ARCH-COMP 2021: Falsification

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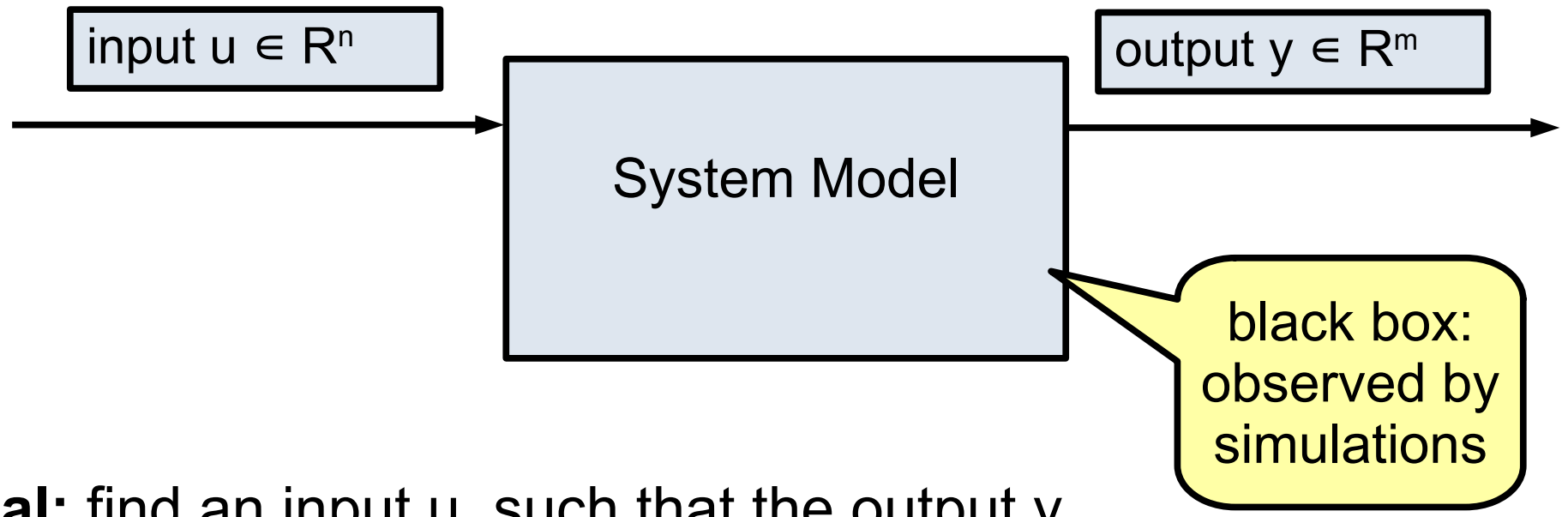
AIST/NII/Kyushu/Kyoto, Japan | ASU, USA | ENS/ENSTA/Decyphir Fance | LMU, Germany | University of Luxembourg

