INSE 6250 – QUALITY METHODOLOGIES FOR SOFTWARE SUMMER 2024

Modeling and Verification of an Insurance Purchase Website Using Uppaal

Submitted By

Supriya Avala – 40258501
Bhanu Teja Kakarla – 40256174
Kunati Bala Krishna Yadav – 40292128
Naveen Rayapudi – 40291526

Under the Guidance of

DR. JAMAL BENTAHAR

ABSTRACT:

Our project investigates the use of Uppaal, an integrated tool environment for modelling and validating real-time systems, to create an insurance purchasing website. Such websites are critical digital platforms where users may traverse various insurance packages, receive information, and interact with providers. The platform's design prioritizes user-friendly interfaces, straightforward navigation, and rich information to enable seamless user interactions. With Uppaal's modeling, validation, and verification capabilities, developers can ensure the website's stability and performance. It validates temporal logic properties, ensures safety, liveness, and reachability, and provides simulation and visualization tools to observe system activity. Integrating Uppaal into the development process guarantees that the insurance website satisfies high standards of functionality, security, and responsiveness, hence improving user experience and operational efficiency.

UPPAAL Overview

Uppaal is an integrated tool environment for modeling, validation, and verification of real-time systems. Uppaal checks properties expressed in temporal logic, exploring the state space to verify safety, liveness, and reachability. The tool also provides simulation and visualization features, allowing users to observe system behavior over time

Insurance Purchase Website Model

An **insurance website** serves as a digital platform where users can explore insurance products, obtain information, and interact with insurance providers. These websites typically feature user-friendly interfaces, clear navigation menus, and relevant content. Visitors can learn about different insurance types (such as auto, health, or home insurance), compare quotes, and access customer service.

Using Uppaal for Insurance Website Model

Uppaal can be applied to any Real-time system models, and this can verify various aspects of the Insurance website

- Modeling: Represents the different components of website as states and specifies the transitions between the states based on the user action (e.g., viewing, purchasing, submitting forms)
- Verification: Verify properties like responsiveness, security (e.g., authentication protocols), and correctness (e.g., form validation). It also ensures desired properties hold.
- Simulation: Simulate user interactions to observe how the website behaves over time.

Example Scenario

Consider an insurance website where users can browse different insurance plans, consult an agent, select a desired plan and purchase, and make payments. Uppaal can model these interactions as states and transitions, allowing verification of scenarios like:

- Visibility of plans to whoever visits the site.
- Ensuring that only authenticated users can access their existing plan and purchase of new plans.
- Validating the secure payment process to purchase the desired plan of the user

Parameters

User States: These are the different states that a user can be in when interacting with the website. Examples from your model include “User_Logged”, “Get_Quote”, and “Policy_Renewal”. Each of these states represents a different part of the user’s journey on the website.

Temporal Constraints: The model includes timed transitions, indicated by clocks. These represent actions or events that are time-dependent. For example, a session timeout might move the user from a “Logged_In” state back to a “Start” state if there’s no activity for a certain period of time.

Decision Points: These are points in the system where a decision has to be made, usually resulting in different states or transitions based on the outcome of the decision.

Transitions: These are the actions that move the user from one state to another.

Specifications

User Interface : Clearly define user-friendly interfaces for various scenarios (e.g., viewing plans, purchasing plans, managing profiles, handling claims).

Authentication and Security: Robust authentication mechanisms (sign in, sign up, error handling).

Payment Processing: There are Several ways to pay (Debit/Credit Card, Samsung Pay, Apple Pay) and also finalization of the transaction and creation of the receipt.

Claims Handling: Easy process for raising and viewing claim, email notifications for claim updates.

Error Handling: Proper error messages and handling for failed actions (e.g., invalid credentials).

Logout and Session Management: Secure logout process and Session management for user activities.

Advantages of Uppaal

- Comprehensive Modeling: UPPAAL allows you to represent complex systems using timed automata, capturing real-world behaviors with precision.
- Verification: The model-checker in UPPAAL verifies properties like reachability, absence of deadlocks, and temporal correctness. It exhaustively explores the system's state space.
- Simulation: UPPAAL provides interactive simulation, allowing you to observe system behavior over time. It aids in understanding and debugging.
- Accessibility: Compared to other tools, UPPAAL is more intuitive and accessible for modeling critical systems.

Desired Results

No Deadlocks: Make sure the system is free of deadlocks so that the process may continue without interruption.

User Actions: Verify the reachability and executability of every desired user activity, such as buying plans, and making payments.

Property Verification: All safety, liveness, and reachability properties should be satisfied. This ensures that the system behaves as expected under all scenarios.

Conclusion

Choosing Uppaal for the development of an insurance website provides significant benefits in terms of system dependability, load performance, and regulatory compliance. Its strengths in model checking, concurrency management, and real-time capabilities make it particularly useful for efficiently managing complicated insurance operations such as policy issuance and claims processing.

References

- **Ahmed, Z., Shaikh, M. K., & Mahar, I. (2018). Model Checking Knowledge And Commitments In Multi-Agent Systems Using Actors And UPPAAL.** https://www.researchgate.net/publication/324202437_Model_Checking_Knowledge_And_Commitments_In_Multi-Agent_Systems_Using_Actors_And_UPPAAL

- **Andersson, P., David, A., Larsen, K. G., Legay, A., Mikucionis, M., & Poulsen, D. (2021). UPPAAL Tutorial.** https://uppaal.org/texts/21-tutorial.pdf

- **Larsen, K. G., & Pettersson, P. (1997). Uppaal in a Nutshell.** https://www.semanticscholar.org/paper/Uppaal-in-a-nutshell-Larsen-Pettersson/ec48771b3e35ed451c721d99805541c2ad431a8a?utm_source=direct_link

- **Rajeev Alur, Costas Courcoubetis, and David Dill. 1993. Model-checking in dense real-time. Information and Computation 104, 1 (1993), 2–34.**

- **Uppaal. (n.d.). Verifier.** https://docs.uppaal.org/gui-reference/verifier/

- **Amato, F., Casola, V., Cozzolino, G., De Benedictis, A., Mazzocca, N., & Moscato, F. (year). A Security and Privacy Validation Methodology for e-Health Systems.**