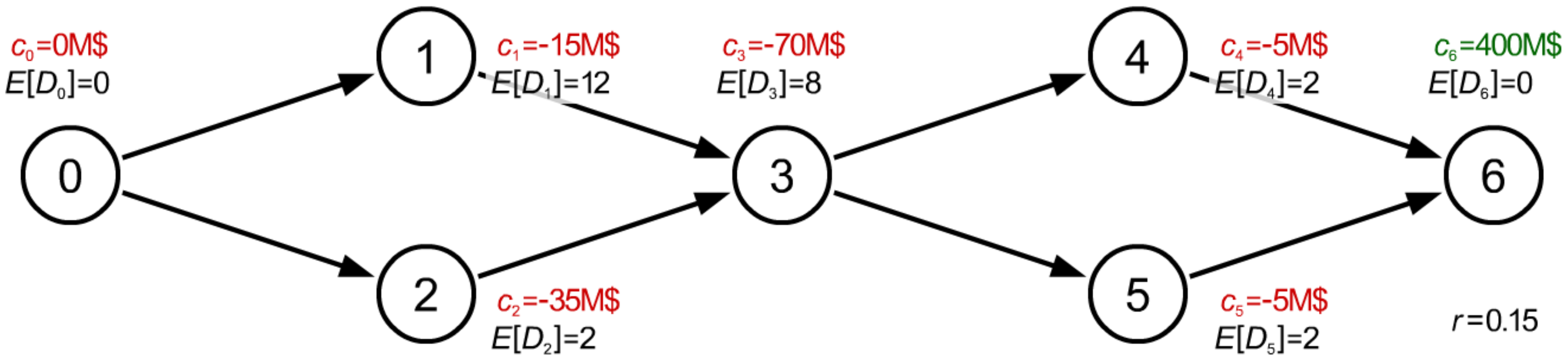

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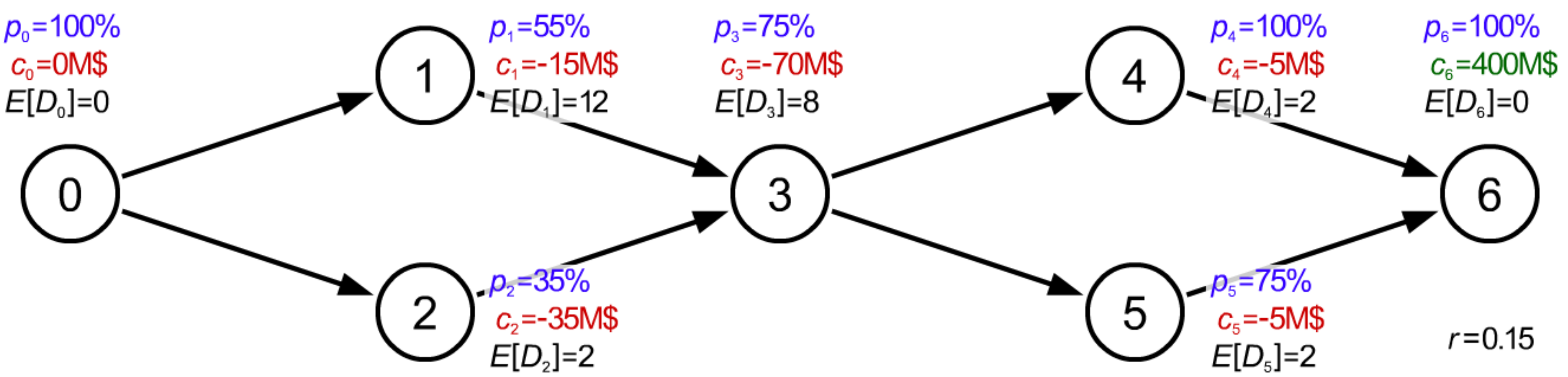

