Model Checking

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IAIK

Today

Administrative

Motivation

Material & Communications

OLD FASHIONED, PHYSICAL LECTURE!

Lecture: Thursday 4 – 5:30P

Practicals: Right after, only if there is something to discuss

Question Hours: Wednesday 10 AM, after first exercise starts, on discord

Webpage: https://www.iaik.tugraz.at/course/model-checking-705080-sommersemester-2022/

Discord: https://discord.gg/3bCzK4Ux7J, channel mc (robot)

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2022-03-03	**4:30-6:30**	**HSi13**	Intro
2022-03-10	4:30-6:30	HSi13	Modeling Systems – Chapter 3
2022-03-17	4:30-6:30	**HS BE01**	SAT-Based Model Checking – Ch.10
2022-03-24	**2:00-4:00**	**HSi13**	SAT-Based Model Checking – Ch. 10
2022-03-31	2:00-4:00	HSi13	SAT-Based Model Checking – Ch. 10
2022-04-07	2:00-4:00	HSi13	Temporal Logic – Chapter 4
2022-04-28	2:00-4:00	HSi13	CTL Model Checking – Chapter 5
2022-05-05	2:00-4:00	HSi13	CTL Model Checking – Chapter 5
2022-05-12	2:00-4:00	HSi13	LTL Model Checking -Chapter 7
2022-05-19	2:00-4:00	HSi13	LTL Model Checking -Chapter 7
2022-06-02	2:00-4:00	HSi13	Software Model Checking - Chapter 14
2022-06-09	2:00-4:00	HSi13	Probabilistic Model Checking 1
2022-06-23	2:00-4:00	HSi13	Probabilistic Model Checking 2
2022-06-30	2:00-4:00	HSi13	Research

Exercise

Date	Type	Topic	Lecturer
2022-03-03 16:30-18:30 HSi13	Lecture	Intro	Roderick
2022-03-10 16:30-18:30 HSi13	Lecture	Modeling Systems - Chapter 3	Roderick
2022-03-17 16:30-18:30 HS BE01	Lecture	SAT-Based Model Checking - Chapter 10	Roderick
2022-03-17 18:30-19:30 HS BE01	Handout	Warmup Assignment	Vedad
2022-03-24 14:00-16:00 HSi13	Lecture	SAT-Based Model Checking -Chapter 10	Roderick
2022-03-24 16:00-17:00 HSi13	Tutorial	Z3 Introduction	Vedad
2022-03-31 14:00-16:00 HSi13	Lecture	SAT-Based Model Checking - Chapter 10	Roderick
2022-03-31 16:00-17:00 HSi13	Tutorial	Modelling with Yosys, BTOR	Vedad
2022-04-07 14:00-16:00 HSi13	Lecture	Temporal Logic - Chapter 4	Roderick
2022-04-07 16:15-17:15 HSi2	Handout	BMC Assignment	Vedad

How to get a grade?

Lecture: Two options

1. Do weekly homework (by yourself), do a good job. Course grade = homework grade, **OR**
2. Take the exam

(Not happy with homework grade? Take exam!)

Practical:

– Three assignments with point distribution 30/40/30.

737 Max

“The people who wrote the code for the original MCAS system were obviously terribly far out of their league and did not know it”.
346 deaths

Deductive Verification?

```
{false == false} ↔ {true}
r = false;
{r == (V_{j=0}^{-1} a[j] == x)} ↔ {r == false}
i = 0;
{r == (V_{j=0}^{i-1} a[j] == x)}
while(i != n) {
  {(r == (V_{j=0}^{i-1} a[j] == x)) ∧ i != n}
  {r == (V_{j=0}^{i-1} a[j] == x)}
  if(a[i] == x) {
    {(r == (V_{j=0}^{i-1} a[j] == x)) ∧ a[i] == x}
    {(true == (V_{j=0}^{i} a[j] == x)) ∧ a[i] == x} ↔ {true ∧ a[i] == x} ↔ {a[i] == x}
    r = true;
    {r == (V_{j=0}^{i} a[j] == x)}
  } else {
   {(r == (V_{j=0}^{i} a[j] == x)) ∧ a[i] != x} ↔ {(r == (V_{j=0}^{i-1} a[j] == x)) ∧ a[i] != x}
  }
  {r == (V_{j=0}^{i} a[j] == x)}
  i = i + 1;
  {r == (V_{j=0}^{i-1} a[j] == x)}
}
{r == (V_{j=0}^{n-1} a[j] == x) ∧ i == n} ↔ {r == (V_{j=0}^{i-1} a[j] == x) ∧ i == n}
{r == (V_{j=0}^{n-1} a[j] == x)}
```

- (Manual) Proofs
- No diagnostics
- Full specifications
- Concurrency is hard

(But: things have gotten better!)

Automatic Verification!

