

Topics for this Lecture

- | Delta Debugging

Simplification Failures

- Once we have a test case that produces a program failure, we must find out what is relevant for the failure:
 - Does the failure really depend on all the inputs in the test case?
 - Does the failure require this sequence of function calls?
- Why simplify?
 - Ease of communication.
 - Easier debugging.
 - Identify duplicates test cases.

Real-World Scenario: The Mozilla Bugathon

```
<td align=left valign=top>
<SELECT NAME="op sys" MULTIPLE SIZE=7>
<OPTION VALUE="All">All<OPTION VALUE="Windows 3.1">Windows
3.1<OPTION VALUE="Windows 95">Windows 95<OPTION VALUE="Windows
98">Windows 98<OPTION VALUE="Windows ME">Windows ME<OPTION
VALUE="Windows 2000">Windows 2000<OPTION VALUE="Windows
NT">Windows NT<OPTION VALUE="Mac System 7">Mac System 7<OPTION
VALUE="Mac System 7.5">Mac System 7.5<OPTION VALUE="Mac
System 7.6.1">Mac System 7.6.1<OPTION VALUE="Mac System 8.0">Mac
System 8.0<OPTION VALUE="Mac System 8.5">Mac System
8.5<OPTION VALUE="Mac System 8.6">Mac System 8.6<OPTION VALUE="Mac
System 9.x">Mac System 9.x<OPTION VALUE="MacOS X">MacOS
X<OPTION VALUE="Linux">Linux<OPTION VALUE="BSDI">BSDI<OPTION
VALUE="FreeBSD">FreeBSD<OPTION VALUE="NetBSD">NetBSD<OPTION
VALUE="OpenBSD">OpenBSD<OPTION VALUE="AIX">AIX<OPTION
VALUE="BeOS">BeOS<OPTION VALUE="HP-UX">HP-UX<OPTION
VALUE="IRIX">IRIX<OPTION VALUE="Neutrino">Neutrino<OPTION
VALUE="OpenVMS">OpenVMS<OPTION VALUE="OS/2">OS/2<OPTION
VALUE="OSF/1">OSF/1<OPTION VALUE="Solaris">Solaris<OPTION
VALUE="SunOS">SunOS<OPTION VALUE="other">other</SELECT></td>
<td align=left valign=top>
<SELECT NAME="priority" MULTIPLE SIZE=7>
<OPTION VALUE="--">--<OPTION VALUE="P1">P1<OPTION
VALUE="P2">P2<OPTION VALUE="P3">P3<OPTION VALUE="P4">P4<OPTION
VALUE="P5">P5</SELECT>
</td>
<td align=left valign=top>
<SELECT NAME="bug severity" MULTIPLE SIZE=7>
<OPTION VALUE="blocker">blocker<OPTION
VALUE="critical">critical<OPTION VALUE="major">major<OPTION
VALUE="normal">normal<OPTION VALUE="minor">minor<OPTION
VALUE="trivial">trivial<OPTION
VALUE="enhancement">enhancement</SELECT>
</tr>
</table>
```

File

Print

Segmentation Fault

How do people solve these problems?