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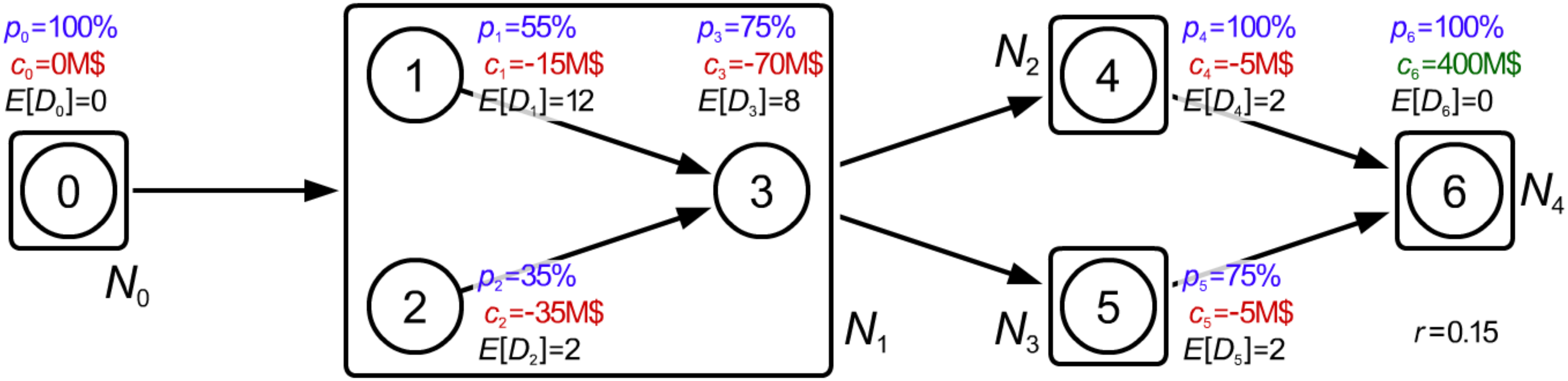

