Interactive Media and Game Development

Debugging

Debugging Introduction

- Debugging is methodical process for removing mistakes in program
- So important, whole set of tools to help. Called "debuggers"
  - Trace code, print values, profile
  - New Integrated Development Environments (IDEs) (such as Game Maker) have it built in
- But debugging still frustrating
  - Beginners not know how to proceed
  - Even advanced can get "stuck"
- Don't know how long takes to find
  - Variance can be high
- What are some tips? What method can be applied?

Outline

- 5-step debugging process
- Game Maker specifics
- Debugging tips

Step 1: Reproduce the Problem Consistently

- Find case where always occurs
  - "Sometimes game crashes after kill boss" doesn't help much
- Identify steps to get to bug
  - Ex: start single player, room 2, jump to top platform, attack left, …
  - Produces systematic way to reproduce

Step 2: Collect Clues

- Collect clues as to bug
  - Clues suggest where problem might be
  - Ex: if crash using projectile, what about that code that handles projectile creation and shooting?
- And beware that some clues are false
  - Ex: if bug follows explosion may think they are related, but may be from something else
- Don't spend too long - get in and observe
  - Ex: see reference pointer from arrow to unit that shot arrow should get experience points, but it is NULL
  - That's the bug, but why is it NULL?

Step 3: Pinpoint Error

1) *Propose a hypothesis* and prove or disprove
   - Ex: suppose arrow pointer corrupted during flight. Add code to print out values of arrow in air. But equals same value that crashes. *Hypothesis is wrong.* But now have new clue.
   - Ex: suppose unit deleted before experience points added. Print out values of all in camp before fire and all deleted. *Yep, that's it.*

And/Or, 2) *divide-and-conquer* method
   - Sherlock Holmes: "when you have eliminated the impossible, whatever remains, however improbably, must be the truth"
   - Setting breakpoints, look at all values, until discover bug
   - The "divide" part means break it into smaller sections
     - Ex: if crash, put breakpoint ½ way. Is it before or after? Repeat.
   - Look for anomalies, NULL or NAN values

Step 4: Repair the Problem

- Propose solution. Exact solution depends upon stage of problem.
  - Ex: late in code cannot change data structures. Too many other parts use.
  - Worry about "ripple" effects.
- Ideally, want original coder to fix.
  - If not possible, at least try to talk with original coder for insights.
- Consider other similar cases, even if not yet reported
  - Ex: other projectiles may cause same problem as arrows did

Step 5: Test Solution

- Obvious, but can be overlooked if programmer is sure they have fix (but programmer can be wrong!)
- So, test that solution repairs bug
  - Best by independent tester
- Test if other bugs introduced (beware "ripple" effect)

Debugging Prevention

- Add infrastructure, tools to assist
  - Alter game variables on fly (speed up)
  - Visual diagnostics (maybe on avatars)
  - Log data (events, units, code, time stamps)
- Always initialize variables when declared
- Indent code, use comments
- Use consistent style, variable names
- Avoid identical code – harder to fix if bug found
  - Use a script
- Avoid hard-coded (magic numbers) – makes brittle
- Verify coverage (test all code) when testing

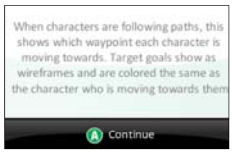
Outline

- 5-step debugging process (done)
- Kodu specifics (next)
- Debugging tips

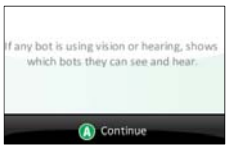
Debugging in Kodu (1 of 4)

- Built-in debugging aids
  - Path
  - Collision
  - Sight and sound

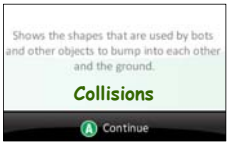
Debugging in Kodu (2 of 4)



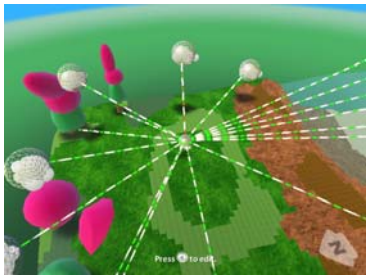
Path



Sight and Hearing



Debugging in Kodu (3 of 4)



Debugging in Kodu (4 of 4)

- To help see when/if events triggered, add own debug "messages"
  - Color, express …

Debugging Tips (1 of 3)

- *One thing at a time*
  - *Fix one thing at a time* – don't try to fix multiple problems
  - *Change one thing at a time* – test hypothesis. Change back if doesn't fix problem.
  - *Start with simpler case that works* - then add more complex code, one thing at a time
- *Question your assumptions* – don't even assume simple stuff works, or "mature" products
  - Ex: libraries and tutorials can have bugs

Debugging Tips (2 of 3)

- *Check code recently changed* – if bug appears, may be in latest code (not even yours!)
- *Use debugger* – breakpoints, memory watches, stack …
- *Break complex calculations into steps* – may be equation that is at fault or "cast" badly
- *Check boundary conditions* – classic "off by one" for loops, etc.
- *Minimize randomness* –
  - Ex: can be caused by random seed or player input. Fix input (script player) so reproducible

Debugging Tips (3 of 3)

- *Take a break* – too close, can't see it. Remove to provide fresh prospective
- *Explain bug to someone else* – helps retrace steps, and others provide alternate hypotheses
- *Debug with partner* – provides new techniques
  - Same advantage with code reviews, peer programming
- *Get outside help* – tech support for consoles, Web examples, libraries, …