

Critical Skills for Research/Career Development

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Slides: <http://people.engr.ncsu.edu/txie/advice/criticalskills.pdf>

More Advice: <http://people.engr.ncsu.edu/txie/advice/>

Related Blog Post: <http://asegrp.blogspot.com/2011/01/student-advising-critical-skills-for.html>

Example Critical Skills

- **Problem solving skills**
 - Given a faced difficulty/challenge, how to isolate, generalize, and solve it
 - Given a big problem, how to decompose it to subproblems and solve them (i.e., divide & conquer)
 - **Research management skills (e.g., time management)**
 - Given a submission deadline, how to make it
 - » What to work on and what not to work on given time constraints
 - » What to work on now and what to work on next
 - » How to manage risks (risk management)
 - » How to leverage the help from advisors, collaborators, and peer students
 - **Logical reasoning/thinking/presentation skills**
 - How to write and explain things logically and clearly
 - <http://www.amazon.com/Being-Logical-Guide-Good-Thinking/dp/0812971159>
 - **Innovation skills**
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Pitfall: No Justification on Correlating Current Action Items to Goals

- **Ex: Work on implementing a technique that is unclear on how (significantly) to help address the research problem targeted by the project/paper**
 - Before you invest on implementing a technique (esp. when the investment is substantial), you'd better give rough estimation on how much benefit you implemented technique would provide w.r.t. overall approach effectiveness (e.g., based on manual inspection results of sampled evaluation subjects)
 - **Ex: No evaluation subjects or initial results (system acceptance tests) available, or don't use them, to gauge or guide the current action items**
 - You'd better prepare your system acceptance tests before you implement your approach
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Pitfall: No Strategic Prioritization on Action Items

- **Ex: Delay sending writing portions (especially abstract, intro, example, eval setup, related work) to advisor or senior collaborators**
 - <http://asegrp.blogspot.com/2008/12/on-reviewing-students-paper-drafts.html>
 - <http://asegrp.blogspot.com/2008/12/why-shall-we-research-advisors-avoid.html>
- **Ex: Delay in delegating or allocating subtasks to junior collaborators**
 - **Need to allocate and delegate subtasks early on so that junior collaborators could concurrently work on subtasks**



Pitfall: Lack Big Picture or Top-Down Thinking

- **Ex: Not clear on what exact problems the proposed approach is addressing and how the proposed approach is better/different than related work**
 - Prepare writing of abstract/intro/related work early for advisor/collaborators to review
- **Ex: Not clear on what subproblems can be decomposed from the target problem**
 - Often students do decomposition at the solution space rather than the problem space; need to iterate with advisor/collaborators on such problem decomposition



