

# A Verified Certificate Checker for Floating-Point Error Bounds

**Heiko Becker, MPI-SWS, Germany**

Eva Darulova, MPI-SWS, Germany

Magnus O. Myreen, Chalmers University of Technology, Sweden

# Floating-Point Computations have errors

```
f = 4 * 0.1 - 0.1
```

```
f : double = 4 * 0.1 - 0.1;
```

# Floating-Point Computations have errors

```
f = 4 * 0.1 - 0.1
```

```
f : double = 4 * 0.1 - 0.1;
```

0.3

# Floating-Point Computations have errors

$f = 4 * 0.1 - 0.1$

0.3

`f : double = 4 * 0.1 - 0.1;`

$\neq$

0.30000000000000004

# Floating-Point Computations have errors

`f = 4 * 0.1 - 0.1`

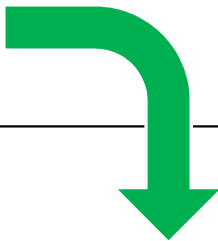
`f : double = 4 * 0.1 - 0.1;`

0.3

$\neq$

0.30000000000000004

**roundoff error**



$$|f - \tilde{f}| \leq \varepsilon$$

# Floating-Point Computations have errors

`f = 4 * x - 0.1`

`double f = 4 * x - 0.1;`

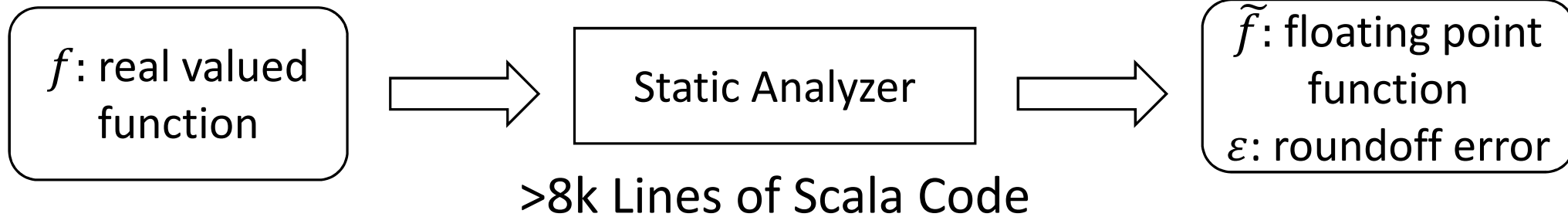
roundoff error


$$\max_x |f - \tilde{f}| \leq \varepsilon$$

# Daisy: A Static Analyzer

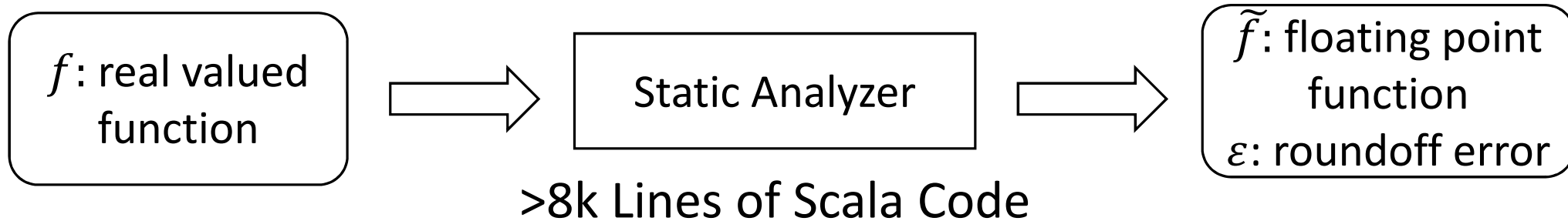


# Daisy: A Static Analyzer



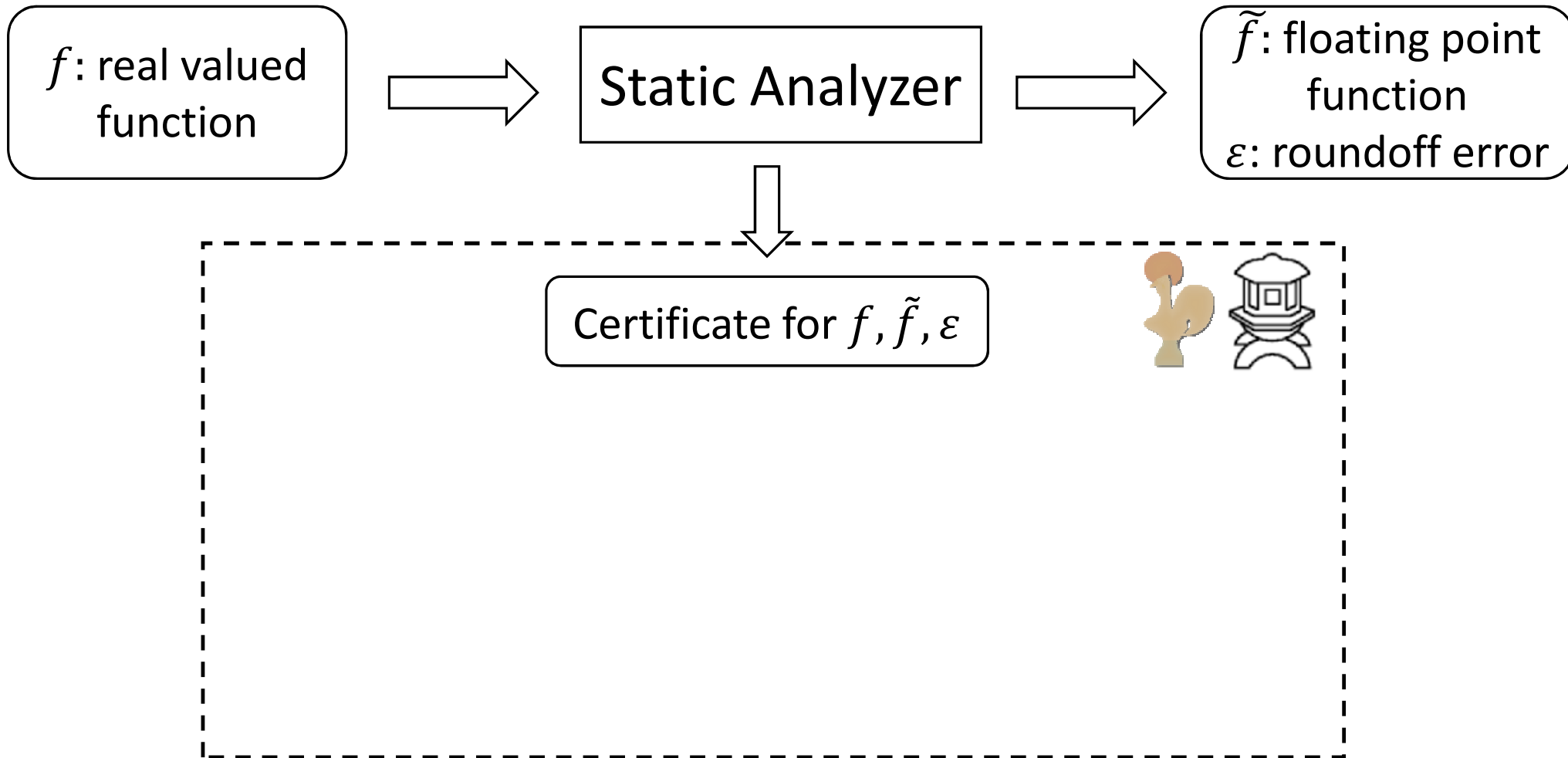


# Daisy: A Static Analyzer

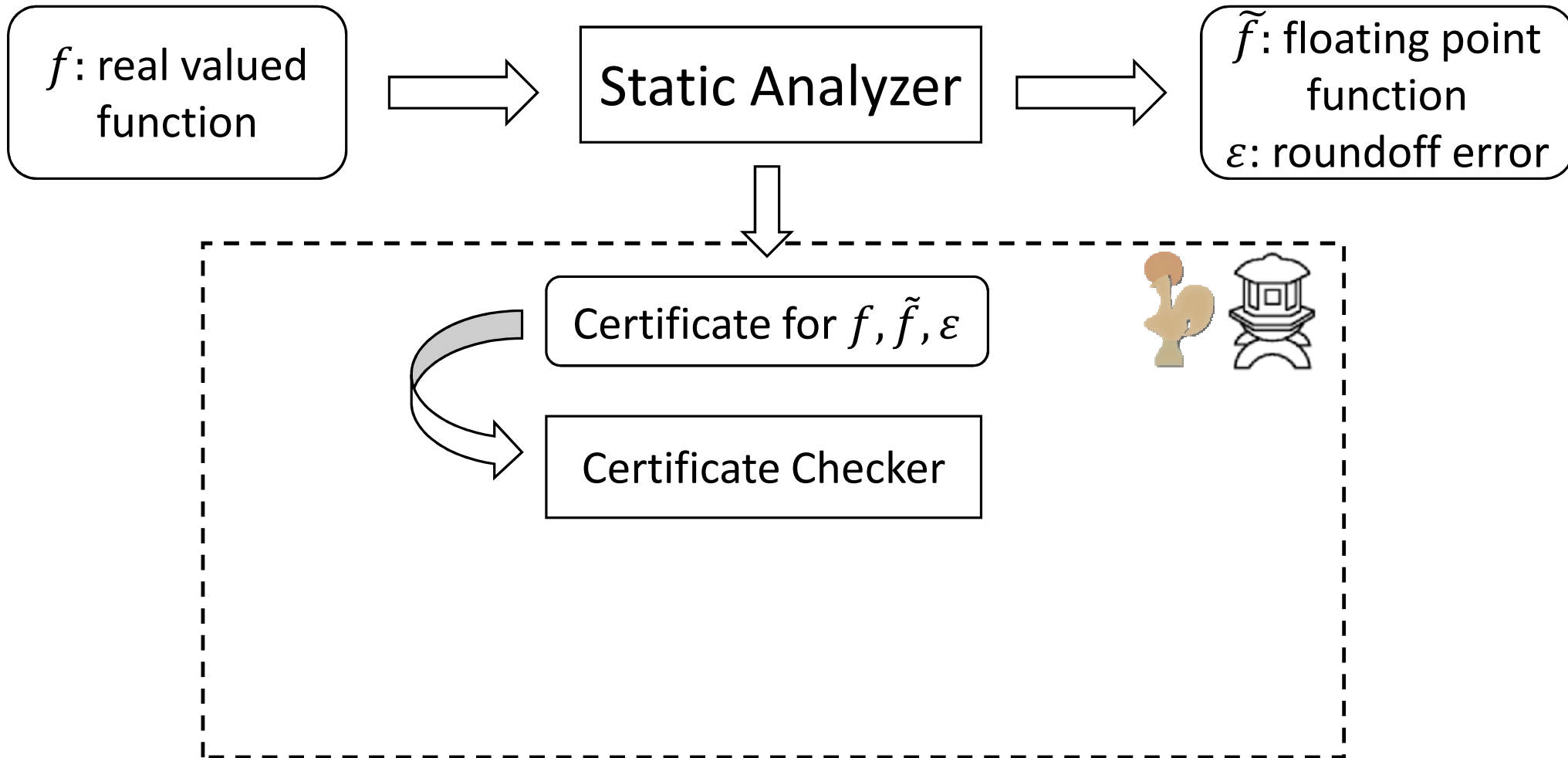


Is the computed  
roundoff error  $\varepsilon$  correct?

