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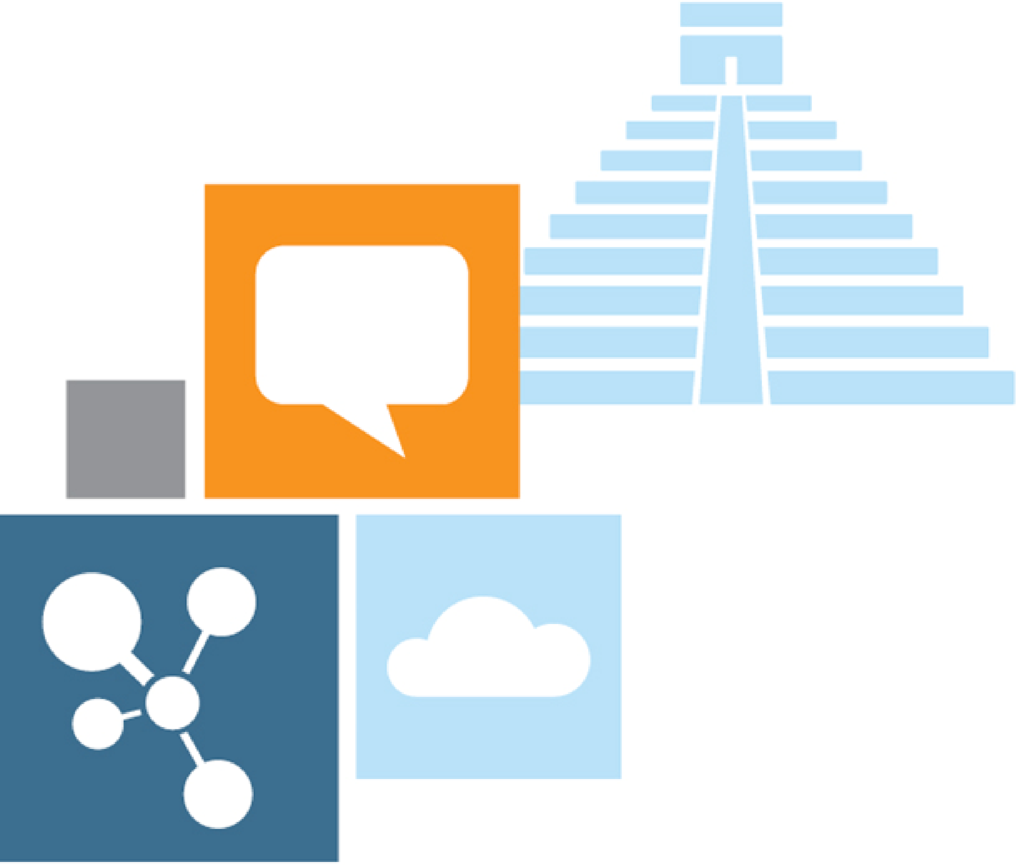

