SOFTWARE RELIABILITY PREDICTION FOR ARMY VEHICLE
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AGENDA

• Objective
• Approach
• AVS reliability metrics
• Prediction algorithm
• Summary

OBJECTIVE

• Formulate Army vehicle software (AVS) reliability metrics
• Develop AVS reliability prediction technique

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APPROACH

• Formulate AVS reliability metrics
  – Investigate IT architecture documents
  – Capture details.
    • Data characteristics (e.g., format, size, storage, and encryption)
    • Inputs and outputs
    • Test cases
    • Configuration and Fault handling
  – Formulate metrics
  – Quantify
• Develop AVS reliability prediction technique
  – Fuzzy logic
  – Fuzzy sets

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IT ARCHITECTURE DOCUMENTS

• Transform user requirements into implementation
• Pure text or Unified Modeling Language (UML)
• No implementation details
• Guide for designers and developers

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FUZZY LOGIC

• Approximation technique for imprecise situations
  – Handle vagueness using heuristic technique (expert knowledge)
  – Fuzzy set theory based (Lotfi Zadeh)
  – Linguistic terms usage
    • Hot, cold, very tall, high reliability
  – Expert knowledge rules in linguistic terms
    • If more defects reliability is low
      – Linguistic terms = more and low
• Fuzzy sets
  – Elements with different membership grades between 0 and 1
  – If X is a set denoted by Y, then a fuzzy set S in X is a set of ordered pairs
    • $S = \{x | \mu_S(x) \in [0, 1] \times x \}$ where $\mu$ is a membership function
    • Example: $S = \{7'0.6, 7'5', 1, 6'0', 0.8, 6', 0.7, 5', 0.3\}$
**Title:** Software Reliability Prediction for Army Vehicle

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**Abstract:**
**AVS RELIABILITY METRICS**

- Data handling (D)
  - Data and its characteristics
  - Test cases
- Interoperability (I)
  - Exchange data within predefined access restrictions
  - Inputs & outputs
  - Test cases
- Configurability (C)
  - Multiple operating environments
  - Test cases
- Fault handling (F)
  - Fault handling mechanisms
  - Test cases

**INTEROPERABILITY (I)**

- \( I_i = \# \) of required distinct inputs
- \( O_i = \# \) of required distinct outputs
- \( T_1 \) = total test cases for all the input details
- \( T_2 \) = \# of test cases that are planned for testing all inputs and outputs
- \( T_3 \) = \# of test cases that are planned for testing all output details
- \( N_i = \# \) of input details
- \( N_o = \# \) of output details

\[
T_1 = \sum \frac{T_{1i}}{N_i}
\]

\[
D = 3 - \left( \frac{D_2 + D_3}{D_1} + \frac{T_3}{D_1} \right)
\]

**CONFIGURABILITY (C)**

- \( C_i \) and \( C_o \) = the number of distinct inputs and outputs, respectively
- \( T_4 \) = \# of test cases planned for configurable event logging
- \( T_5 \) = \# of test cases planned for configurable fault handling
- \( T_6 \) = \# of test cases that are planned for testing all data characteristics per data element
- \( N_i \) = total \# of data characteristics

\[
C = 8 \left( \frac{C_i + C_o}{I_i} \right) + \left( \frac{T_4 + T_5}{O_i} \right)
\]

**FAULT HANDLING (F)**

- \( E_i \) = \# of required distinct inputs
- \( E_o \) = \# of required distinct outputs
- \( F_i \) = \# of required distinct inputs planned for fault handling
- \( F_o \) = \# of required distinct outputs planned for fault handling
- \( T_{11} \) = total test cases for all the input details
- \( T_{12} \) = \# of test cases that are planned for testing all input details
- \( T_{13} \) = \# of test cases that are planned for testing all output details
- \( T_{14} \) = \# of test cases planned for testing its fault handling
- \( I_i \) = \# of required inputs
- \( O_o \) = \# of required outputs

\[
F = 6 \left( \frac{E_i + F_i}{I_i} + \frac{E_o + F_o}{O_o} \right)
\]

**PREDICTION ALGORITHM**
ALGORITHM: Main Steps

- Fuzzify (fuzzification) inputs
- Apply expert knowledge based rules
- Defuzzify (defuzzification)
- Predict AVS reliability

FUZZIFICATION

- Map crisp inputs to membership grades
- Input membership functions

FUZZIFICATION: Continued

- 'D' = 0.225
- \[ \max (\mu_{LM}, \mu_{L}) = \max(0.3, 0.11) = 0.3 \]

APPLY RULES

- Fuzzy reasoning - aggregation of results
- Maximum of mean value
- 'and' operator \( D \land I \land F \land C = \min (\mu_D, \mu_I, \mu_F, \mu_C) \)
- 'or' operator \( D \lor I \lor F \lor C = \max (\mu_D, \mu_I, \mu_F, \mu_C) \)

FUZZY RULES AND DEFUZZIFICATION

SUMMARY

- Concept introduction
  - AVS reliability metrics
    - IT Architecture documents
  - AVS reliability prediction algorithm
    - Approximation
    - Fuzzy logic
- Simple data collection
- Ordinary computer skill