How do simplify this HTML file

to this HTML file?

```
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<SELECT>



Delta Debugging

- One automated technique for reducing down large failing inputs is **delta debugging**. Website <https://www.st.cs.uni-saarland.de/dd/>
- **Delta debugging** implements binary search technique.
- **Delta debugging** is based on the scientific method: **hypothesis, experiment, and refine**.
- **Delta debugging** automatically removes irrelevant information from a failing test case in order to attain a “minimal” bug-inducing input.
 - **REMEMBER DELTA DEBUGGING: IT CAN SAVE YOU
ENDLESS HOURS OF EFFORT**

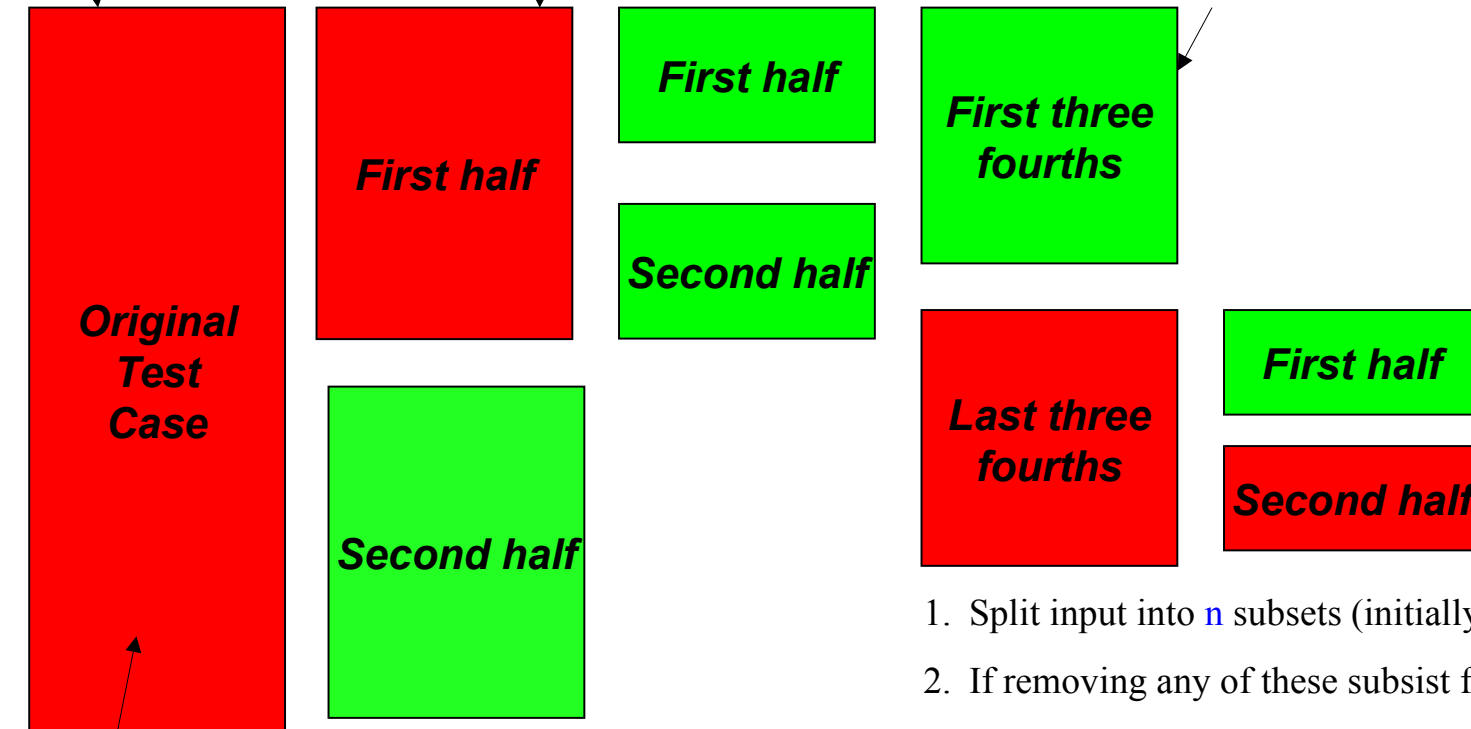
Delta Debugging

▯ Based on a clever modification of a “binary search” strategy

1) Split input into n subsets (initially $n=2$)

2) If removing any of these subsets fails, proceed with this subset.

3) Otherwise, increase granularity.



A failing test case

1. Split input into n subsets (initially, $n=2$)
2. If removing any of these subsets fails, proceed with this subset, and $n = \max(n-1, 2)$
3. Otherwise, increase the granularity, $n = \min(2n, \text{input})$, and go to #1

The Mozilla Bugathon

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</table>
```

File

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Segmentation Fault

The Mozilla Bugathon

Bold parts remain in the input, the rest is removed. N=number of characters.

1	<SELECT NAME="priority" MULTIPLE SIZE=7>	F	N=40 characters
2	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	N=20 characters
3	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	N=20 characters
4	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	N=30 characters
5	<SELECT NAME="priority" MULTIPLE SIZE=7>	F	N=30 characters
6	<SELECT NAME="priority" MULTIPLE SIZE=7>	F	N=20 characters
7	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	N=10 characters
8	<SELECT NAME="priority" MULTIPLE SIZE=7>	P
9	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	...
10	<SELECT NAME="priority" MULTIPLE SIZE=7>	F	...
11	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	...
12	< SELECT NAME="priority" MULTIPLE SIZE=7>	P	...
13	<SELECT NAME="priority" MULTIPLE SIZE=7>	P	...

F means input caused failure

P means input did not cause failure
(input passed)

The Mozilla Bugathon

Bold parts remain in the input, the rest is removed

14	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
15	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
16	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	F
17	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	F
18	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	F
19	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
20	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
21	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
22	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
23	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
24	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
25	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	P
26	<code><SELECT NAME="priority" MULTIPLE SIZE=7></code>	F

The Mozilla Bugathon

- ‡ After 26 tries we found that printing an HTML file which consists of:
 - **<SELECT>** causes Mozilla to crash
- Delta debugging technique automates this approach of repeated trials for reducing the input

References:

<https://www.st.cs.uni-saarland.de/dd/>

Zeller, Andreas. "**Yesterday, my program worked. Today, it does not. Why?.**" Software Engineering ESEC/FSE'99. Springer Berlin Heidelberg, 1999.

Zeller, Andreas, and Ralf Hildebrandt. "**Simplifying and isolating failure-inducing input.**" IEEE Transactions on Software Engineering 28, no. 2 (2002): 183-200.

<http://classes.engr.oregonstate.edu/eecs/summer2015/cs362-002/>