Microsoft® Research

Faculty Summit 2012

Riviera Maya, Mexico | May 23-25 | In partnership with CONACYT

Engineering Methods for Ensuring Program Correctness

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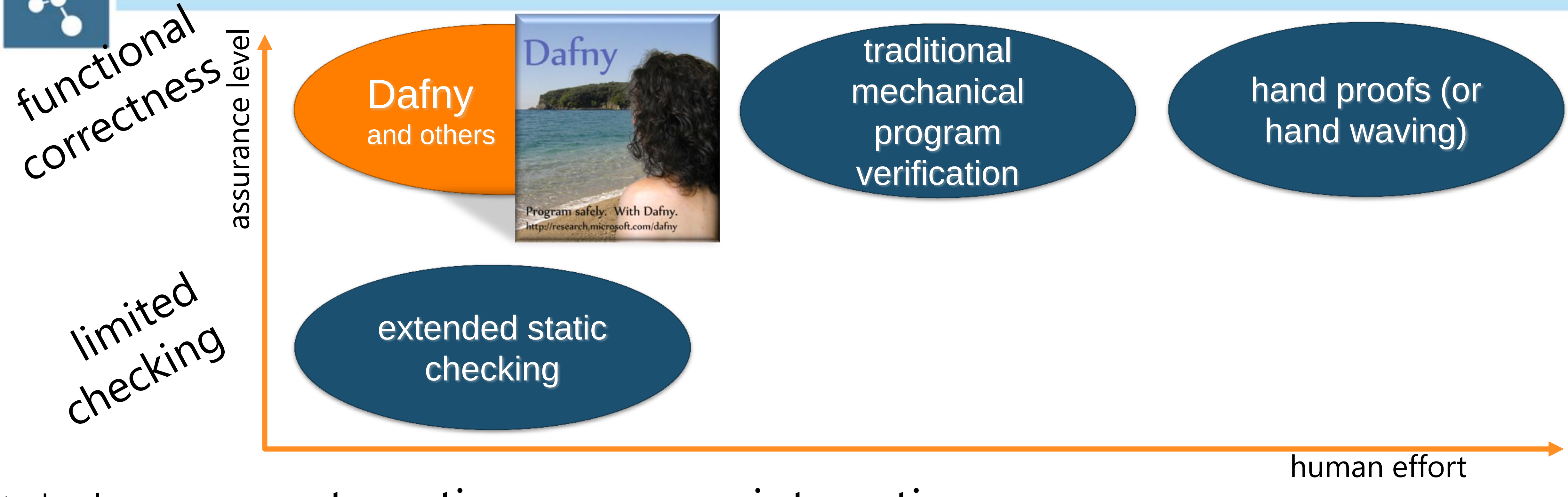
24 Mayo 2012

Some formal methods at Microsoft

Model checking:	*Static Driver Verifier*
White-box fuzzing:	*SAGE*
Semantic differencing:	*SymDiff*
Program verification:	*VCC, Dafny*

Program verification



functional correctness

limited checking

assurance level

Dafny
and others

Dafny

Program safely. With Dafny.
http://research.microsoft.com/dafny

traditional mechanical program verification

hand proofs (or hand waving)

extended static checking

human effort

technology:

automatic decision procedures (SMT solvers)

interactive proof assistants

no machine assistance

Dafny

- Class-based language
  - generic classes, no subclassing
  - object references, dynamic allocation
  - sequential control
- Built-in specifications
  - pre- and postconditions
  - framing
  - loop invariants, inline assertions
  - termination
- Specification support
  - Sets, sequences, inductive datatypes, …
  - User-defined recursive functions
  - Ghost variables