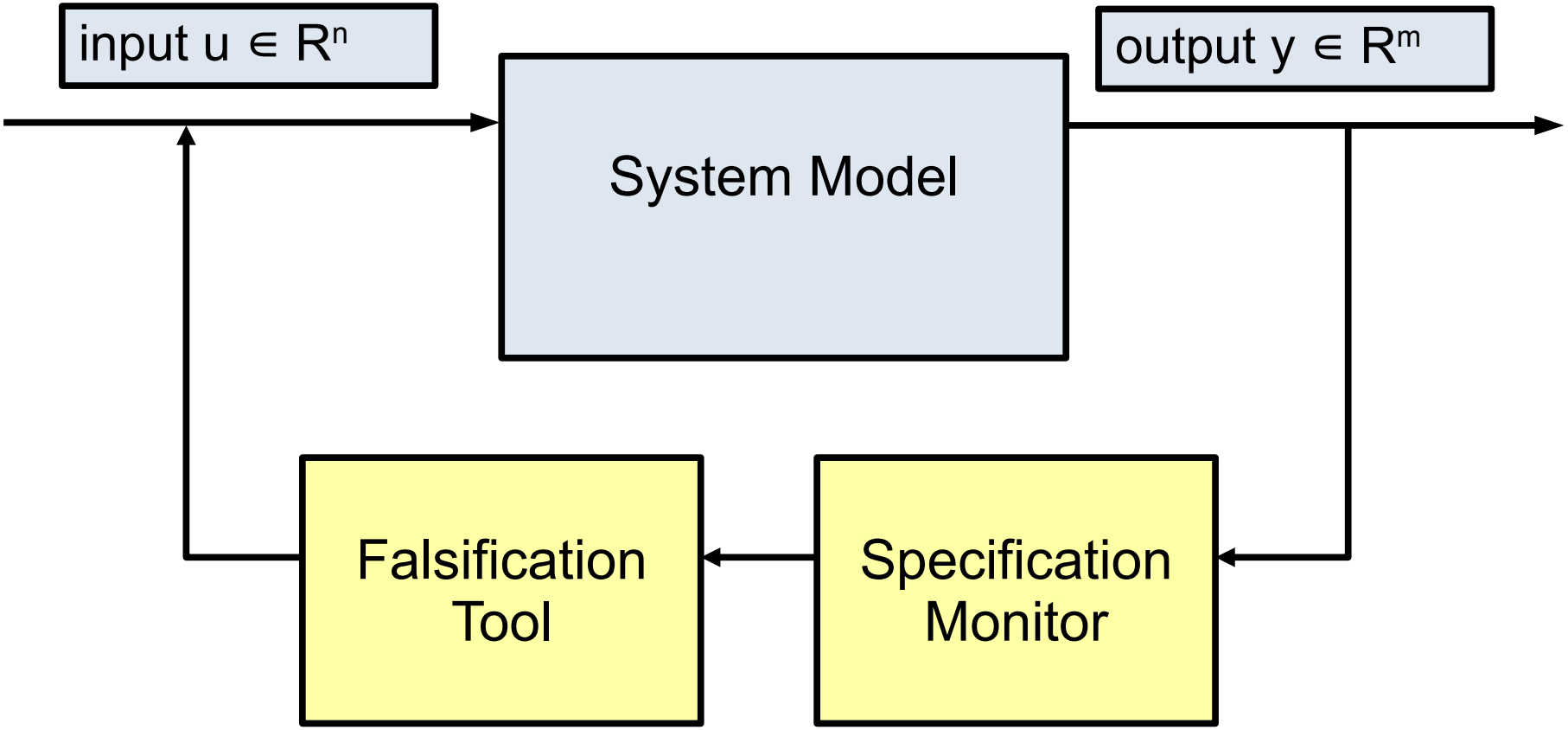
Falsification



Goal: find an input u, such that the output y violates a given specification in temporal logic

how to crash a car into a wall

Falsification



Δ 2021

1) two new tools, some new people (welcome!)
2) new conjunctive requirements (thanks, Logan!)
3) effort towards validating results (thanks everyone!)

Participants

• FalCAuN	(M. Waga)	discrete abstraction + model cecking
• ForSee	(Z. Zhang, P. Arcaini, I. Hasuo)	MCTS, robustness, optimization
• ARIsTEO	(K. Gaaloul, C. Menghi)	surrogate model, refinement
• Breach	(A. Donze)	robustness + stoch. optimization
• falsify	(J. Inoue, Y. Yamagata)	reinforcement learning
• FalStar	(G. Ernst, S. Sedwards)	Las-Vegas tree search
• S-TaLiRo	(S. Yaghoubi, L. Mathesen, A. Chandratre, T. Khandait, G. Pedrielli, G. Fainekos)	robustness + stoch. optimization
• zlscheck	(I. Bennani, M. Pouzet, G. Frehse)	whitebox gradient descent

