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CS4211 Formal Methods for Software Engineering
Mon, 3 August 2020 - Thu, 10 December 2020

Week 1: Introduction
Mon, 10 August 2020 - Fri, 14 August 2020

We will draw a connection between programs and models in this week.

10th August is a public holiday. Please watch the video and try the four exercises in slides 24, 40, 43 and 55 of the PPT slide deck. An ad-hoc extra session was held on Saturday and recording is provided.

Web Lecture: L1:Lecture 1 from 2018
Ignore the discussion on assessment at the start of the 2018 video.

(since assessment is different in 2020, there is no final exam in 2020)

File: Seshia2018_Chapter_ModelingForVerification.pdf (1.59 MB)
Reading on modeling the behavior of programs via state transition systems. The reading is useful to understand how state transition systems can be a unified modeling formalism.

File: 4211-L1-ModelExtraction.ppt (3.02 MB)
Slide deck: exercises in slides 24, 40, 43 and 55.

File: ExtraSessionforLecture1.pdf (426.15 KB)
This was the extra session held on August 22nd since August 10th is a public holiday

Multimedia Channel: Lectures

Conferencing Meeting: Ad-hoc Additional Session in Week 2 ⊙ Cloud Recording
Sat, 22 Aug 2020 09:45 - 11:00

Week 2: Temporal Logics - I
Mon, 17 August 2020 - Fri, 21 August 2020

Temporal logics will be introduced as property specification language. This gives a formal flavor of software requirements.

Web Lecture: L2:Temporal Logics I from 2018

File: TLMC.PDF (14.98 MB)
Reading on Temporal Logics and Model Checking, excerpted from the book "Model Checking" by Clarke, Grumberg and Peled, published 1999.

File: 4211-L2-TemporalLogics.pptx (938.36 KB)
Exercises in slides 8, 32, 33, 43, 58,59,66,78,90-95.

File: Lecture2-Exercises.pdf (224.11 KB)

Re-uploaded this file with some additional clarifications based on questions asked by students.

Multimedia Channel: Lectures

Conferencing Meeting: CS4211 Week 2 2020 👁 Cloud Recording
Mon, 17 Aug 2020 08:45 - 12:00

Week 3: Temporal Logics - II
Mon, 24 August 2020 - Fri, 28 August 2020

This lecture will cover branching time logics, and fixed point characterizations

Web Lecture: L3:Temporal Logics II from 2018

File: TLMC.PDF (14.98 MB)
Reading on Temporal Logics and Model Checking, excerpted from the book "Model Checking" by Clarke, Grumberg and Peled, published 1999.

File: RecursiveCharacterization.pdf (96.98 KB)
The reading for the mathematical part on "Fixed Point Characterizations". The material for this appears in the slide deck "4211-L2-TemporalLogics" slide 70-85

File: 4211-L2-TemporalLogics.pptx (938.36 KB)
Exercises in slides 8, 32, 33, 43, 58,59,66,78,90-95.

File: Lecture3-Exercises.pdf (318.73 KB)
Solutions to most of the exercises and discussions in week 3 Lecture. These exercise slides are embedded inside the Luminus slide deck, and explicitly marked in the week by week Luminus overview.

File: Fixed-points.pptx (80.75 KB)
Additional slides on visualizing fixed points which appear in Lecture video

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W3 👁 Cloud Recording
Mon, 24 Aug 2020 08:45 - 11:45

Week 4: Model Checking Algorithms
Mon, 31 August 2020 - Fri, 4 September 2020

An algorithmic treatment for checking temporal logic properties of finite state machines.

Web Lecture: L4: Model Checking from 2018

File: TLMC.PDF (14.98 MB)
Reading on Temporal Logics and Model Checking, excerpted from the book "Model Checking" by Clarke, Grumberg and Peled, published 1999.

File: Clarke2018_Chapter_IntroductionToModelChecking.pdf (842.53 KB)
General introduction to Model checking. The first author of the article is credited to be one of the inventors of model checking and received the Turing Award.

