Requirements Engineering

(Summer 2021)

Prof. Nan Niu (nan.niu@uc.edu)

https://github.com/nanniu/RE-Summer2021

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Today's Menu

Wednesday (July 14)
Syllabus
"req.s", "why", & "RE"

Thursday (July 15)
Meaning of Requirements
ASN1 Release

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Today's take-aways

→ What're requirements?

→ Why're requirements important?

→ What's requirements engineering (RE)?

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About This Course: Logistics

- Three lectures on each weekday
  - 9:00am-9:45am
  - 9:45am-10:40am
  - 10:50am-11:35am
- To make it appealing, in the beginning of each lecture
  - Take-away of the day
  - Working in academia
  - RE comics
- All slides will be shared ***after*** each day's lectures
  - I need you to stay focused
  - Yet, you don't have to copy (or screenshot) crazily
- Communications shall be done via
  - WeChat group (if the issue is applicable to the entire class)
  - Email (nan.niu@uc.edu) [if the issue is private to yourself)

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About The Instructor

- Where's he coming from?
  - Hometown: Beijing, China
  - B.Eng. (1995-1999), Beijing Institute of Technology, China
  - Programmer (1999-2001), Lenovo, China
  - M.Sc. (2001-2004), University of Alberta, Canada
  - Ph.D. (2004-2009), University of Toronto, Canada
  - Assistant Professor (2009-2014), Mississippi State Univ.
  - Assistant Professor (2014-2018), Univ. of Cincinnati, USA
  - Associate Professor (2018-Present), Univ. of Cincinnati
- What's his research area?
  - Software Engineering, RE, Scientific Software Development, Human-Centric Computing
- How to obtain course-related information?
  https://github.com/nanniu/RE-Summer2021 *(will be updated)*
- Anything else?

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About Me

- Associate Editor

- Steering Committee Member

- Organizer

My Recent Papers

Deep Learning Based Program Generation from Requirements Text: Are We There Yet?

IEEE TRANSACTIONS ON SOFTWARE ENGINEERING

Requirements Engineering in the Days of Artificial Intelligence

About This Course: Objectives

- Examine the state-of-the-art of research & current practice in RE
  - Role of RE in software and systems engineering
  - Current techniques, notations, methods, processes, and tools used in RE
- Gain practical experience in selected RE techniques
- Understand the essential nature of RE
  - Breadth of skills needed for RE, and the many disciplines on which it draws
  - Contextual factors & practicalities
- Gain a basic grounding for research in RE
  - Methodological issues for RE research
  - Current research issues & direction of the field
  - Awareness of the literature

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Class Participation #1

→ Type in the "chat" to ***only me*** your one-sentence definition of "requirements"

- It's very important to use your real name (i.e., official name in the class roster) in the chat, so if needed, please type:
  - "John Smith: [definition of requirements]"

- Class participation counts as part of your grade

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What're "Requirements"?

→ Requirements = stakeholders' needs and desires

→ Stakeholders = those who have a stake in the change being considered & who stand to gain or lose from the change

- The holders of the bets in a gambling game

- Discussion: Who're the STAKEHOLDERS of Webex (https://ucincinnati.webex.com/meet/niunn) and what're their requirements (needs and desires)?

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Stakeholders of Webex

https://ucincinnati.webex.com/meet/niunn

Builder: software developers, testers, marketing & sales …

User: customers (those who pay), users (those who use) …

Contexts: social, legal, ethical, technological, organizational …

Source: *Google Images*

Stakeholders' needs & desires

GitHub

webex by CISCO

Google Drive

Source: *Google Images*

Stakeholders' needs & desires

29th IEEE International Requirements Engineering Conference
Notre Dame, South Bend, USA
September 20-24, 2021

→ Always an important RE topic & will continue to be an important RE topic in the days of AI

https://conf.researchr.org/track/RE-2021/RE-2021-papers#Call-for-Papers

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Your conclusion: _____

- "48% of the failures observed in a medium-scaled software project were attributed to incorrect or misinterpreted functional specifications or requirements"

  V. Basili and B. Perricone, "Software errors and complexity: an empirical investigation", *CACM'84*

- "79.6% of interface faults were due to incomplete or omitted requirements"

  D. Perry and C. Stieg, "Software faults in evolving a large, real-time system: a case study", *ESEC'93*

- NASA spacecraft software systems: "the primary cause of safety-related functional faults is errors in recognizing (understanding) the requirements (62% on Voyager; 79% on Galileo)"

  R. Lutz, "Analyzing software requirements errors in safety-critical, embedded systems", *RE'93*

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Requirements faults are common.

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Your conclusion: _____

"The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical requirements, including the interfaces to people, to machines, and to other software systems. No other part of the work so cripples the resulting system if done wrong. No other part is as difficult to rectify later."

Frederick P. Brooks, Jr.

"Clearly, it pays off to invest effort in finding requirements errors early and correcting them, say 1 man-hour rather than waiting to find the error during operations and having to spend 100 man-hours correcting it."

Barry Boehm

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Side Note

Source: *Google Images*

Requirements faults are costly.

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NASA's Risk Matrix

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Source: *Google Images*

Recap so far

- Requirements are important *because*
  - It's hard (*hardest*) to get them right.
  - It's common to get them wrong.
  - Getting them wrong is costly.
    - Some ($) numbers on the next slide
  - Hence, *"doing requirements right saves money"*.