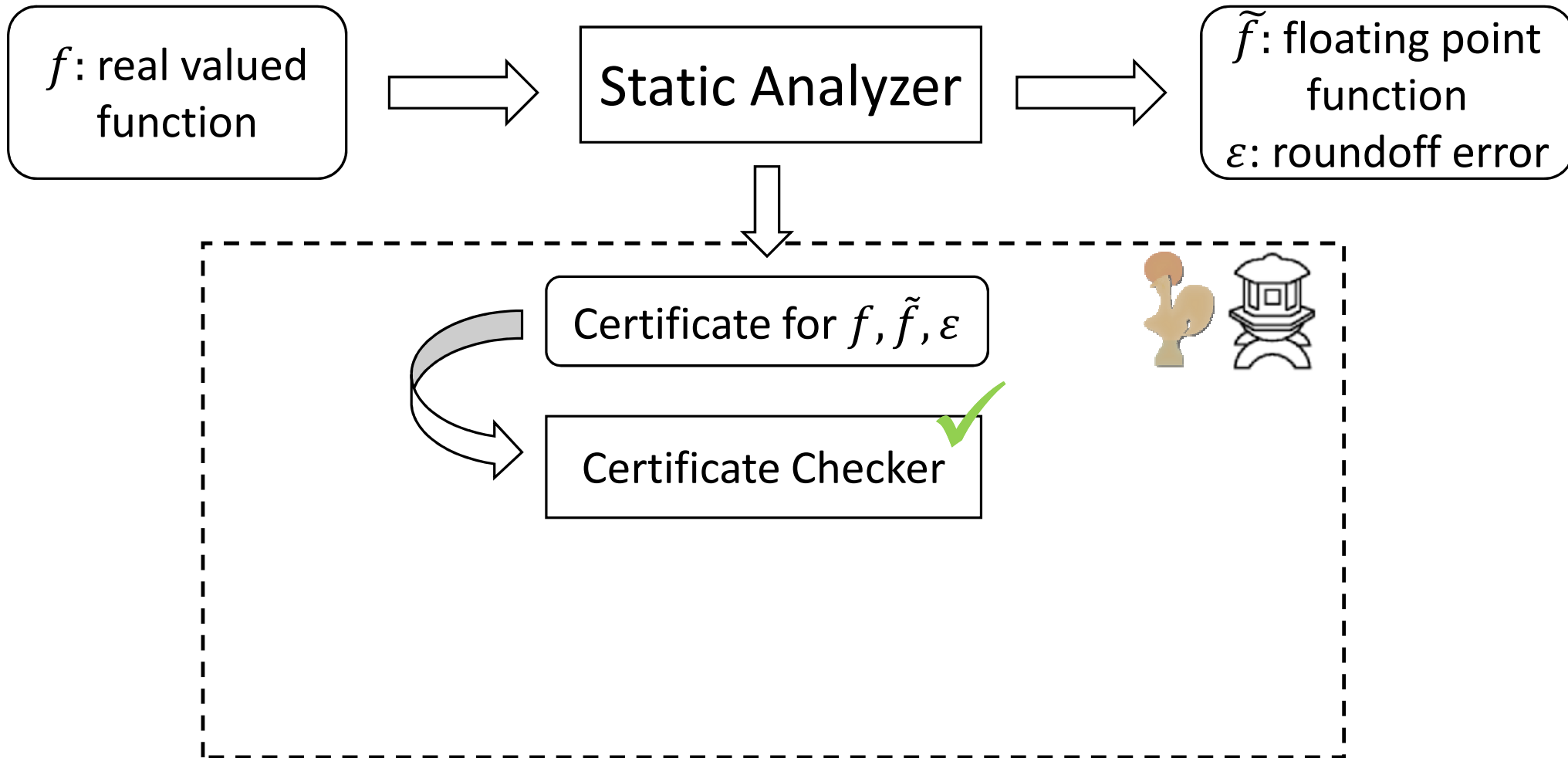
# Checking Certificates For Floating-Point Error Bounds



