Principles of Software Construction: Objects, Design, and Concurrency

Toward SE in practice: People and process

Josh Bloch **Charlie Garrod**

Carnegie Mellon University
School of Computer Science

institute for SOFTWARE RESEARCH

Administrivia

- Homework 5c due tonight, 11:59 p.m.
- Homework 6 available tomorrow morning
  - Due next Wednesday, May 5th
- Final exam released Thursday, May 13th
  - Due Friday, May 14th, 11:59 p.m. EDT
  - Exam review session Wednesday, May 12th, 7-9 p.m. EDT
  - Practice exam released late next week

Key concepts from last Thursday

- Java lambdas and streams

Use caution making streams parallel

Remember our Mersenne primes program?

```
static Stream<BigInteger> primes() {
    return Stream.iterate(TWO, BigInteger::nextProbablePrime);
}

public static void main(String[] args) {
    primes().map(p -> TWO.pow(p.intValueExact()).subtract(ONE))
        .filter(mersenne -> mersenne.isProbablePrime(50))
        .limit(20)
        .forEach(System.out::println);
}
```

Runs in 10.1s on my 12-core, 24-thread Ryzen 9 3900X

Does not reasonably terminate if the stream is .parallel()

Lambdas and streams summary

- When to use a lambda
  - Always, in preference to CICE
- When to use a method reference
  - Almost always, in preference to a lambda
- When to use a stream
  - When it feels and looks right
- When to use a parallel stream
  - When you’ve convinced yourself it has equivalent semantics and demonstrated that it’s a performance win

What Josh didn't show you…

Stream interface is a monster (1/3)

```
public interface Stream<T> extends BaseStream<T, Stream<T>> {
 // Intermediate Operations
 Stream<T> filter(Predicate<T>);
 <R> Stream<R> map(Function<T, R>);
 IntStream mapToInt(ToIntFunction<T>);
 LongStream mapToLong(ToLongFunction<T>);
 DoubleStream mapToDouble(ToDoubleFunction<T>);
 <R> Stream<R> flatMap(Function<T, Stream<R>>);
 IntStream flatMapToInt(Function<T, IntStream>);
 LongStream flatMapToLong(Function<T, LongStream>);
 DoubleStream flatMapToDouble(Function<T, DoubleStream>);
 Stream<T> distinct();
 Stream<T> sorted();
 Stream<T> sorted(Comparator<T>);
 Stream<T> peek(Consumer<T>);
 Stream<T> limit(long);
 Stream<T> skip(long);
```

Stream interface is a monster (2/3)

```
// Terminal Operations
void forEach(Consumer<T>);         // Ordered only for sequential streams
void forEachOrdered(Consumer<T>);  // Ordered if encounter order exists
Object[] toArray();
<A> A[] toArray(IntFunction<A[]> arrayAllocator);
T reduce(T, BinaryOperator<T>);
Optional<T> reduce(BinaryOperator<T>);
<U> U reduce(U, BiFunction<U, T, U>, BinaryOperator<U>);
<R, A> R collect(Collector<T, A, R>); // Mutable Reduction Operation
<R> R collect(Supplier<R>, BiConsumer<R, T>, BiConsumer<R, R>);
Optional<T> min(Comparator<T>);
Optional<T> max(Comparator<T>);
long count();
boolean anyMatch(Predicate<T>);
boolean allMatch(Predicate<T>);
boolean noneMatch(Predicate<T>);
Optional<T> findFirst();
Optional<T> findAny();
```

Stream interface is a monster (3/3)

```
 // Static methods: stream sources
 public static <T> Stream.Builder<T> builder();
 public static <T> Stream<T> empty();
 public static <T> Stream<T> of(T);
 public static <T> Stream<T> of(T...);
 public static <T> Stream<T> iterate(T, UnaryOperator<T>);
 public static <T> Stream<T> generate(Supplier<T>);
 public static <T> Stream<T> concat(Stream<T>, Stream<T>);
}
```

In case your eyes aren’t glazed yet

```
public interface BaseStream<T, S extends BaseStream<T, S>>
   extends AutoCloseable {
 Iterator<T> iterator();
 Spliterator<T> spliterator();
 boolean isParallel();
 S sequential();  // May have little or no effect
 S parallel();    // May have little or no effect
 S unordered();   // Note asymmetry wrt sequential/parallel
 S onClose(Runnable);
 void close();
}
```

It keeps going: `java.util.stream.Collectors`

```
... toList()
... toMap(...)
... toSet(...)
... reducingBy(...)
... groupingBy(...)
... partitioningBy(...)

        .
        .
        .
```