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Importance of RE (some numbers)

- Problems
  - Increased reliance on software
    - E.g. cars, dishwashers, cell phones, web services, …
    - Philips estimates that the amount of software in consumer products is doubling every two years
  - Software now the biggest cost element for mission critical systems
    - E.g. Boeing 777: approximately 50% of entire development cost for the plane was spent on the avionics software
  - Wastage on failed projects
    - E.g. 1997 GAO (US Government Accountability Office) report: $145 billion over 6 years on software that was never delivered
  - High consequences of failure
    - E.g. Ariane 5: $500 million payload
    - E.g. Intel Pentium bug: $475 million
- Key factors:
  - Certification costs
    - E.g. Boeing 777: >40% of software budget spent on testing to FAA standards compliance
  - Re-work from defect removal
    - E.g. Motorola: 60-80% of software budget (was) spent on re-work
  - Changing Requirements
    - E.g. California DMV (Dept of Motor Vehicles) system was cancelled after 6 years, after spending $44 million
    - E.g. London ambulance dispatch system; Denver airport luggage management system

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Importance of RE (most memorable #)

Software defects cost 10-200 times more to correct once fielded than they would if they were detected during requirements engineering.

Source: *S. McConnell, "From the editor – an ounce of prevention", IEEE SW., 18(3):5-7, 2001.*

How the customer explained it

How the Project Leader understood it

How the Analyst designed it

How the Programmer wrote it

How the Business Consultant described it

How the project was documented

What operations installed

How the customer was billed

How it was supported

What the customer really needed

Class Participation #2

→ Type in the "chat" to ***only me*** your answer(s) to ***verb*** requirements

- For example, if the subject matter is "software", then to engineer software can refer to
  - *develop* software
  - *test* software
  - *install* software
  - *configure* software
  - *maintain* software
  - …
- Here, our subject matter is "requirements"

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RE is a set of activities

- *eliciting* requirements,
- *modelling* and *analysing* requirements,
- *communicating* requirements,
- *agreeing* requirements, and
- *evolving* requirements.

↳ aimed at communicating and adjusting requirements

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Ana's Requirement

I want to have a program that tells whether it terminates on any given input.

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Source: *Google Images*

Today's take-aways

→ What're requirements?

- Stakeholders' needs & desires

→ Why're requirements important?

- Because doing requirements right saves money

→ What's requirements engineering (RE)?

- A set of activities (elicitation, modeling, prioritization, realization, evolution, etc.) aimed at communicating and adjusting requirements

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About Textbook

No one textbook covers the field well → No required textbook for this course

- Background readings will be made available on the course website

- *A mandatory* reading BEFORE tomorrow's class (July 15), "Meaning of Requirements", can be found in the course website

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Just because we don't use a textbook…

Just because we don't use a textbook…

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Research Literature

Conferences

- IEEE International Symposium on Requirements Engineering
  - RE'93 - Jan 1993, San Diego, USA
  - RE'95 - Mar 1995, York, UK.
  - …
  - RE'01 - Aug 2001, Toronto, Canada
- IEEE International Conference on Requirements Engineering
  - ICRE'94 - Apr 1994. Colorado Springs, USA.
  - ICRE'96 - Apr 1996. Colorado Springs, USA.
  - …
  - ICRE'00 - Jun 2000, Schaumburg, USA
- In 2002, ICRE and RE merged...
- IEEE International Requirements Engineering Conferences
  - RE'02 - Sept 2002, Essen, Germany
  - RE'03 - Sept 2003, Monterey Bay, USA
  - RE'04 - Sept 2004, Kyoto, Japan
  - RE'05 - Sept 2005, Paris, France
  - …
  - RE'17 – Sept 2017, Lisbon, Portugal
  - RE'18 – Aug 2018, Banff, Canada
  - RE'19 – Sept 2019, Jeju Island, Korea
  - RE'20 – Aug-Sept 2020, Zurich, Switzerland

Journals

- Requirements Engineering Journal
  - published quarterly by Springer
- IEEE Transactions on Software Engineering
  - (published bi-monthly)
- ACM Transactions on Software Engineering and Methodology
  - (published quarterly)
- Various other SE journals:
  - IEEE Software
  - Automated Software Engineering
  - Journal of Systems and Software
  - Information and Software Technology

Workshops

- REFSQ - Int. Working Conference on Requirements Engineering: Foundations of Software Quality
- RE Tracks @ ACMSAC (ACM Symposium on Applied Computing), QUATIC (Int'l Conf. on the Quality of Info. and Comm.s Tech), …

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  - RE'01 - Aug 2001, Toronto, Canada
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  - ICRE'96 - Apr 1996 USA.
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  - y, USA
  - , Japan
  - , Paris, France
  - – Sept 2017, Lisbon, Portugal
  - RE'18 – Aug 2018, Banff, Canada
  - RE'19 – Sept 2019, Jeju Island, Korea
  - RE'20 – Aug-Sept 2020, Zurich, Switzerland

Journals

- Requirements Engineering J l
  - published quarterly
- IEEE Transact Engine
- Software Engineering
- nal of Systems and Software
- Information and Software Technology

Workshops

- REFSQ - Int. Working Conference on Requirements Engineering: Foundations of Software Quality
- RE Tracks @ ACMSAC (ACM Symposium on Applied Computing), QUATIC (Int'l Conf. on the Quality of Info. and Comm.s Tech), …

RE portal link
http://requirements-engineering.org
on course website

Assessments

- 4 individual assignments (20% each)
  - Will allocate certain class time to work on assignments
  - Students may need additional after-class time to complete the assignments
- Class participation (20%)
  - Will be carried out in class time

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Source: *Google Images*