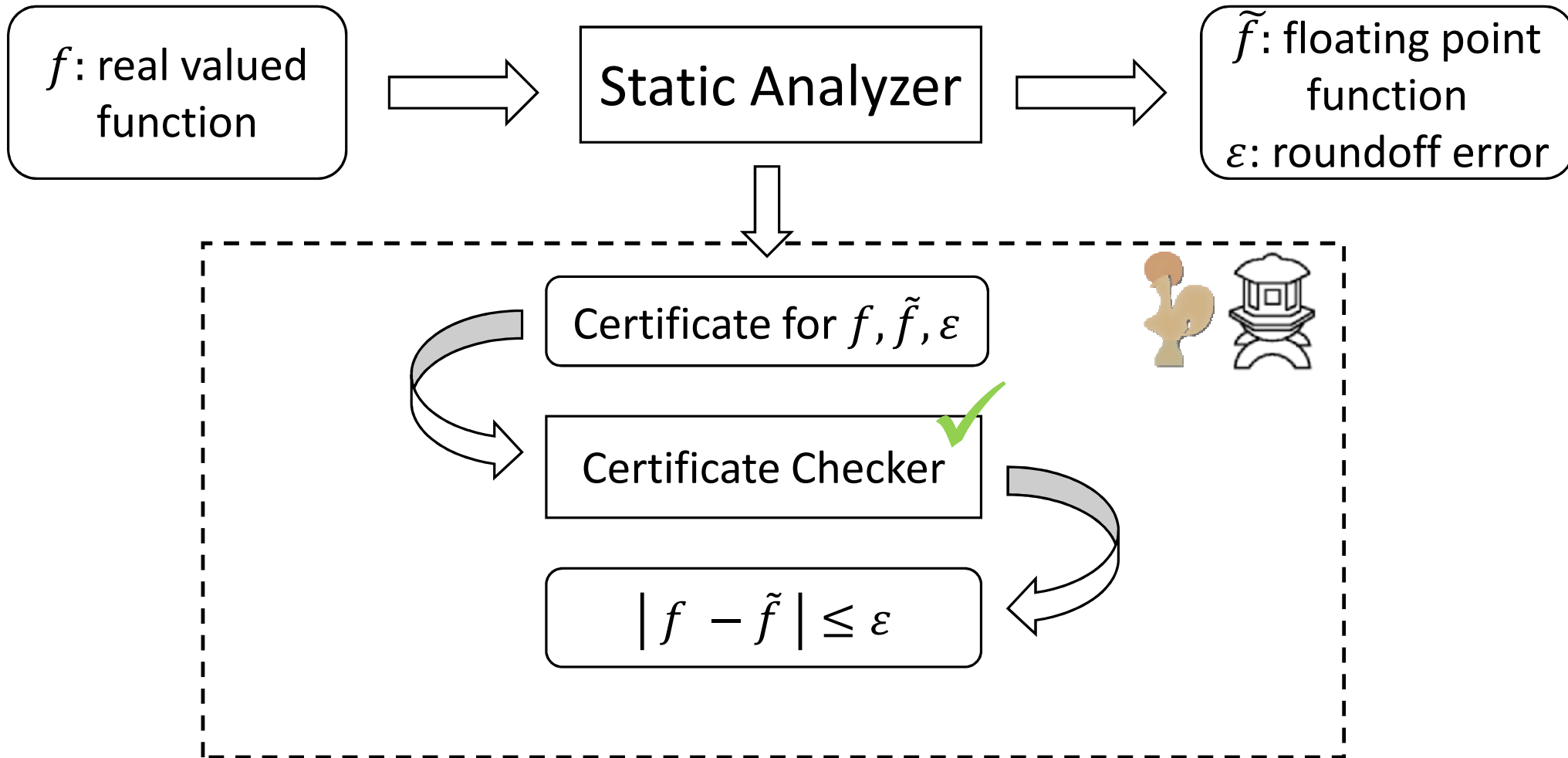
# Checking Certificates For Floating-Point Error Bounds



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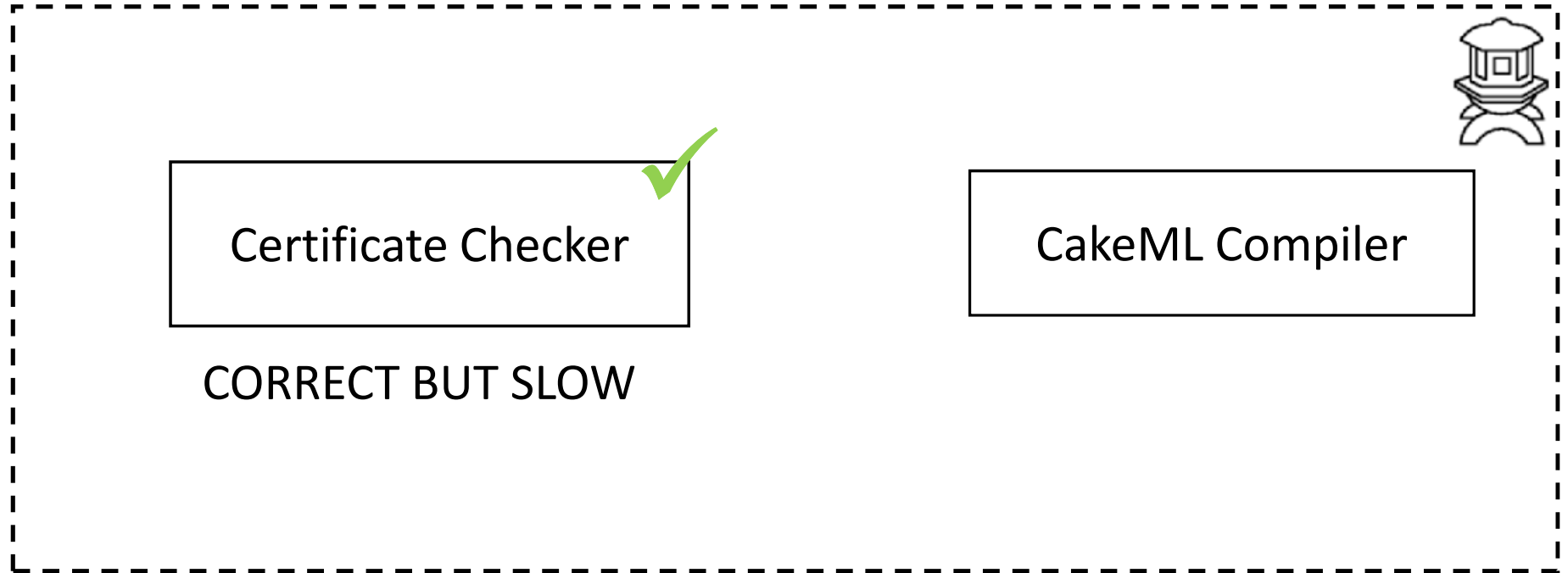
# Extraction using the CakeML compiler toolchain