It keeps going: `java.util.stream.Collectors`

```
... toList()
... toMap(...)
... toSet(...)
... reducingBy(...)
... groupingBy(...)
... partitioningBy(...)

         .
         .
         .
static <T,K,D,A,M extends Map<K,D>> Collector<T,?,M> groupingBy(
    Function<? super T,? extends K> classifier,
    Supplier<M> mapFactory,
    Collector<? super T,A,D> downstream)
```

Optional<T> – a third way to indicate the absence of a result

```
public final class Optional<T> {
    boolean isPresent();
    T get();

    void ifPresent(Consumer<T>);
    Optional<T> filter(Predicate<T>);
    <U> Optional<U> map(Function<T, U>);
    <U> Optional<U> flatMap(Function<T, Optional<U>>);
    T orElse(T);
    T orElseGet(Supplier<T>);
    <X extends Throwable> T orElseThrow(Supplier<X>) throws X;
}
```

Changes to existing libraries… e.g.,

```
public interface Collection<E> {
  …
  default Stream<E> stream();
  default Stream<E> parallelStream();
  default Spliterator<E> spliterator();
}
```

Overall: Streams design discussion

- Recall the fundamental API design principles…

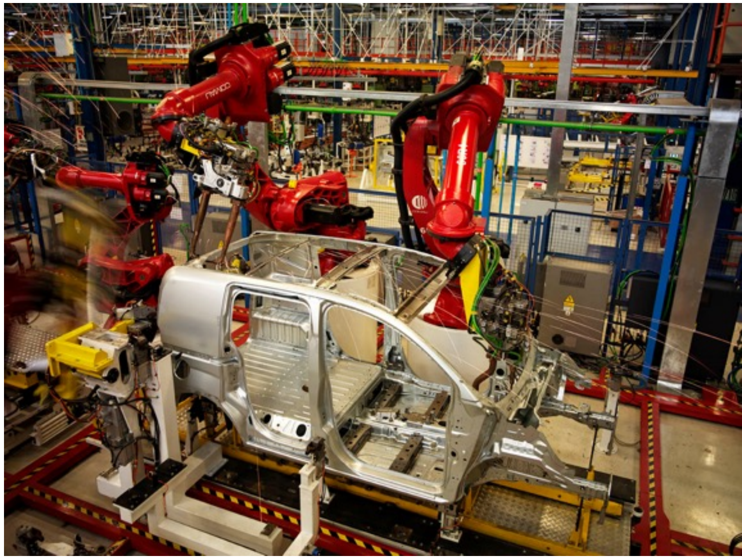
Today: Software engineering in practice

- An introduction to software engineering
- Methodologies discussion: Test-driven development

What is software engineering?

Compare to other forms of engineering

- e.g., Producing a car or bridge
  - Estimable costs and risks
  - Well-defined expected results
  - High quality
- Separation between plan and production
- Simulation before construction
- Quality assurance through measurement
- Potential for automation



Software engineering in the real world

- e.g., HealthCare.gov
  - Estimable costs and risks
  - Well-defined expected results
  - High quality
- Separation between plan and production
- Simulation before construction
- Quality assurance through measurement
- Potential for automation