Pitfall: Bottom-Up Explanation or Illogical Organization of Thoughts

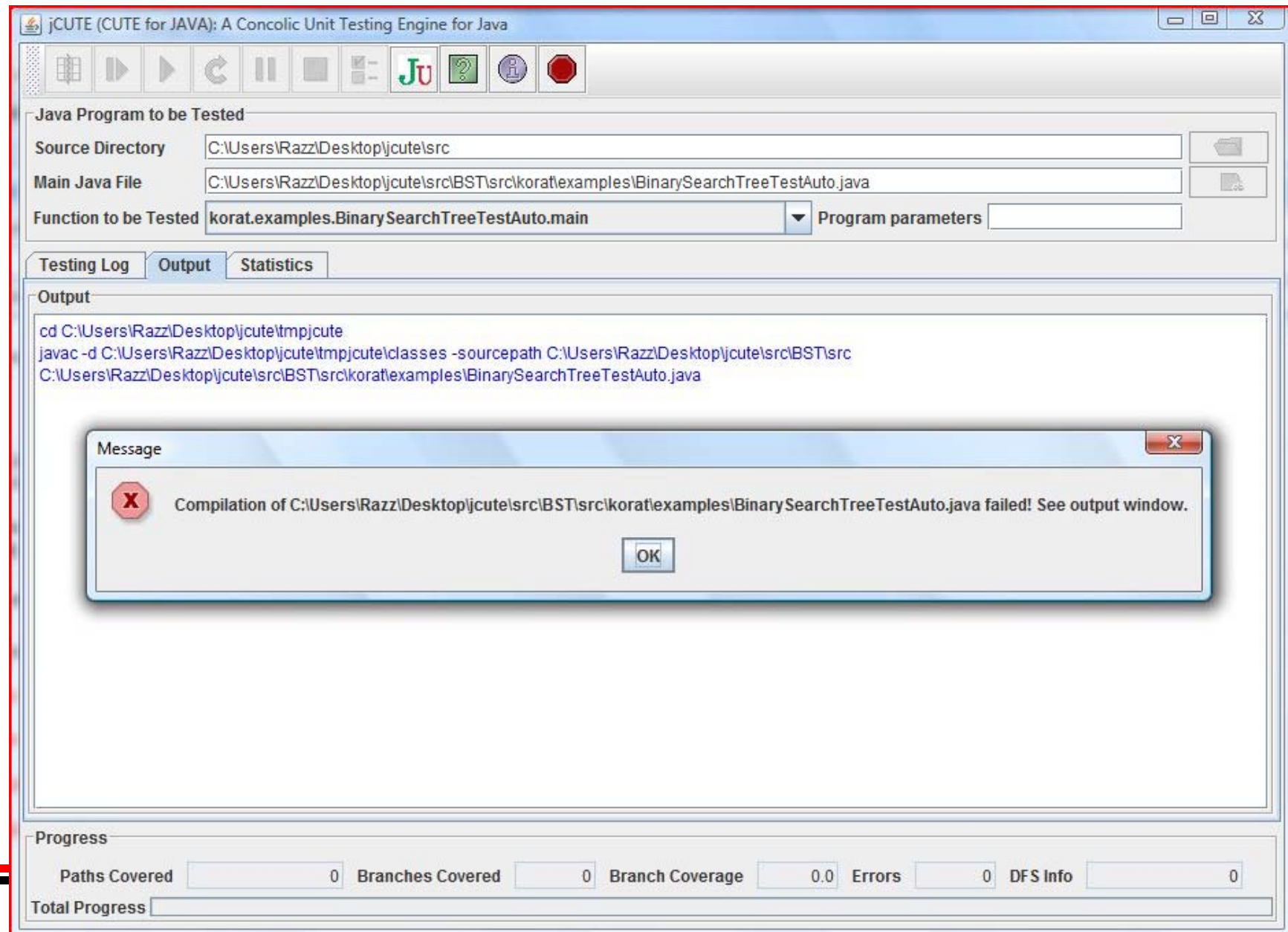
- **Ex: Start showing code internal details before showing how the issues/features would impact the overall approach effectiveness**
 - **Need to show the approach effectiveness (understandable to customers/users) first**
- **Ex: No acceptance tests available when walking through implementation code for features in code bases**
 - **Need to prepare unit acceptance tests first and run them before showing the internal implementation details**
 - **Better to provide system acceptance tests even first**
- **Just like writing a sentence in writing (e.g., familiar info in the beginning of the sentence and new info in the end of the sentence), you need to explain familiar info first, and then move on to less familiar info**

Pitfall: Do Nothing or Little When a Difficulty/Challenge is Faced

- **Tradeoffs: trying hard (strategically) yourself vs. asking helps from others**
 - You need to debug first (at least try to)
- **Ex: Not isolate issues**
- **Ex: Not generalize issues**
- **Next three slides show example issue reports sent to the instructor by some graduate students in a graduate testing course when they apply a testing tool on some code examples**



Pitfall Example I - Not Sending the Output Window Content



Pitfall Example II – Not inspecting the error msg carefully

- C:\Users\Bff>.\jcutegui.bat
'.\jcutegui.bat' is not recognized as an internal or external command, operable program or batch file.
 - C:\Users\Bff>cd jcute
 - C:\Users\Bff\jcute>cd jcute
 - C:\Users\Bff\jcute\jcute>.\jcutegui.bat
 - C:\Users\Bff\jcute\jcute>java -classpath jcute.jar;.;C:\Program Files\Java\jre1.6.0\lib\ext\QTJava.zip cute.Cute
Exception in thread "main" java.lang.NoClassDefFoundError: Files\Java\jre1/6/0\lib\ext\QTJava.zip
Caused by: java.lang.ClassNotFoundException: Files\Java\jre1.6.0\lib\ext\QTJava.zip
at java.net.URLClassLoader\$1.run(Unknown Source)
at java.security.AccessController.doPrivileged(Native Method)
at java.net.URLClassLoader.findClass(Unknown Source)
at java.lang.ClassLoader.loadClass(Unknown Source)
at sun.misc.Launcher\$AppClassLoader.loadClass(Unknown Source)
at java.lang.ClassLoader.loadClass(Unknown Source)
at java.lang.ClassLoader.loadClassInternal(Unknown Source)
Could not find the main class: Files\Java\jre1.6.0\lib\ext\QTJava.zip. Program will exit.
 - C:\Users\Bff\jcute\jcute>
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Pitfall Example III - Not trying Google first

- **Forum: General discussion**
Topic: jCute on 64-bit architecture

Message:

I keep getting exceptions thrown while running jCute (after compile, during test).

