ASYNCHRONOUS ASSERTIONS

What are assertions?

```
public class ATM {
   …
   public void withdraw(Account a, int amount) {
       int oldBalance = a.getBalance();
       a.setBalance(oldBalance – amount);
       assert a.getBalance() < oldBalance;
       dispense(amount);
   }
}
```

Assertions allow programmers to verify that their program is in a certain status

What are assertions?

```
public class ATM {
   …
   public void withdraw(Account a, int amount) {
       a.addTransaction(-amount, "ATM Withdrawal");
       assert a.findTransaction(-amount, "ATM
              Withdrawal") != null;
       dispense(amount);
   }
}
```

What is the problem here?

What are assertions?

- Assertions are used to verify your assumptions about the program
- Evaluating assertions is expensive – especially if they rely on expensive calculations themselves
- Because of this, you may opt to remove them from your production code
- This leads to some implications…

What are assertions NOT?

```
public class ATM {
   …
   public void withdraw(Account a, int amount) {
       assert amount > 0;
       a.addTransaction(-amount, "ATM Withdrawal");
       dispense(amount);
   }
}
```

Assertions cannot be used to verify user or method inputs

What are assertions NOT?

```
public class ATM {
   …
   public void withdraw(Account a, int amount) {
       assert a.addTransaction(-amount, "ATM
              Withdrawal") == true;
       dispense(amount);
   }
}
```

Assertions cannot have side effects

Idea

- If assertions are used only for debugging, we do not need the control flow to be halted while we evaluate the assertion
- After all, we are sure that it is true anyway
- Why not do it asynchronously?
- Problem: By then, object values have probably changed

Snapshotting

- If we copy the stack and the heap at the time of the assertion, we can make sure we still have the correct data
- That‘s expensive…
- Thus, only copy objects that are really modified
- Copy-on-write

Snapshotting

- Copy-on-write automatically guarantees isolation, preservance of identity, and consistent references
- If many assertions are made, objects are copied more than necessary

Snapshotting

- Every assertion defines ist own epoch
- Instead of having only a „modified“ flag, objects are checked whether they were changed in a later epoch
- Only then they have to be copied

Snapshotting

- Of course, if the epochs match, copies can be shared

- Objects created after an assertion‘s epoch do not have to be copied

In case of an error…

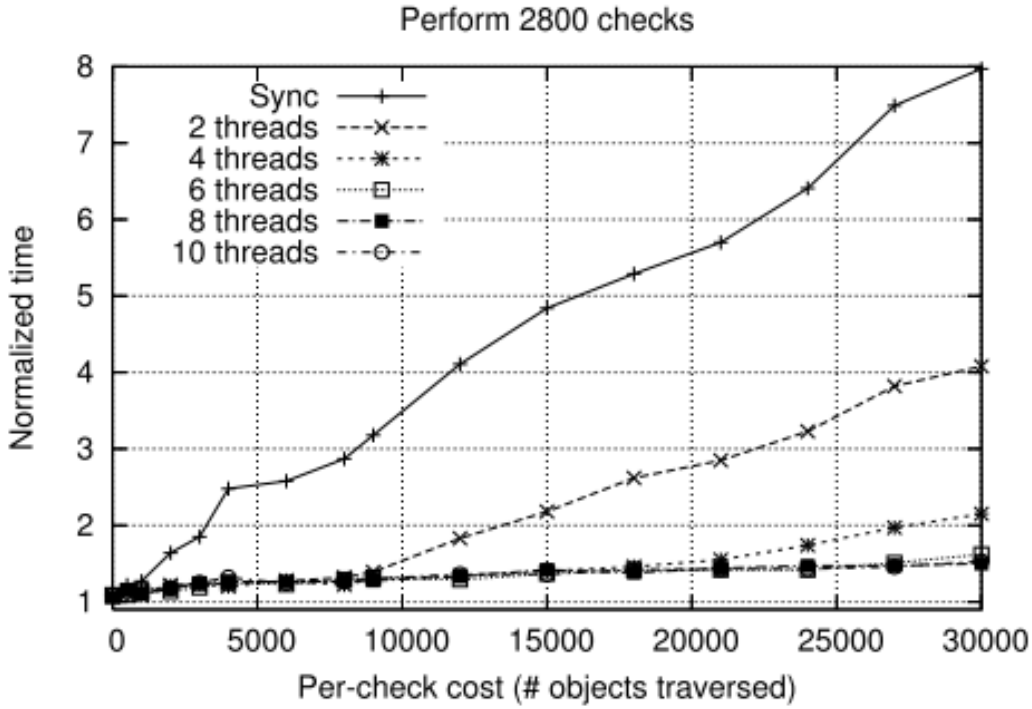
- The user can decide how to handle assertion errors:
  - Either the program terminates, throwing an AssertionError, or
  - The user can handle the situation by using a handle to the asynchronous evaluation