HealthCare.gov

2019 Open Enrollment is here – and ends Dec 15

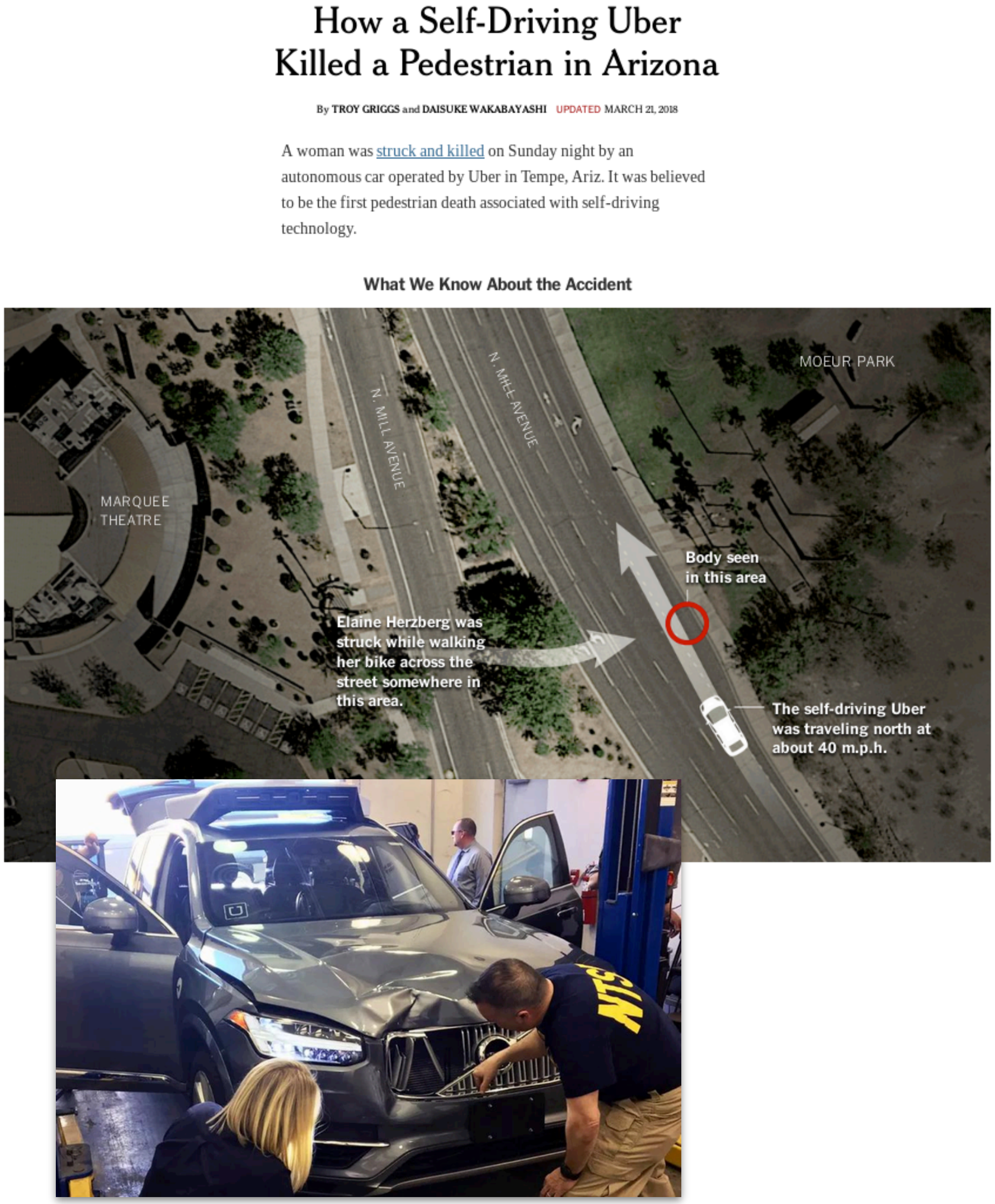
First time applying on HealthCare.gov?

Have a 2018 Marketplace plan?

1968 NATO Conference on Software Engineering

Sociotechnical systems

- A *sociotechnical system* is, roughly, any interlinked system of people, technology, and their environment



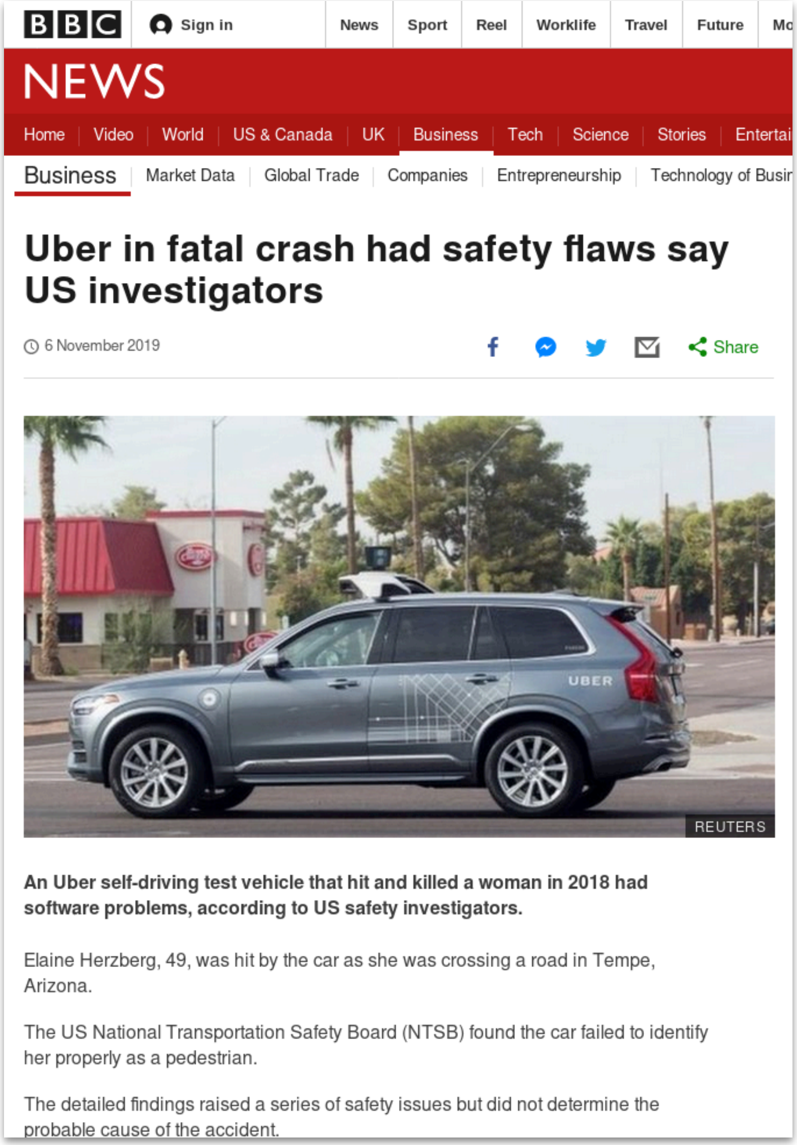
How a Self-Driving Uber Killed a Pedestrian in Arizona

