Performance Evaluation of UML Software Architectures with Multiclass Queueing Network Models

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Software Performance Modeling

1. Software Model
2. UML Model
3. Performance Results
4. QN Model
5. Model Evaluation

- Modeling Algorithm
- Feedback
Performance Modeling Framework

Annotated UML Model

- Simulation Model
- Sim Model Execution
- QN Model
- QN Model Evaluation

Performance Results
Performance Modeling with multiclass QN

• Starting point
  ♦ Use Case diagrams (workloads)
  ♦ Deployment diagrams (hardware model)
  ♦ Activity diagrams (system execution model)

• Target notation
  ♦ Mixed Multiclass QN model
  ♦ Use Case diagrams ➤ Workloads
  ♦ Deployment diagrams ➤ Service centers
  ♦ Activity diagrams ➤ Topology
Why?

- Performance model generation can be done efficiently
  - $O(\#transitions + \#action\ states)$
- Performance model can be solved efficiently
  - If some constraints are satisfied
- The approach uses standard UML SPT profile annotations
  - Can be integrated with existing software performance modeling frameworks based on the profile
Translating UC diagrams

<<PAopenLoad>>

PAoccurrence = \( \lambda \)

<<PAclosedLoad>>

PApopulation = \( N \)
PAextDelay = \( Z \)
Translating Activity diagrams
the easy case

A1 → R1
A2 → R2
A3 → R3

R1 → R2 → R3
Translating Activity diagrams the difficult case
Outline of the transformation algorithm

• Translate one Activity diagram at a time
  ♦ Each Activity diagram corresponds to a single chain
• Resources correspond to service centers
• Translate an Activity diagram as follows
  ♦ All actions requesting service from the same resource receive a unique label in the range [1..k]
  ♦ If there is a transition with probability $p$ from an action with label $r$ requesting service from resource $i$ to an action with label $s$ requesting service from resource $j$
    • Set $P[i,r,j,s] = p$
Example / 1
Example / 2
Example / 3
Example / 4
Example / 4

1-p

p
Example / 5
Example / 6
Example / 7

The diagram illustrates a system where the probability of success is denoted by $p$, and the probability of failure is $1-p$. The system transitions through different states, with the success probability $p$ and the failure probability $1-p$ at each stage.

1. The first stage has a transition with probability $p$.
2. The second stage has a transition with probability $1-p$.
3. The third stage has a transition with probability $p$.
4. The final stage has a transition with probability $1-p$.

The system is represented with circles and arrows indicating the flow of states based on the probabilities.
Example / 8

Diagram showing a flowchart with nodes and connections, illustrating a probabilistic process with parameters $p$ and $1-p$. The diagram includes multiple loops and conditional paths, typical of a probabilistic model or algorithm.
Conclusions and Future Works

- We proposed an algorithm for translating annotated UML specifications in multiclass, multichain QN performance models.

- Future works include:
  - Integration of the approach in a general framework.
    - Partly done, nearly incorporated in our tool UML-Ψ.
  - Extend the approach to UML2.0 composite structure diagrams (and the new QoS profile?)
Thank you!