Requirements

- Example (automatic transmission):
  - within 20s the speed remains below 120
  - formally: $\Box_{[0,20]}\ (v < 120)$
- Example (magnetic levitation controller):
  - the position stabilizes in a certain way
  - $\Diamond_{[0.0,\ 1.0]}\ (Pos > 3.2)\ \wedge$

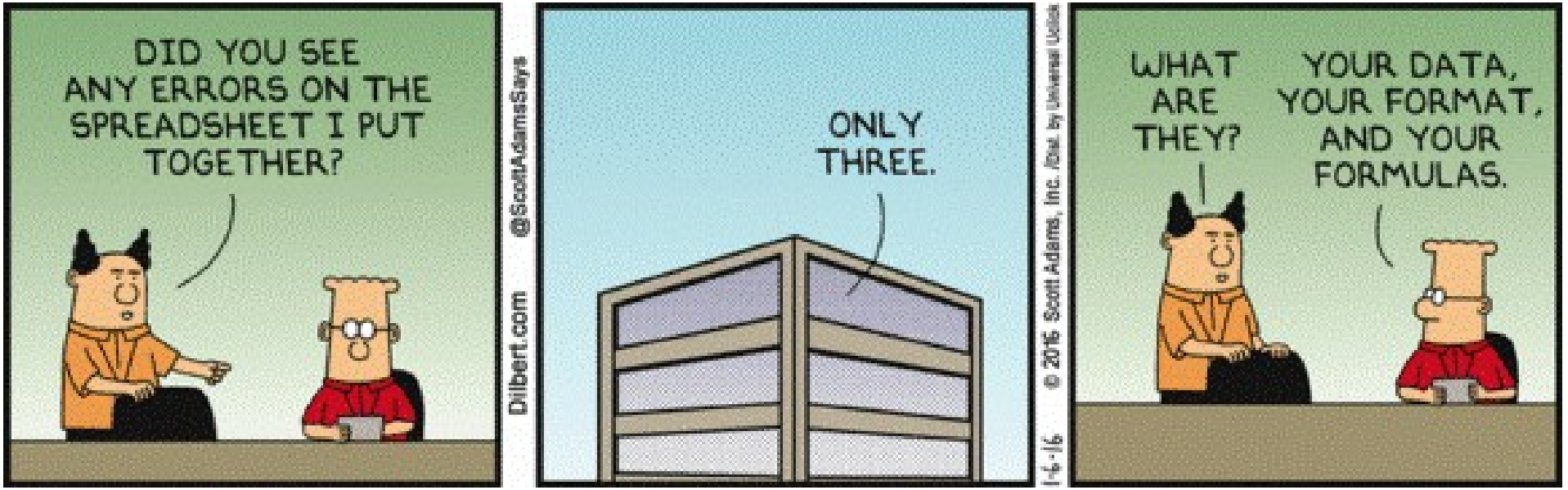
    $\Diamond_{[1.0,\ 1.5]}\ (\Box_{[0,\ 0.5]}\ 1.75 < Pos < 2.25)\ \wedge$

