

Empirical Software Engineering

CSE 8340 — Spring 2014

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Module Ia: ESE Overview

- ESE: Empirical Software Engineering
- About CSE 8340
- Relation to Software Measurement
- GQM and ESE

What Is ESE?

- *Empirical Software Engineering (ESE)*:
Applying empirical techniques/methods to solve software engineering problems.

- Objects of study:
 - ▷ Observation of SE activities.
 - ▷ Case studies in SE.
 - ▷ Controlled experiments.

- Analysis and conclusions:
 - ▷ Data from the above activities.
 - ▷ Statistical and other analyses.
 - ▷ Conclusions draw based on data/analyses.

- Typically goal driven (*solve...*).

Software Engineering Perspective

- Key components of S/W Eng.
 - ▷ Methods and processes
 - ▷ Formal foundations (math/theory)
 - ▷ Experimentation (scientific)

- Methods and process
 - ▷ Methods and methodologies
 - structured programming
 - OO
 - specialized methods
 - specification: formal vs informal
 - black-box/white-box/random testing
 - ▷ Process models
 - ▷ Mixing method and process
 - clean room example
 - ▷ 7314/7316/7319 and other MS/CS courses.

Software Engineering Perspective

- Formal foundations
 - ▷ Mathematics/logic/statistics
 - formal specifications
 - program verification
 - statistical models
 - ▷ Computer science
 - language and ADT \Rightarrow OO
 - systems/tools/CASE

- Experimentation (scientific)
 - ▷ Trace/case studies
 - ▷ Controlled experiment
 - ▷ Measurement and analysis
 - ▷ Empirical validation
 - ▷ Observation-based vs. goal-oriented
 - ▷ This class 8340: all areas

ESE in Software Processes

- Mega-Process: Initiation, Development, Maintenance, Termination.

- Components: Requirement, Specification, Design, Coding, Testing, Release.

- Process Variations:
 - ▷ Waterfall: sequence and dependencies;
 - ▷ Iterative: incremental, divide&conquer;
 - ▷ Spiral: risk management;
 - ▷ Mixed/synthesized.

- ESE: Measurement and analysis throughout different components of the products and processes.

- Relation to CSE 7316/7319/7314/7315, etc.

ESE in SE Activities

- Observational studies:
 - ▷ Passive observations of industrial practice, etc.
 - ▷ Try to draw preliminary conclusions based on observations and related data.
 - ▷ Multiple observations \Rightarrow validation.

- Case studies:
 - ▷ Semi-active.
 - ▷ Pre-set study goals.
 - ▷ Conclusions need further validation.

- Controlled experiments:
 - ▷ Active design and experimentation.
 - ▷ Closest to scientific experiments.
 - ▷ Solid conclusions.

ESE in Software Measurement

- Example: testing evaluation
 - ▷ Test results and expenditure.
 - ▷ Test cases and measurement.
 - ▷ Internal measurements: size/complexity/etc.
 - ▷ Environmental data: process/people/setup
 - ▷ Evaluation results: reliability.

- Data/analysis from other phases:
 - ▷ Product: code, documents etc.
 - external: quality, cost, schedule etc.
 - ▷ Process: entities/relations/environment
 - ▷ People: experience etc.
 - ▷ Various assessment/prediction/improvement.

- Relation to CSE 8314.

ESE and Product Measurement

- Product specific (static):
 - ▷ Code, testcase, document
 - ▷ Structure vs. information flow
 - ▷ Control/data/presentation
 - ▷ Metrics and data collection
 - ▷ ESE: product quality/etc. questions?

- Execution specific (dynamic):
 - ▷ Path verification (white-box)
 - ▷ Usage to component mapping (black-box)
 - ▷ Measurement along the path
 - ▷ Usage of the measurement data
 - ▷ ESE: performance/reliability/etc.?

ESE and Other Measurement

- Process characteristics
 - ▷ Entities, relationships, and integration
 - ▷ Preparation, execution and followup

- People characteristics
 - ▷ Skills and experience
 - ▷ Roles: planners/developers/testers
 - ▷ Process management and teams

- Environmental characteristics
 - ▷ Hardware/software environment
 - ▷ Product/market environment

- ESE: based on above measurements.

How Does CSE 8340 Fit In?

- (Area I) ESE fundamentals:
 - ▷ Generic activities and steps.
 - ▷ Overall framework.

- (Areas II&III) ESE studies:
 - ▷ Assessment/prediction focus:
 - hypothesis testing related studies.
 - ▷ Improvement focus:
 - risk id./analysis related studies
 - ▷ Other empirical studies.

- (Area IV) Trends etc.:
 - ▷ Application domains
 - ▷ Data
 - ▷ Other topics

ESE Framework: GQM

- Background:
 - ▷ Software Engineering Laboratory
 - ▷ TAME projects
 - ▷ Key personal: Basili et al.

- Software Engineering Laboratory
 - ▷ NASA/GSFC
 - ▷ University of Maryland
 - ▷ Computer Sciences Corp.
 - ▷ 1st SEI process award recipient
 - ▷ Software measurement and ESE:
 - among the first ESE studies
 - software measurement and analysis
 - goal-question-metric (GQM) paradigm
 - experience factory (EF)

ESE and GQM

- GQM: what is it?
 - ▷ Goal: goal of the (measurement) study.
 - ▷ Questions: questions related to goals.
 - ▷ Metrics: metrics answering questions.

- GQM background/foundations:
 - ▷ Goal oriented approach.
 - ▷ Measurement based.
 - ▷ Scientific experimentation.
 - ▷ Hierarchy or paradigm: diagram.

- Relation to ESE:
 - ▷ Can serve as general guidelines for ESE.
 - ▷ Related EF: similar to scientific labs in ESE.

ESE and EF

- EF: What is it?
 - ▷ Experience Factory
 - ▷ Separation of concerns
 - ▷ In connection with GQM/TAME
 - ▷ In ESE: Similar to scientific labs that conducts scientific experiments.

- Experience Factory
 - ▷ Input from product organization
 - ▷ Output to product development
 - ▷ Internal organization
 - ▷ Implementation in NASA/SEL

GQM/EF Recent Development

- Research activities:
 - ▷ New NSF-funded Center:
 - Univ. Maryland and USC (Boehm)
 - GMQM and other activities
 - ▷ Fraunhofer Institute and Centers
 - ▷ Others

- GQM extensions:
 - ▷ GMQM: success model
 - ▷ Specialized guidelines
 - Kitchenham et al.
 - Tian measurement/model, etc.
 - ▷ More emphasis on scientific experimentation

- EF beyond NASA/SEL.