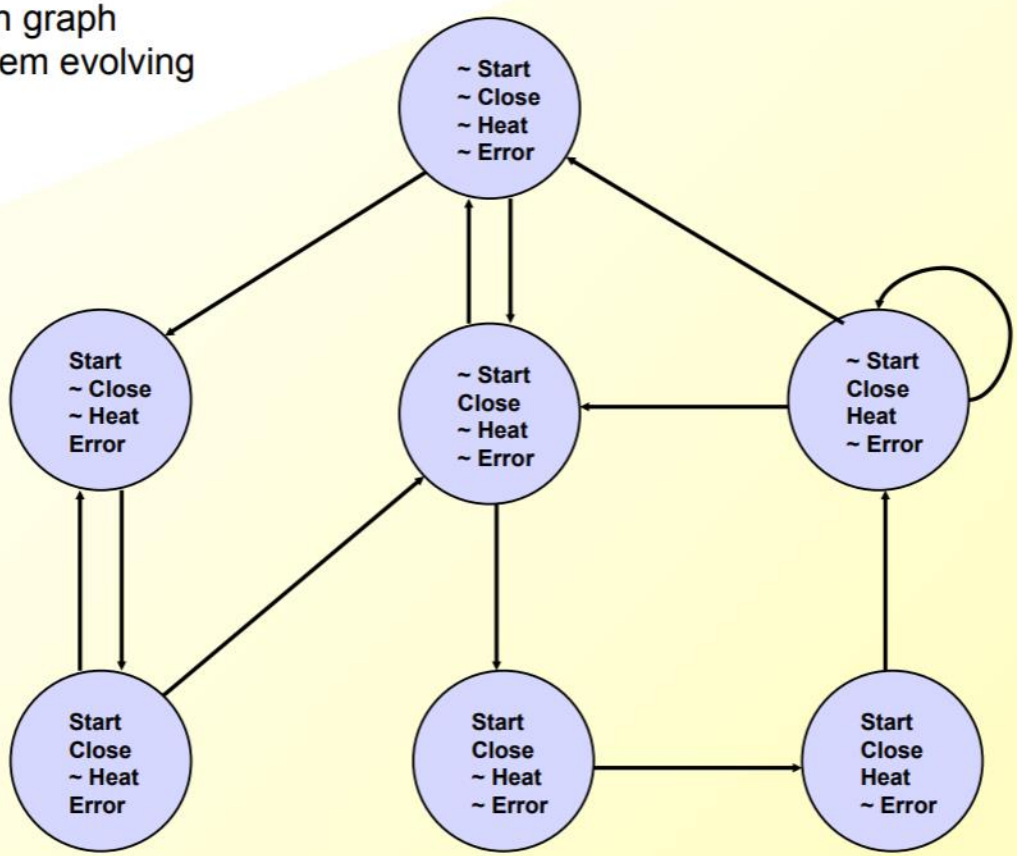
- Program = finite state machine = graph
- Bug hunting = efficient graph search
- “Interesting” properties = “complicated” graph searches
  - Need language to express interesting things!

- But how to search a graph efficiently?

Model of computation

Microwave Oven Example

State-transition graph describes system evolving over time.



What properties are interesting?

Slide by Ed Clarke

Efficiency

- 1981: EMC Model checker ~10^4 states
- 1992 BDDs:

Symbolic Model Checking: 10^{20} States and Beyond*

J. R. Burch, E. M. Clarke, and K. L. McMillan

School of Computer Science, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213

AND

D. L. Dill and L. J. Hwang

Stanford University, Stanford, California 94305

- 1999 SAT·

Symbolic Model Checking without BDDs*

Armin Biere[1], Alessandro Cimatti[2], Edmund Clarke[1], and Yunshan Zhu[1]

Efficiency

1992 Abstraction

Construction of Abstract State Graphs with PVS

Susanne Graf and Hassen Saidi
VERIMAG[1]
{graf,saidi}@imag.fr

~1995: Partial Order Reduction

~2000: Software

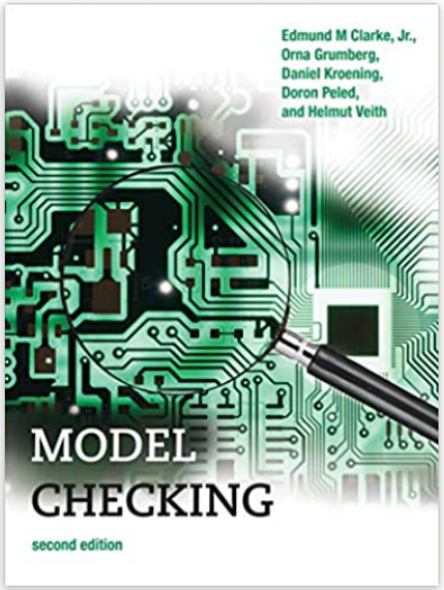
The SLAM Toolkit

Thomas Ball and Sriram K. Rajamani

Microsoft Research
http://www.research.microsoft.com/slam/


acm
A.M.
TURING
AWARD
2007
EDMUND M. CLARKE, E. ALLEN EMERSON, JOSEPH SIFAKIS
Model Checking: An Automated Quality Assurance Method

The Book



Model Checking, second edition (Cyber Physical Systems Series) Gebundene Ausgabe – 4. Dezember 2018

Englisch Ausgabe | von Edmund M. Clarke Jr. (Autor), & 4 mehr

★★★★★ 2 Sternebewertungen

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Verfügbar als Kindle eBook. Kindle eBooks können mit der kostenlosen Kindle-App auf allen Geräten gelesen werden.
Verkauf und Versand durch Amazon.
Menge: 1

Clarke, Grumberg, Kroening, Peled, Veith, *Model Checking,* MIT Press 2018 (This is the second edition. The first has a shorter author list.)

Other good books:
Clarke, Henzinger, Veith, Bloem, *Handbook of Model Checking,* Springer 2018
Baier, Katoen. *Principles of Model Checking,* MIT Press, 2008