File: 4211-L4-Checking.pdf (782.15 KB)
Re-uploaded lecture notes for week 4. Exercises in slides 8, 32, 37, 49, 51

File: Lec4-Exercises.pdf (396.98 KB)

Exercises and solutions to exercises embedded in Lecture 4 on Model Checking

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W4 ⊙ Cloud Recording
Mon, 31 Aug 2020 08:45 - 11:45

Week 5: Model Checking tools
Mon, 7 September 2020 - Fri, 11 September 2020

An introduction to the SPIN model checker and its underlying algorithm.

Demo of SPIN will be done in class.

Please see:

Files under the folder **SPIN-files** in Luminus

The tool: http://spinroot.com/spin/whatispin.html

Homework 1 (Quiz) is conducted in this week.

SPIN assignment is released in this week

Web Lecture: L5:SPIN from 2018

File: SPINieee97.pdf (247.66 KB)
A basic reading about SPIN model checker

File: Holzmann2018_Chapter_Explicit-StateModelChecking.pdf (720.55 KB)
Model checking algorithm implemented inside the SPIN model checker. We will use the SPIN checker for the assignment in CS4211.

File: 4211-L5-SPINChecker.pptx (807.73 KB)
See slide 43, that is where the Assignment using SPIN (25 marks) is introduced.

File: LTLVerification.pdf (434.00 KB)
Reading on LTL Verification.

File: Assignment_Introduction_Document.pdf (177.46 KB)
The assignment description document

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W5 ⊙ Cloud Recording
Mon, 7 Sep 2020 08:45 - 11:45

Week 6: Software Model Checking
Mon, 14 September 2020 - Fri, 18 September 2020

Model checking techniques adapted for software verification, will be discussed in this lecture. This will complete our discussion on model checking and model checkers.

Web Lecture: L6:Software Model Checking from 2018

File: SWMC1.pdf (1.15 MB)
Overview article on Software Model Checking appearing in the Communications of the ACM magazine.

File: SWMC2.pdf (207.50 KB)
Basic reading on software model checking based on an article published in 2001 by researchers from Microsoft Research.

File: 4211-L6-SWMC.pptx (2.62 MB)

File: Mid19-Answers.pdf (302.91 KB)
Last year's midterm. The last question is from a material which has not been taught this year.

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W6 ▶ Cloud Recording
Mon, 14 Sep 2020 08:45 - 11:45

Recess Week
Sat, 19 September 2020 - Sun, 27 September 2020

No lectures will be held in this week.

Week 7: Midterm Examination
Mon, 28 September 2020 - Sat, 3 October 2020

The midterm examination will be held in class.

The rest of the class time will be used for

- discussing relevant points with respect to hands-on SPIN assignment

File: Assignment_Introduction_Document.pdf (177.46 KB)
The assignment description document

File: Assignment Introduction.pptx (2.42 MB)
The assignment introduction slides presented in week 7

File: Midterm Answers.pdf (235.69 KB)

Multimedia Channel: Lectures

Week 8: Symbolic Execution
Mon, 5 October 2020 - Fri, 9 October 2020

Symbolic execution; its usage in program testing and verification

Web Lecture: L8:SymbolicExecution
Lecture video from 2018

File: SymbolicExecution.pdf (168.10 KB)
Reading on symbolic execution from the book "Testing and Analysis" by Pezze and Young.

File: DART.pdf (160.00 KB)
Directed Automated Random Testing, by Godefroid, Klarlund and Sen, PLDI 2005

File: 4211-L8-Symbolic.pptx (937.57 KB)
Lecture notes

File: Revise-Symbolic.pptx (1.62 MB)

Multimedia Channel: Lectures

Conferencing Meeting: CS4211 Week 8 🔘 **Cloud Recording**
Mon, 5 Oct 2020 08:45 - 11:45

Week 9: Hoare Logic
Mon, 12 October 2020 - Fri, 16 October 2020

Construction of hand-written proofs for programs will be discussed.

Web Lecture: L9: Hoare Logic
lecture video from 2018

File: program_verification.pdf (362.93 KB)
Reading on Hoare Logic and program verification, excerpted from the book "Logic in Computer Science" by Huth and Ryan, published 1999.