The exception message says wrong ELF class: [ELFCLASS32](#) (possible cause: [architecture word width mismatch](#))

Has anyone else run into this. Does anyone know what is causing the use of the wrong ELF class?

Google is your good friend



Key Elements in Bug Reporting/Problem Diagnosis

- **Reproduce: test it again**
- **Isolate: test it differently**
- **Generalize: test it elsewhere**

Reproduce

- **Always check reproducibility of the failure as part of writing bug report**
 - **Three times is a good rule of thumb**
- **Document a crisp sequence of actions that will reproduce the failure**

Reproduce - Example

● Good

Steps to Reproduce

- 1. I started the SpeedyWriter editor, then I created a new file.*
- 2. I then typed in four lines of text, repeating “The quick fox jumps over the lazy brown dog” each time, using different effects each time, bold, italic, strikethrough, and underline.*
- 3. I highlighted the text, then pulled down the font menu, and selected Arial.*
- 4. This nasty bug trashed all the text into meaningless garbage, wasting the user’s time.*
- 5. I was able to reproduce this problem three out of three tries.*

● Bad

Nasty bug trashed contents of new file that I created by formatting some text in Arial font, wasting my time.

Isolate

- **Change variables that may alter symptom**
 - **Make changes one by one**
 - **Requires thought and understanding of SUT**
 - **May not be immediately obvious**
- **Can be extensive**
 - **Match amount of effort to severity of problem**
- **Good isolation shows due diligence and gives developers head start on debugging**



Isolate - Example

● Better

Steps to Reproduce

1. I started the SpeedyWriter editor, then I created a new file.
2. I then typed in four lines of text, repeating “The quick fox jumps over the lazy brown dog” each time, using different effects each time, bold, italic, strikethrough, and underline.
3. I highlighted the text, then pulled down the font menu, and selected Arial.
4. This nasty bug trashed all the text into meaningless garbage, wasting the user’s time.
5. I was able to reproduce this problem three out of three tries.

Isolation

On the vague suspicion that this was just a formatting problem, I saved the file, closed SpeedyWriter and reopened the file. The garbage remained.

If you save the file before Arializing the contents, the bug does not occur.

The bug does not occur with existing files.

This only happens under Windows 98.

● Good

Steps to Reproduce

1. I started the SpeedyWriter editor, then I created a new file.
2. I then typed in four lines of text, repeating “The quick fox jumps over the lazy brown dog” each time, using different effects each time, bold, italic, strikethrough, and underline.
3. I highlighted the text, then pulled down the font menu, and selected Arial.
4. This nasty bug trashed all the text into meaningless garbage, wasting the user’s time.
5. I was able to reproduce this problem three out of three tries.

Isolation

Doesn’t happen on Solaris.

Generalize

- **Look for related failures in SUT**
 - Does the same failure occur in other modules or locations?
 - Are there more severe occurrences of the same fault?
- **Avoid confusing unrelated problems**
 - Same symptom can arise from different bugs
- **Generalizing reduces duplicate bug reports and refines understanding of failure**



Generalize - Example

● Better

Steps to Reproduce

1. I started the SpeedyWriter editor, then I created a new file.
2. I then typed in four lines of text, repeating “The quick fox jumps over the lazy brown dog” each time.
3. I highlighted the text, then pulled down the font menu, and selected Arial.
4. This nasty bug trashed all the text into meaningless garbage, wasting the user’s time.
5. I was able to reproduce this problem three out of three tries.

Isolation

Also happens with Wingdings and Symbol fonts.

On the vague suspicion that this was just a formatting problem, I saved the file, closed SpeedyWriter and reopened the file. The garbage remained.

If you save the file before changing the font of the contents, the bug does not occur.

The bug does not occur with existing files.

This only happens under Windows 98.

● Good

Steps to Reproduce

1. I started the SpeedyWriter editor, then I created a new file.
2. I then typed in four lines of text, repeating “The quick fox jumps over the lazy brown dog” each time, *using different effects each time, bold, italic, strikethrough, and underline.*
3. I highlighted the text, then pulled down the font menu, and selected Arial.
4. This nasty bug trashed all the text into meaningless garbage, wasting the user’s time.
5. I was able to reproduce this problem three out of three tries.

Isolation

On the vague suspicion that this was just a formatting problem, I saved the file, closed SpeedyWriter and reopened the file. The garbage remained.

If you save the file before Arializing the contents, the bug does not occur.

The bug does not occur with existing files.

This only happens under Windows 98.