    $\Box_{[2.0,\ 3.0]}\ (1.825 < Pos < 2.175)$

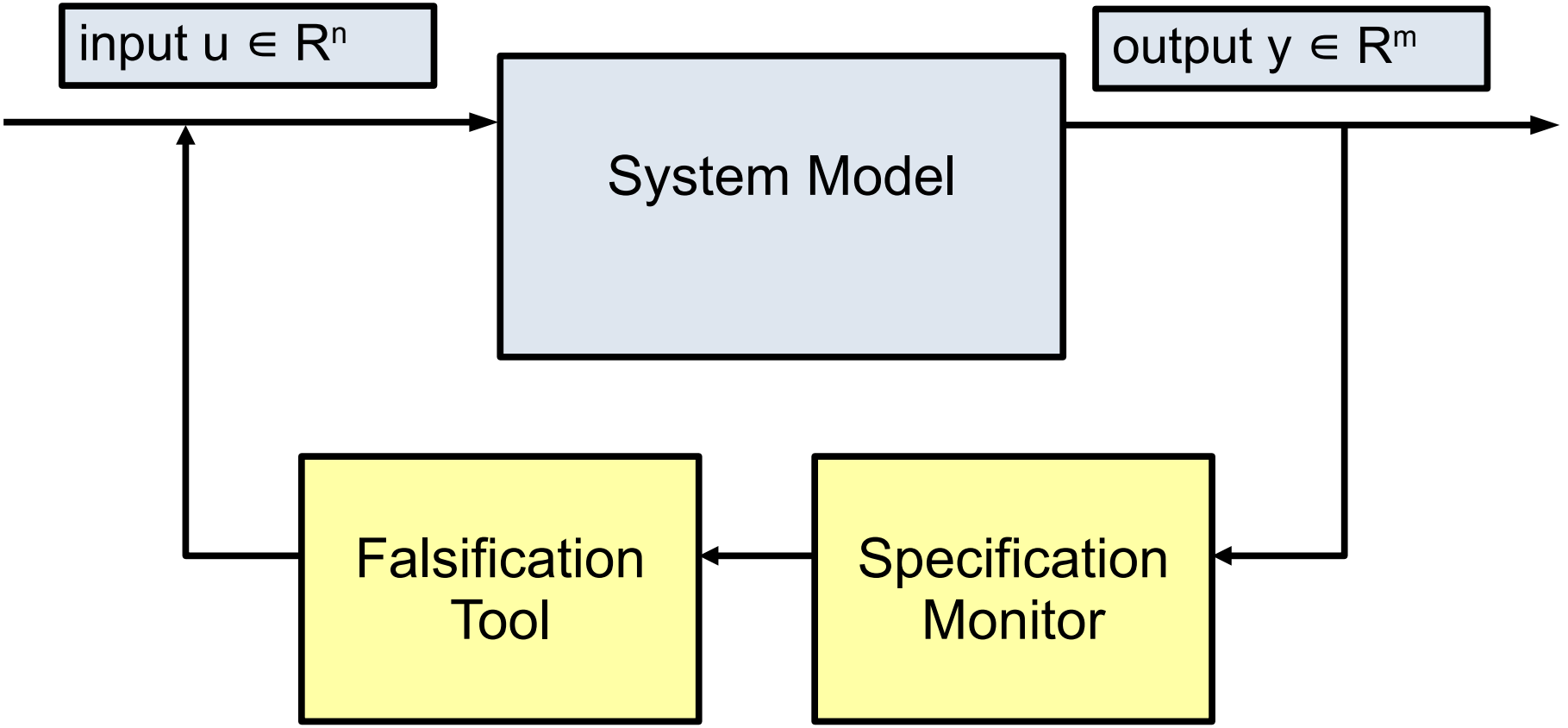
check multiple requirements at once

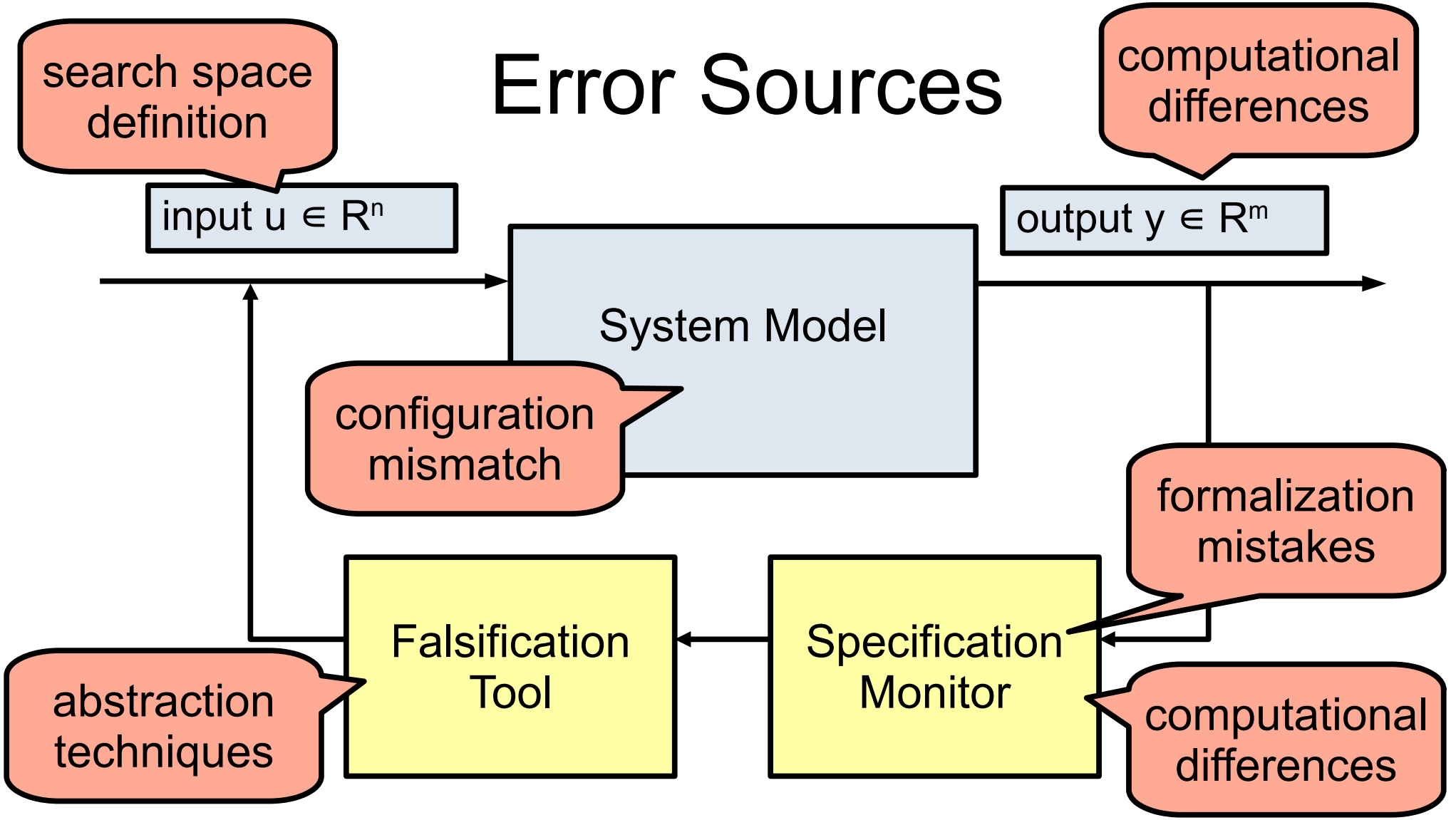
but possibly conflicting search guidance

Validation


DID YOU SEE ANY ERRORS ON THE SPREADSHEET I PUT TOGETHER?
Dilbert.com @ScottAdamsSays
ONLY THREE.
1-6-16 © 2016 Scott Adams, Inc. /Dist. by Universal Uclick
WHAT ARE THEY?
YOUR DATA, YOUR FORMAT, AND YOUR FORMULAS.

Error Sources




Error Sources
search space definition
computational differences
input u ∈ Rⁿ
output y ∈ Rᵐ
System Model
configuration mismatch
formalization mistakes
Falsification Tool
Specification Monitor
abstraction techniques
computational differences

2021/FALS/Validation.md

formalization

search space

reported verdict

simulation & computation

```
property: AT1
formula: □_[0, 20] (speed < 120)
input is within bounds
using stop time as provided: 20.0
falsified is correct
expected robustness -0.014
computed robustness -0.013
robustness error 0.001
[...]
```

Validity via Robustness Score

by how much did we miss the wall?

reported (by participants)	computed (by validator)	confirmed falsification?
r < 0	r < 0	
r < 0	r < threshold	
r >= 0	_	