File: Revise-HoareLogic.pptx (465.94 KB)

File: 4211-L9-Hoare.pptx (510.84 KB)
Slight changes only with some explanations. Slide numbering should not affected, I only deleted one redundant slide from the very end.

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W9 🔘 **Cloud Recording**
Mon, 12 Oct 2020 09:00 - 11:45

Week 10: Debugging
Mon, 19 October 2020 - Fri, 23 October 2020

We will start discussions on debugging and continue the discussions to the next week for term paper.

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Programming assignment using SPIN will be due this Friday.

Web Lecture: L10: FormalDebugging
Lecture video from 2018. Some parts from 2020, specifically symbolic techniques for debugging, are not covered in the video.

File: jpl1995.pdf (8.34 MB)
"A survey of Program Slicing Techniques" by Frank Tip, 1995. The article is relevant, but sections 3 and 4 of the article are very detailed and cover various kinds of programs.

File: DebuggingCACM.pdf (957.43 KB)

File: 4211-L10-Debug.pptx (647.99 KB)

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W10 🔘 **Cloud Recording**

Mon, 19 Oct 2020 09:00 - 11:45

Week 11: Discussion on term paper
Mon, 26 October 2020 - Fri, 30 October 2020

Term paper will be due on 23rd November

In your term paper, you can write a 2 page critique of any of the papers referenced in the CACM article. Please see the file CS4211Termpaper2020.PDF for the detailed instructions on what to submit.

Weblink: CACM article covering possible papers to cover in Term paper

Weblink: [Optional] Latest CACM article covering future directions from materials in Term Paper

File: CS4211-TermPaper-Short.pptx (1.05 MB)
Short Description of Possible papers to cover in CS4211 Term paper

File: CS4211Termpaper2020.pdf (123.61 KB)
The term paper materials / instructions are posted in advance, whoever wants to take a look.

File: CS4211-TermPaper-Long.pptx (1.12 MB)
Please refer to these slides to get a general overview of the techniques covered in the term paper.

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W11 ⏏ **Cloud Recording**
Mon, 26 Oct 2020 09:00 - 11:45

Week 12: Visual formal Requirements
Mon, 2 November 2020 - Fri, 6 November 2020

Visual descriptions of temporal logic style requirements in the form of Live Sequence Charts will be covered.

Web Lecture: L12a:Req
Lecture video from 2018. Segment starts from 45 minutes past.

Web Lecture: L12b:Req
Lecture video from 2018

File: LSCs.pdf (258.04 KB)
"Live Sequence Charts: Breathing Life into Message Sequence Charts", by Damm and Harel published 2001. Live Sequence Charts provide a visual formalism for capturing requirements.

File: AirttrafficcontrolSampleReq.pdf (44.35 KB)
Sample Requirements Document for weather control subsystem

File: 4211-L12-Req.pptx (934.08 KB)
Revised version uploaded, as discussed at the end of today's class.

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W12 ⏏ **Cloud Recording**

Mon, 2 Nov 2020 09:00 - 11:45

Week 13: Semantics of Modeling Notations
Mon, 9 November 2020 - Fri, 13 November 2020

This will be the last lecture of the module.

The second homework has also been given out in this week.

Web Lecture: L13: Modeling
Lecture video from 2018

File: Modeling.pdf (965.15 KB)
Excerpts from the book "Embedded Systems and Software Validation" by Abhik Roychoudhury, Elsevier, Morgan Kaufmann Systems-on-Silicon Series, 2009

File: 4211-L13-Modeling.ppt (5.69 MB)

File: GradedHomeWork2020.docx (37.83 KB)
This is the homework due on 16 Nov. Please take this one as the definitive copy of the homework, I corrected some wording and marks distribution compared to the version shown in class.

File: CS4211Reflections.pdf (117.11 KB)
Updated the reflections document based on discussions.

Multimedia Channel: Lectures

Conferencing Meeting: CS4211_W13   Cloud Recording
Mon, 9 Nov 2020 09:00 - 11:45

Reading Week
Mon, 16 November 2020 - Fri, 20 November 2020

Homework 2 is due on Monday 16 November 2020

Examination Week
Sat, 21 November 2020 - Sat, 5 December 2020

Term paper is due on Monday 23 November 2020