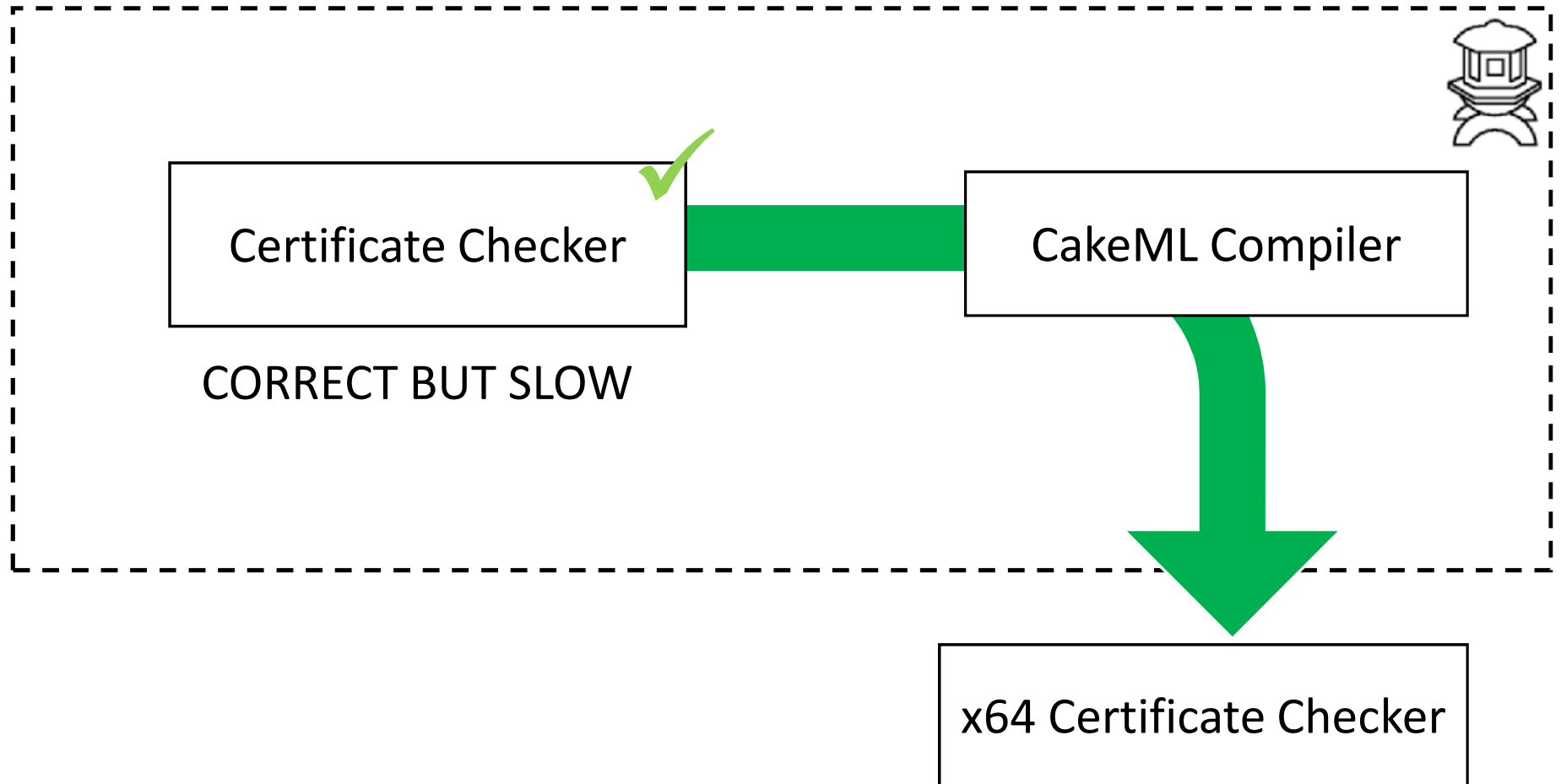
Certificate Checker

CORRECT BUT SLOW

# Extraction using the CakeML compiler toolchain

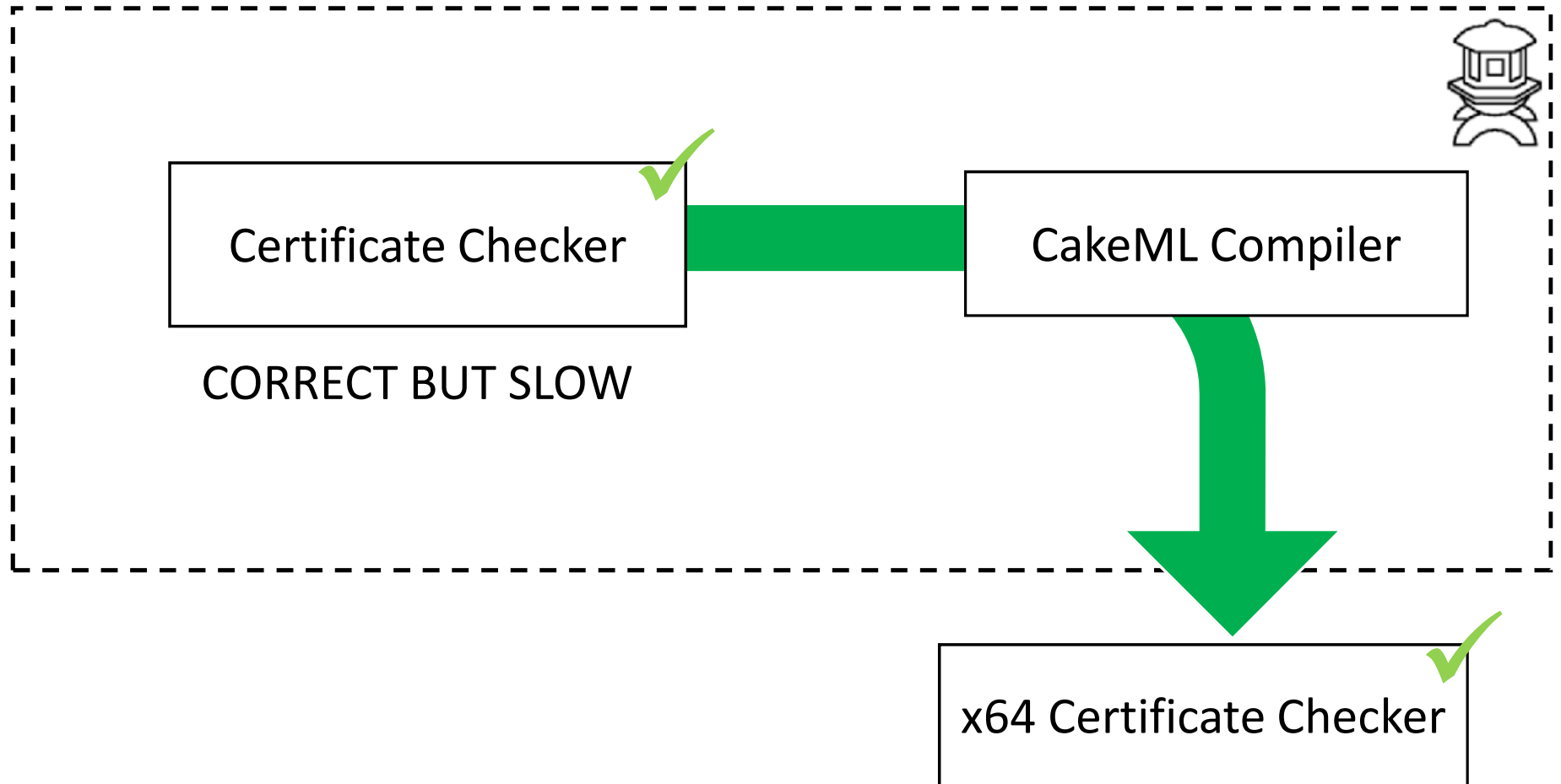


# Extraction using the CakeML compiler toolchain