Erwin Wurm: Truck, 2015

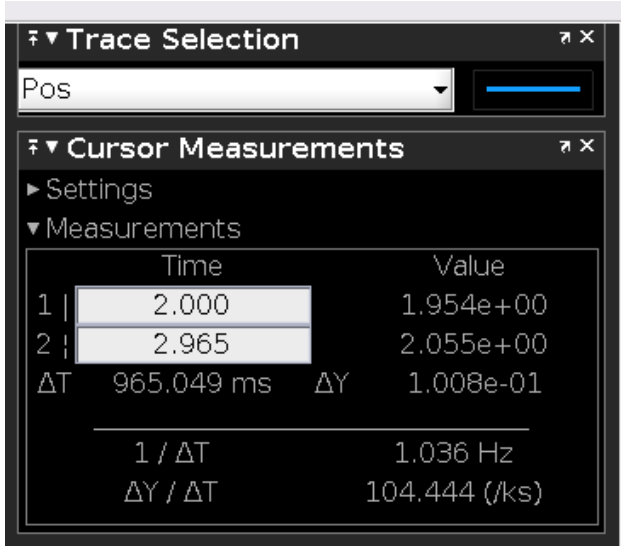
Findings

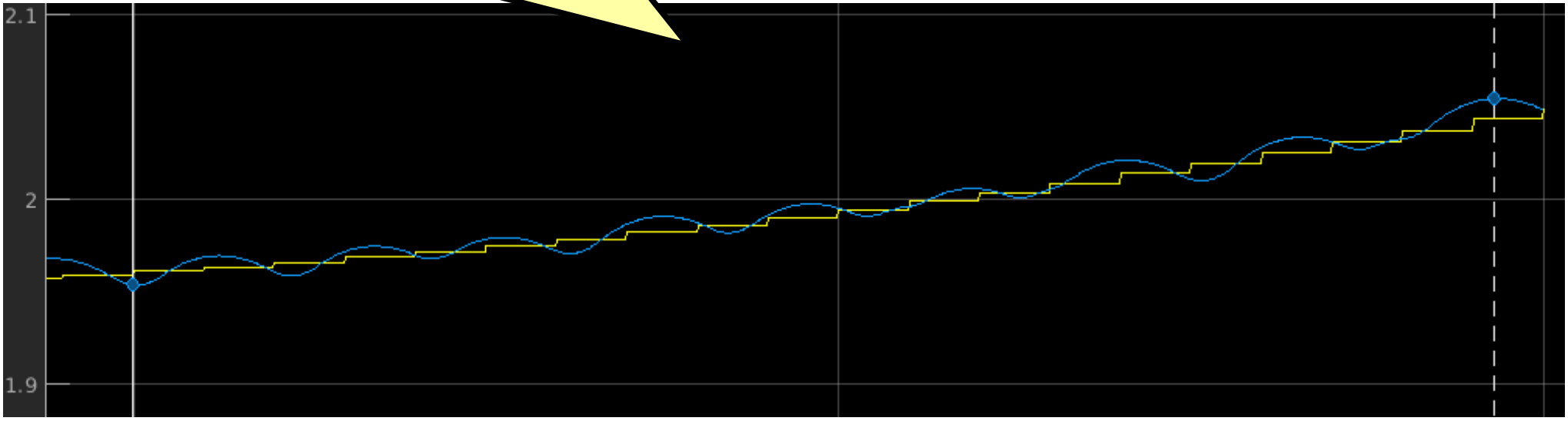
- Discrepancies discovered everywhere
  - documentation somewhat lacking/imprecise/inconsistent
  - some mistakes: formalization, input ranges
  - signal sampling and reporting (granularity, interpolation)

- Summary
  - majority of new results confirmed | some old results wrong
  - obvious & large discrepancies now fixed
  - small discrepancies: computational mismatch or actual errors?