By TROY GRIGGS and DAISUKE WAKABAYASHI UPDATED MARCH 21, 2018

A woman was struck and killed on Sunday night by an autonomous car operated by Uber in Tempe, Ariz. It was believed to be the first pedestrian death associated with self-driving technology.

What We Know About the Accident

MOEUR PARK
N. MILL AVENUE
N. MILL AVENUE
MARQUEE THEATRE
Body seen in this area
Elaine Herzberg was struck while walking her bike across the street somewhere in this area.
The self-driving Uber was traveling north at about 40 m.p.h.
NTSB



Uber in fatal crash had safety flaws say US investigators

6 November 2019

An Uber self-driving test vehicle that hit and killed a woman in 2018 had software problems, according to US safety investigators.

Elaine Herzberg, 49, was hit by the car as she was crossing a road in Tempe, Arizona.

The US National Transportation Safety Board (NTSB) found the car failed to identify her properly as a pedestrian.

The detailed findings raised a series of safety issues but did not determine the probable cause of the accident.

https://www.nytimes.com/interactive/2018/03/20/us/self-driving-uber-pedestrian-killed.html?mtrref=www.google.com&assetType=REGIWALL
https://www.bbc.com/news/business-50312340
https://www.bbc.com/news/technology-44243118

Search **Bloomberg** Si

Technology

Boeing's 737 Max Software Outsourced to $9-an-Hour Engineers

By Peter Robison
June 28, 2019, 4:46 PM EDT

- Planemaker and suppliers used lower-paid temporary workers
- Engineers feared the practice meant code wasn't done right

The cockpit of a grounded 737 Max 8 aircraft. *Photographer: Dimas*

It remains the mystery at the hea
crisis: how a company renowned
made seemingly basic software m
deadly crashes. Longtime Boeing
was complicated by a push to ou
contractors.

The Max software -- plagued by is
planes grounded months longer
week revealed a new flaw -- was c
was laying off experienced engin
suppliers to cut costs.

**https://spectrum.ieee.org/aerospace/aviation/h
developer**

How the Boeing 737 Max Disaster Looks to a Software Developer

Design shortcuts meant to make a new plane seem like an old, familiar one are to blame

By **Gregory Travis**

The views expressed here are solely those of the author and do not represent positions of IEEE Spectrum *or the IEEE.*

Photo: Jemal Countess/Getty Images

This is part of the wreckage of Ethiopian Airlines Flight ET302, a Boeing 737 Max

A year after the first 737 Max crash, it's unclear when the plane will fly again

Two crashes of Boeing's 737 Max 8 killed 346 people, and authorities are blaming Boeing's design, a faulty sensor and airline staff. Plus: Everything you need to know about the plane.

Kent German November 1, 2019 9:01 AM PDT 63

ed killing 346 people.

ts 737 Max 8 that killed 346 people, Boeing is facing
its newest and most critical aircraft models. The
und the world, and the Federal Aviation

Summary

- Software engineering requires consideration of many issues, social and technical, above code-level considerations
- Interested?   Take 17-313
- Shameless plug: Take API Design, 17-480