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- *m* modules N_i

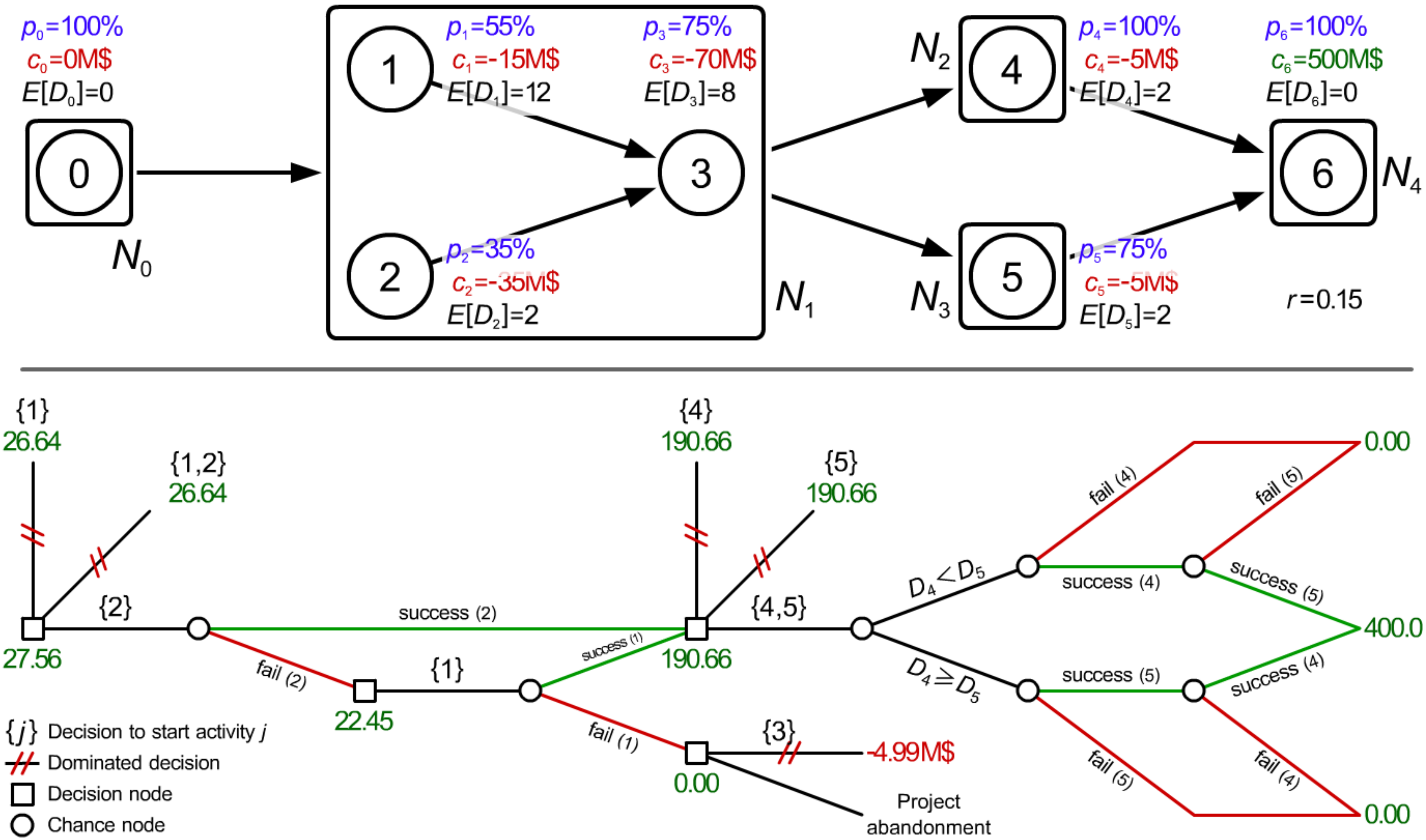
SOLUTION METHODOLOGY

We build on earlier work of Creemers et al. (2010)*:

- At any moment in time, the state of each activity *j* can be:
  - Not Started
  - In progress
  - Past (successfully finished, failed or considered redundant because another activity of its module has completed successfully)
- The state of the system is defined by the state of the activities
- Use of Phase-Type distributions to model activity durations
- Use of a Continuous-Time Markov chain to model the statespace
- The optimal eNPV is found using a backward SDP-recursion

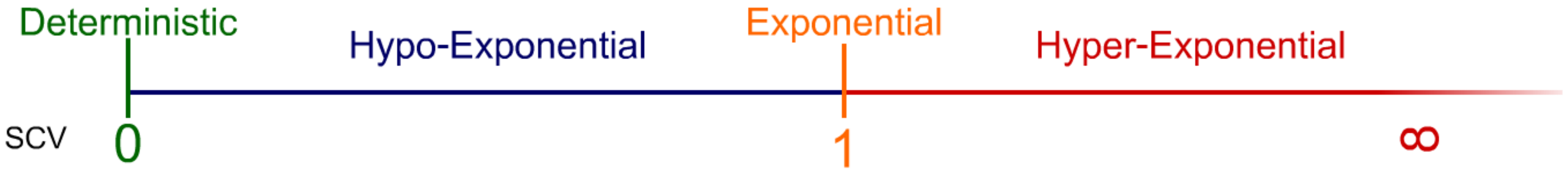
*Creemers S, Leus R & Lambrecht M (2010). Scheduling Markovian PERT networks to maximize the net present value. Operations Research Letters, vol. 38, no. 1, pp. 51 - 56.