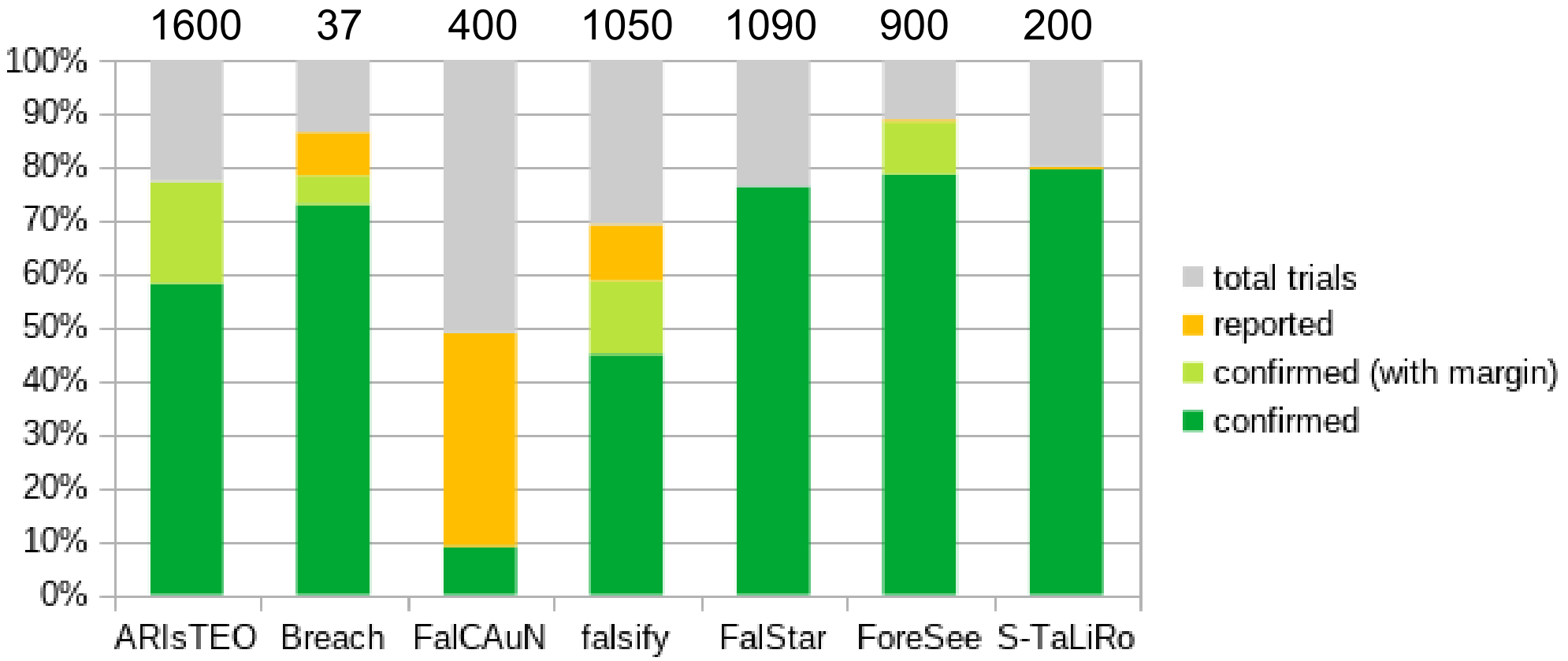
Troubleshooting

check manually:
does this signal falsify?