Basic features

demo

TreeFill.dfy, BinarySearch.dfy, SchorrWaite.dfy

Classes

demo

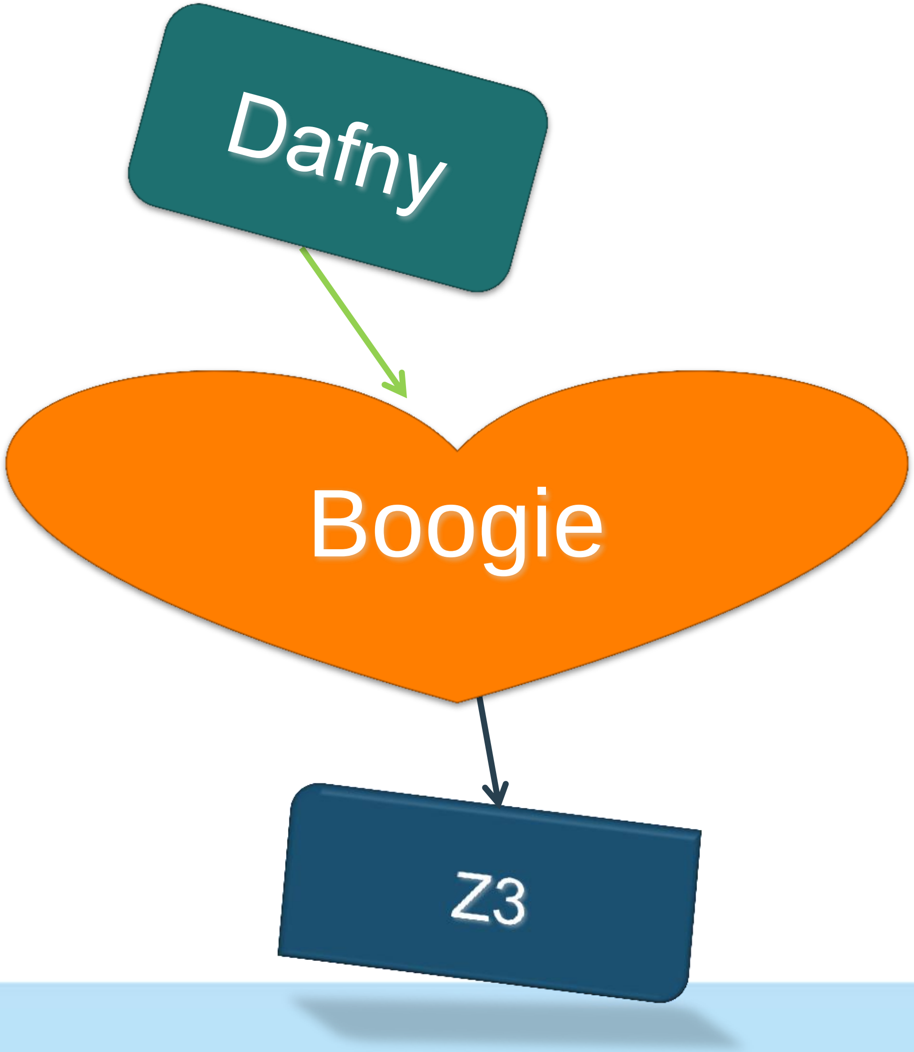
Counter.dfy

Proving lemmas

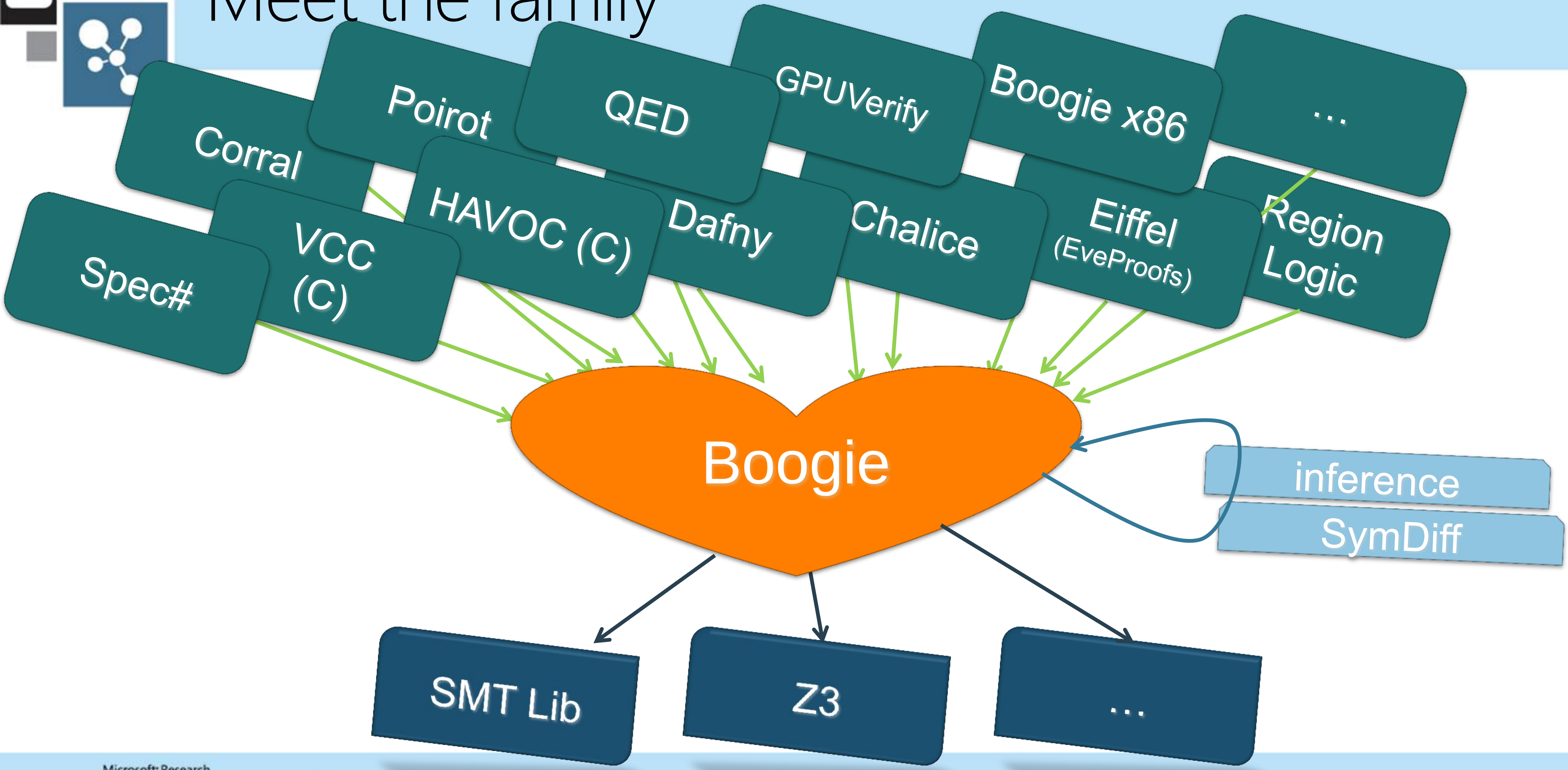
demo

Induction.dfy, TortoiseHare.dfy

Verification architecture



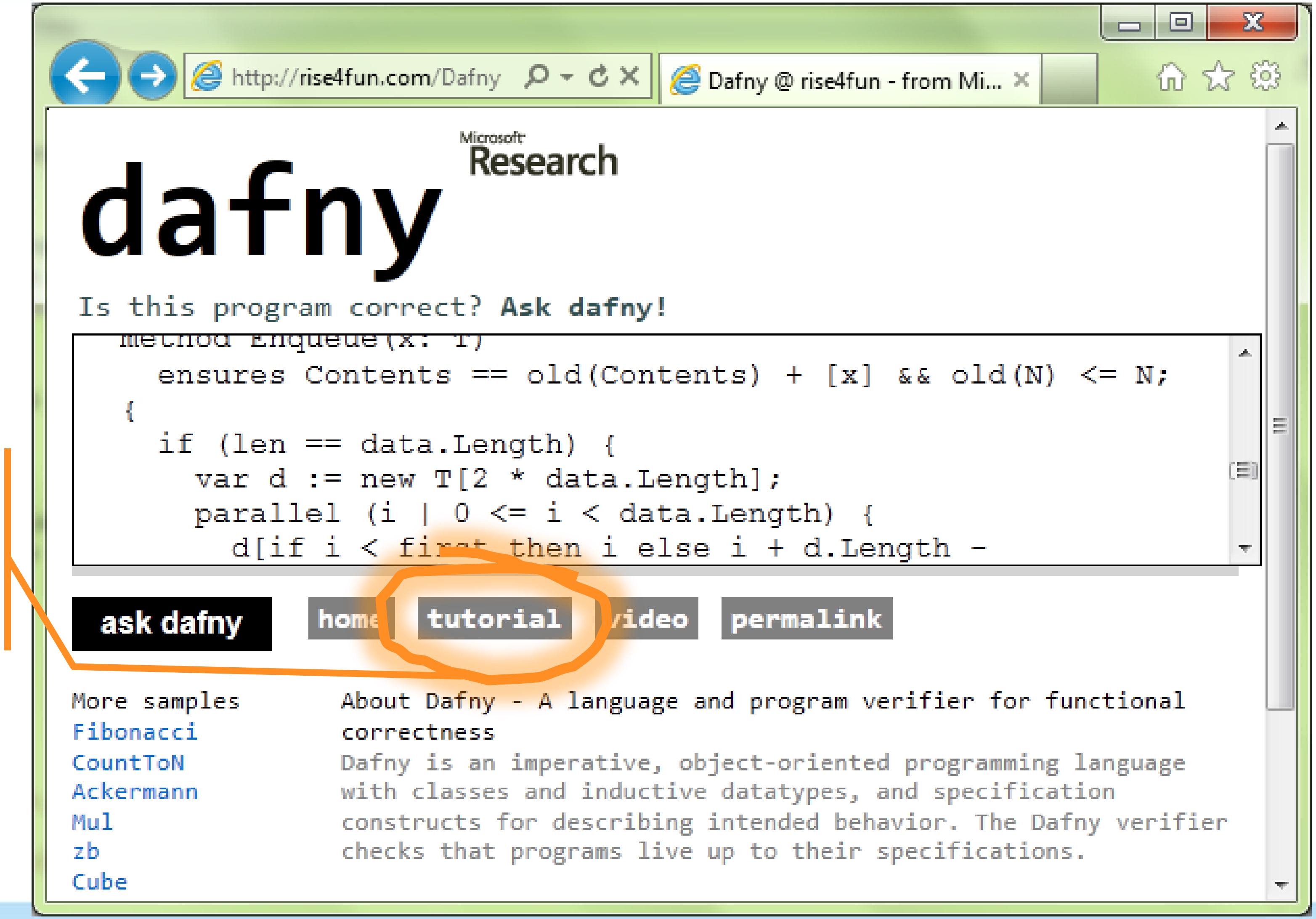
Meet the family



Dafny users

- Used in teaching
- >100,000 unique Dafny programs submitted to rise4fun.com
- 6 teams of out 29 made use of Dafny at the VSTTE 2012 program verification competition
- 2 of 6 medalists at the competition used Dafny

Using Dafny on the web



Is this program correct? **Ask dafny!**

```
  method Enqueue(x: T)
    ensures Contents == old(Contents) + [x] && old(N) <= N;
  {
    if (len == data.Length) {
      var d := new T[2 * data.Length];
      parallel (i | 0 <= i < data.Length) {
        d[if i < first then i else i + d.Length -
```

More samples
Fibonacci
CountToN
Ackermann
Mul
zb
Cube

About Dafny - A language and program verifier for functional correctness

Dafny is an imperative, object-oriented programming language with classes and inductive datatypes, and specification constructs for describing intended behavior. The Dafny verifier checks that programs live up to their specifications.

Dafny tutorial

What's next

- More use
- More teaching
- Refinement – programming in stages
- Synthesis – programming by specification

Conclusions

- Full functional-correctness verification is becoming more automatic
- Dafny
  - Use
  - Teach
  - Extend

- Dafny (download, source, documentation)
  http://research.microsoft.com/dafny
  http://rise4fun.com/Dafny/tutorial/guide
- rise4fun
  http://rise4fun.com
- Verification Corner
  http://research.microsoft.com/verificationcorner

```
method Main() {
  print "hello, Dafny\n";
  assert 10 < 2;
}
```

Is this program correct? Click 'ask dafny'! Read more or watch the video.

Verification Corner

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