SOLUTION METHODOLOGY: ILLUSTRATION OF A POLICY



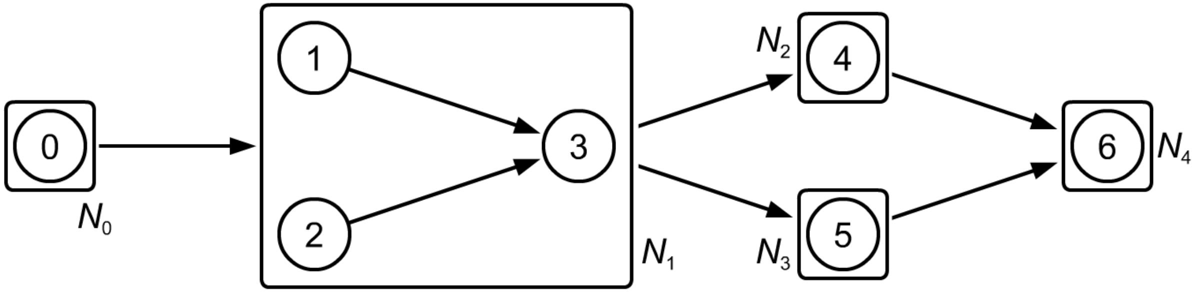
RESEARCH QUESTION

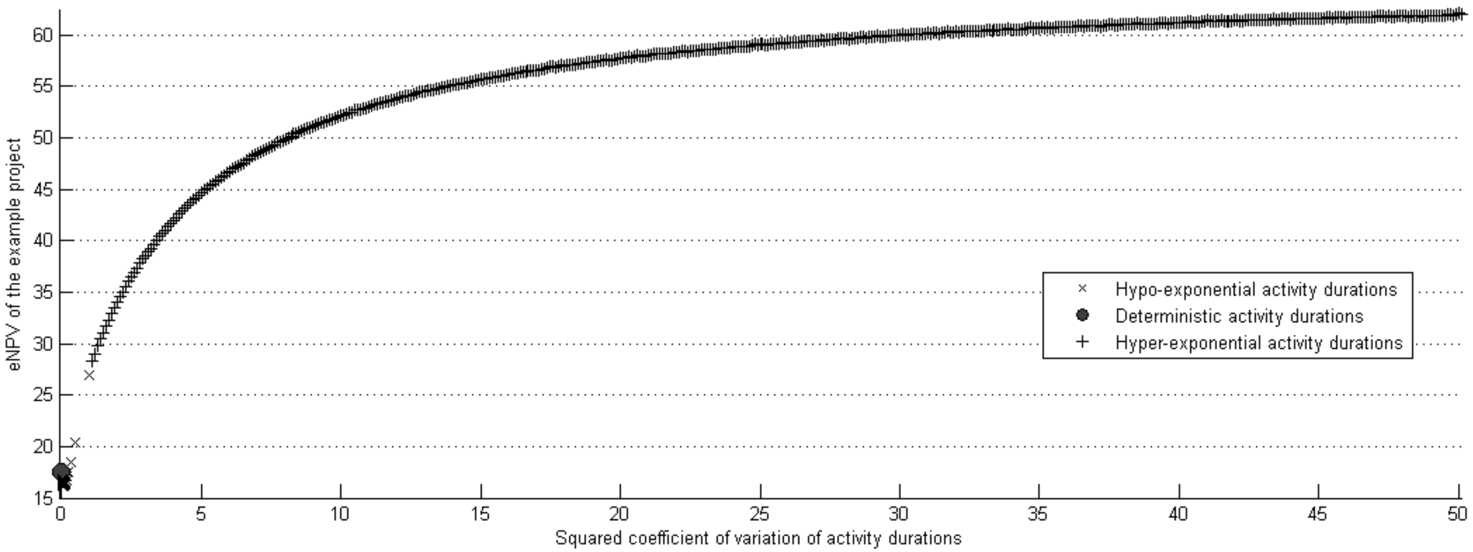
- What is the impact of the variability of activity durations on the eNPV of a project?
- Experimental setup:
  - All activities in the project have the same level of variability
  - Variability is expressed using the Squared Coefficient of Variation (SCV)
  - We observe SCV's ranging from 0 (deterministic) to ∞
  - We use Phase-Type distributions to model the activity durations*



*We adopt the two-moment matching approximation of Creemers S & Lambrecht M (2010). An advanced queueing model to analyze appointment-driven service systems. Computers and Operations Research., vol. 36, no. 10, pp. 2773 - 2785.