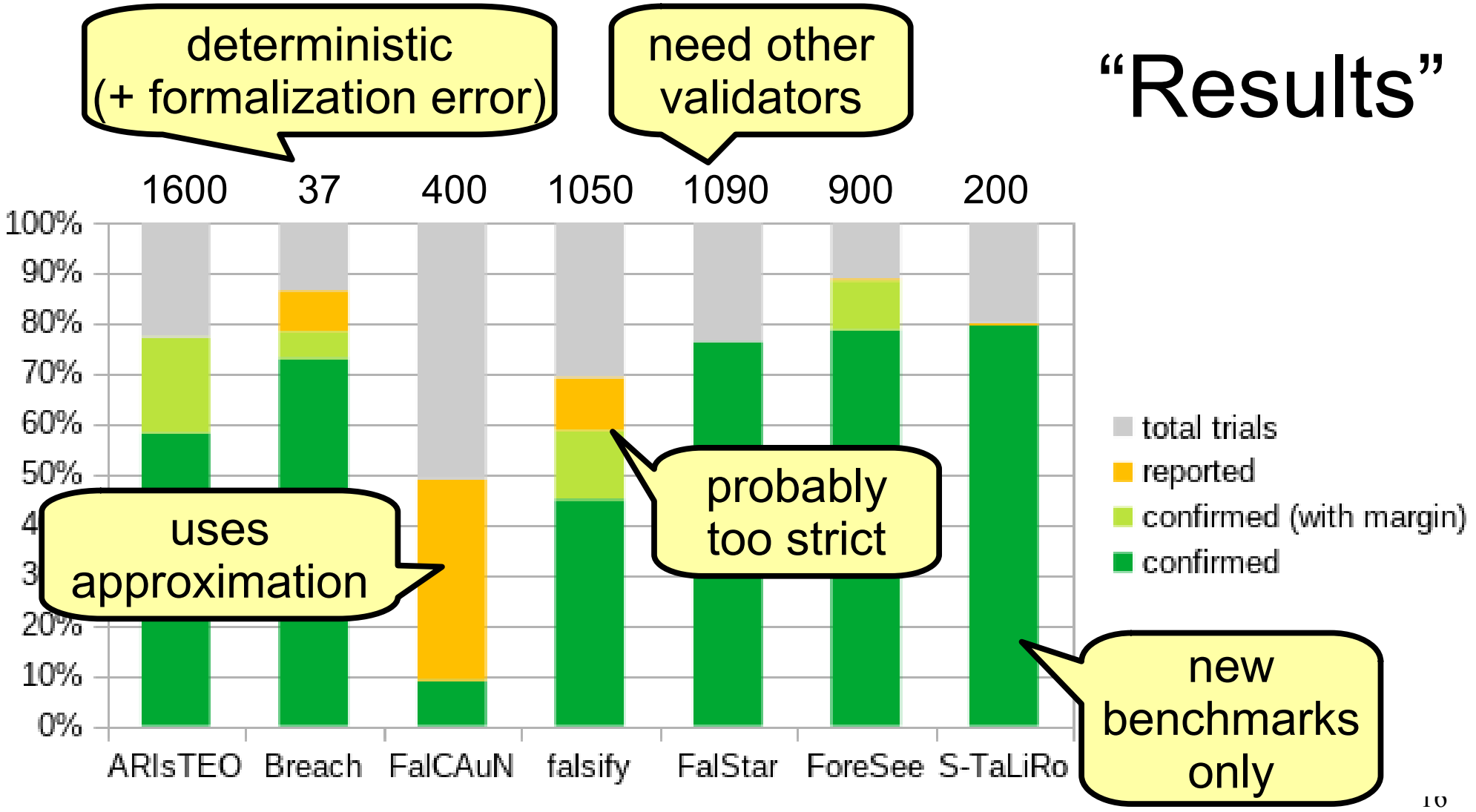




“Results”


1600
37
400
1050
1090
900
200
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
ARIsTEO
Breach
FalCAuN
falsify
FalStar
ForeSee
S-TaLiRo
total trials
reported
confirmed (with margin)
confirmed

“Results”


deterministic
(+ formalization error)
need other
validators
1600
37
400
1050
1090
900
200
100%
90%
80%
70%
60%
50%
20%
10%
0%
uses
approximation
probably
too strict
new
benchmarks
only
total trials
reported
confirmed (with margin)
confirmed
ARIsTEO
Breach
FalCAuN
falsify
FalStar
ForeSee
S-TaLiRo

Conclusion & Outlook

- collection of results still ongoing

- both needed
  - Validation: reported results are plausible
  - Repeatability: performance is plausible

- next year
  - start much earlier, converge with reporting format
  - repeatability (on CodeOcean)
  - non-Matlab models (Zélus, Python), harder benchmarks