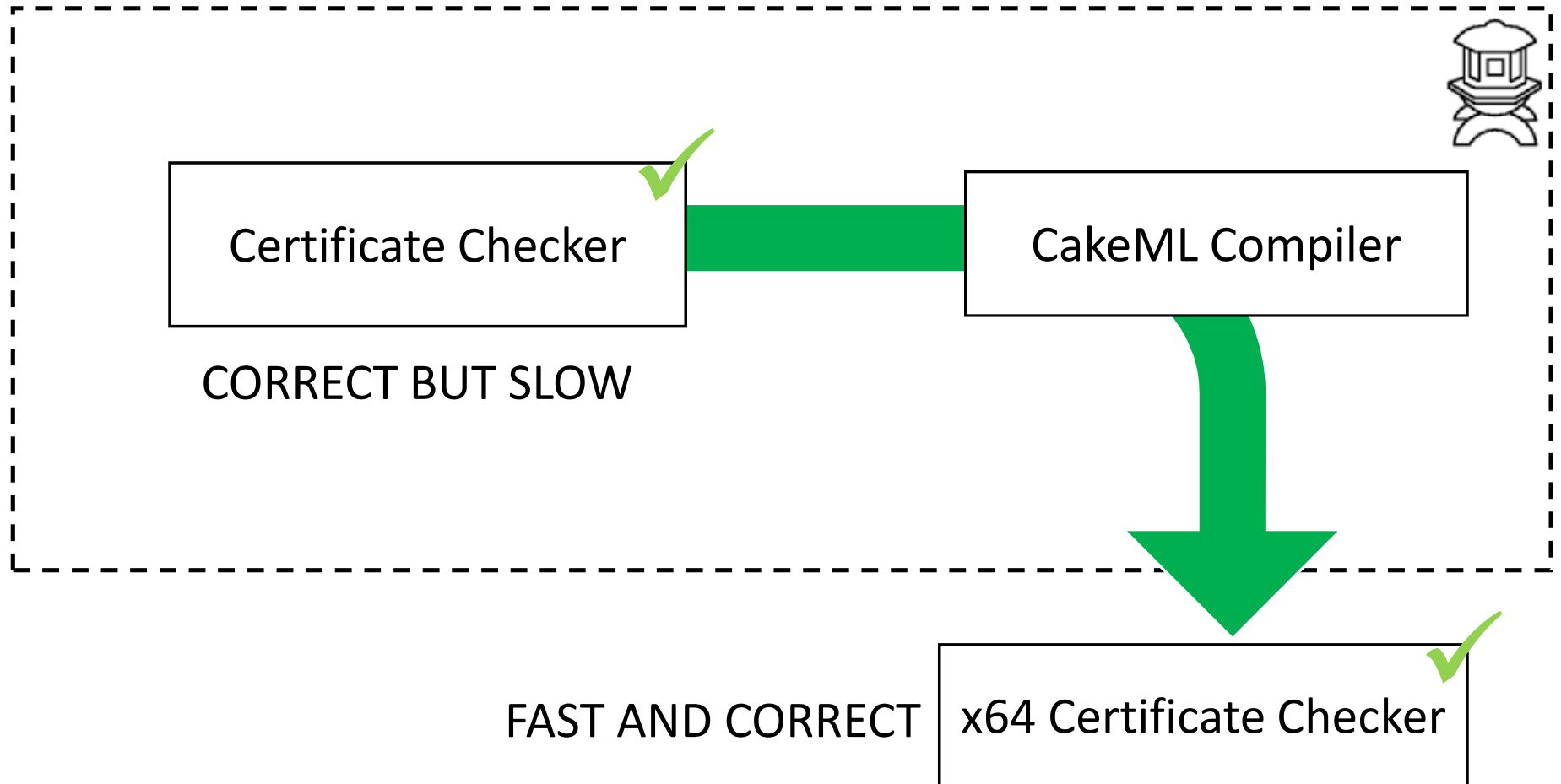




# Extraction using the CakeML compiler toolchain



# Extraction using the CakeML compiler toolchain



**We built a verified Certificate Checker for Floating Point roundoff errors.**

More on:

Future Work:

- Use CertiCoq to extract from Coq
- Connect to CompCert and CakeML

<https://mpi-sws.org/~hbecker>

Come talk to me  
or send me a mail:

[hbecker@mpi-sws.org](mailto:hbecker@mpi-sws.org)