RESULTS: PROJECT NETWORK





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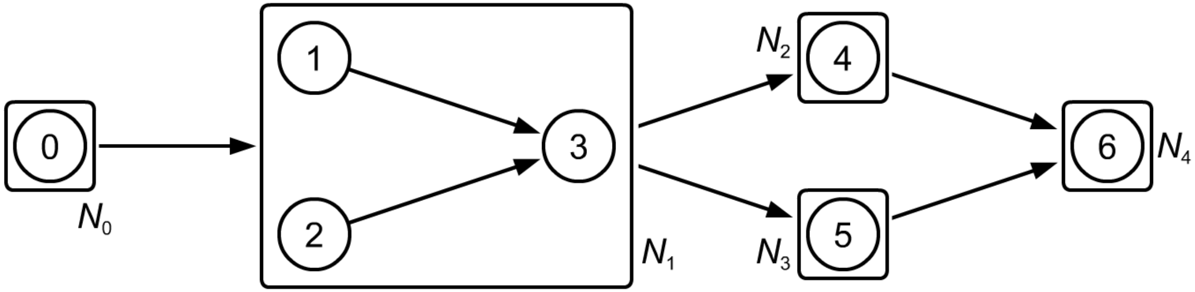
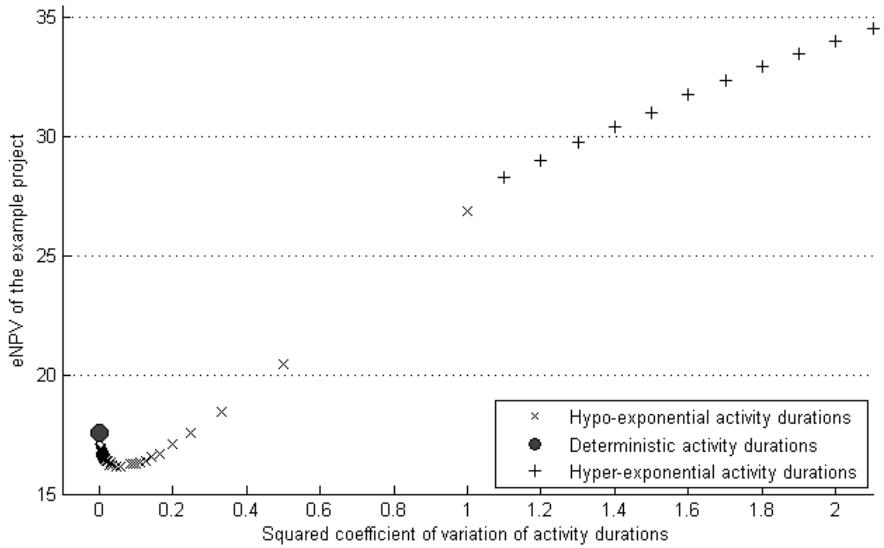
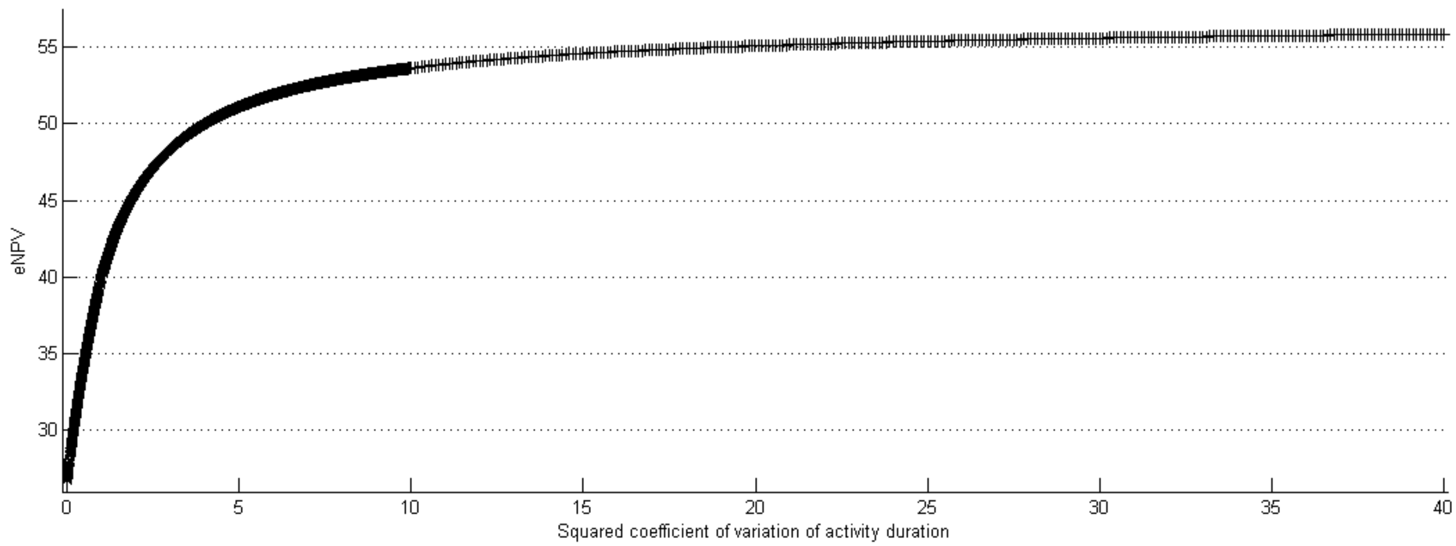




Computational results indicate that networks with up to 120 activities can be solved to optimality

RESULTS: INDIVIDUAL ACTIVITY



SUMMARY

- We have extended the model of Creemers et al. (2010) to incorporate general activity durations (using Phase-Type distributions) & to allow for modular projects
- We have shown that variability in the duration of activities is not always bad with respect to the NPV of a project
- We have shown that even for a single activity, variability in the duration can be beneficial