Discussion

- „Handle into the future“ in violation of the JLS

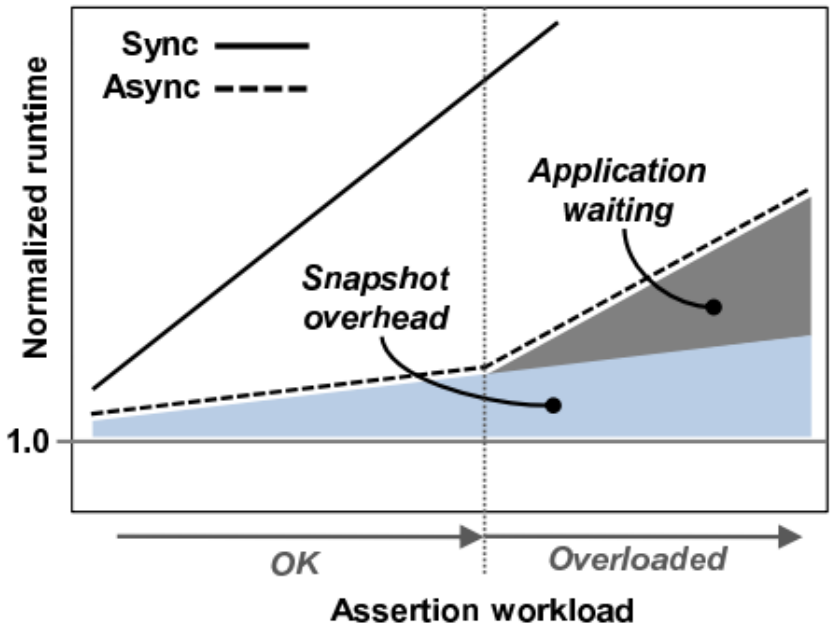
Evaluation

- Microbenchmarks: Simple data structures, synthetic benchmark: No significant improvement
- JBB2000:



Evaluation

- Asynchronous assertions reduce the overhead by approx. 90%
- They scale good, at least as long as the checker threads are not overloaded:

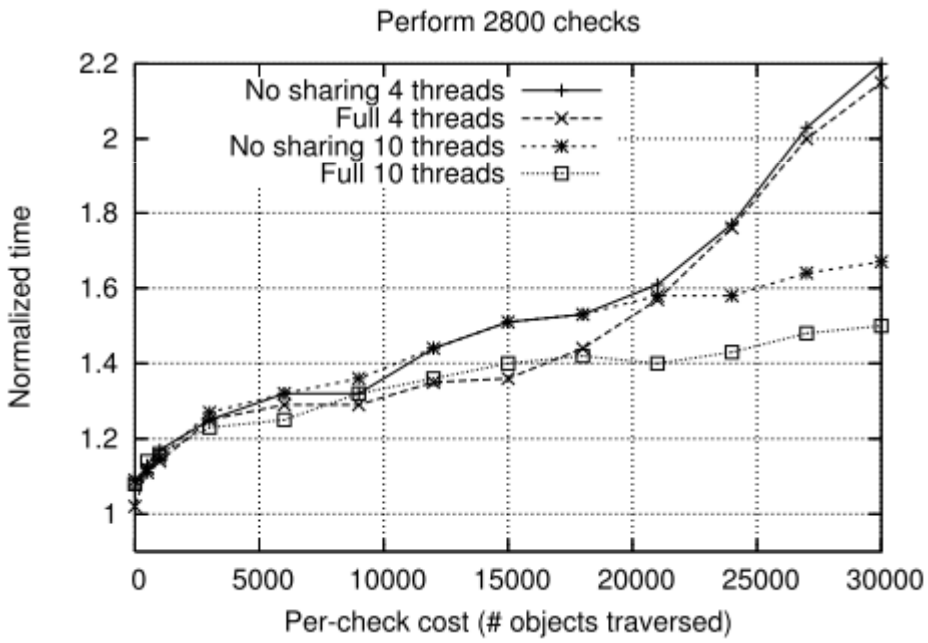


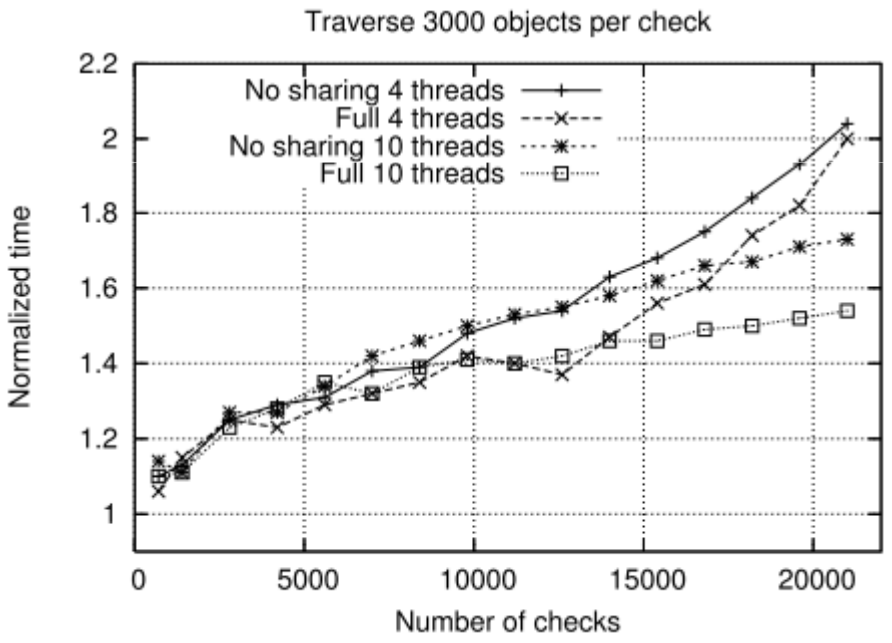
Discussion

- Fallback to synchronous assertions if checkers are overloaded?
- Profile assertions and execute simple ones synchronously?

Evaluation

- Sharing copies helps:





Discussion

- Are the benchmarks used really meaningful?

Reception

- Only two theseses reference the paper
- Not in the Jikes Research Archive
- Not available in other VMs
- Why?

Discussion

- Questions?

Discussion