ELEC 875
Design Recovery
and
Automated Evolution

Week 2 Class 1
Empirical Studies

Empirical Studies

- Studies Software Engineers
  - ◊ what do they really do
  - ◊ what do they really need
- Difficult
  - ◊ multiple variables
  - ◊ expensive
    - students/professional developers
    - real/artificial projects
  - ◊ software engineers like other users are conditioned by their past
- Workshop on Empirical Studies of Software (WESS)

Lethbridge & Singer

- T.C. Lethbridge
  - ◊ School of Information Technology and Engineering, University of Ottawa
- J. Singer
  - ◊ National Research Council
- Study various companies in the Ottawa area

WESS '97 Paper

- Understanding Software Maintenance Tools: Some Empirical Research
- Overview paper of Empirical Research
- What is a Tool
  - ◊ Used by software engineer to perform a software engineering task
  - ◊ hierarchical tools
- 5 Questions
  - ◊ What tools and what tasks?
  - ◊ What differences do tools make?
  - ◊ Why use (or not use) a particular tool?
  - ◊ What new tools or improvements to tools?
  - ◊ How can tools be introduced to SEs?

WESS '97 Paper

- Measures
  - ◊ What tools are used
  - ◊ Number of times each tool is used
  - ◊ Elapsed time spend using a tool
  - ◊ Goals and tasks for particular usage of a tool
  - ◊ List of positive attributes
  - ◊ List of negative attributes
  - ◊ Time to perform a given task

WESS '97 Paper

- Data Collection
  - ◊ Questionnaires (web based)
  - ◊ Interviews

    - General structured interviews

    60-90 minutes, 10 page protocol (24 developers)

    - Regular debriefings (every few weeks)

    30-60 minutes

    - Tool reviews - specific tool and subtotals

    30-60 minutes

WESS '97 Paper

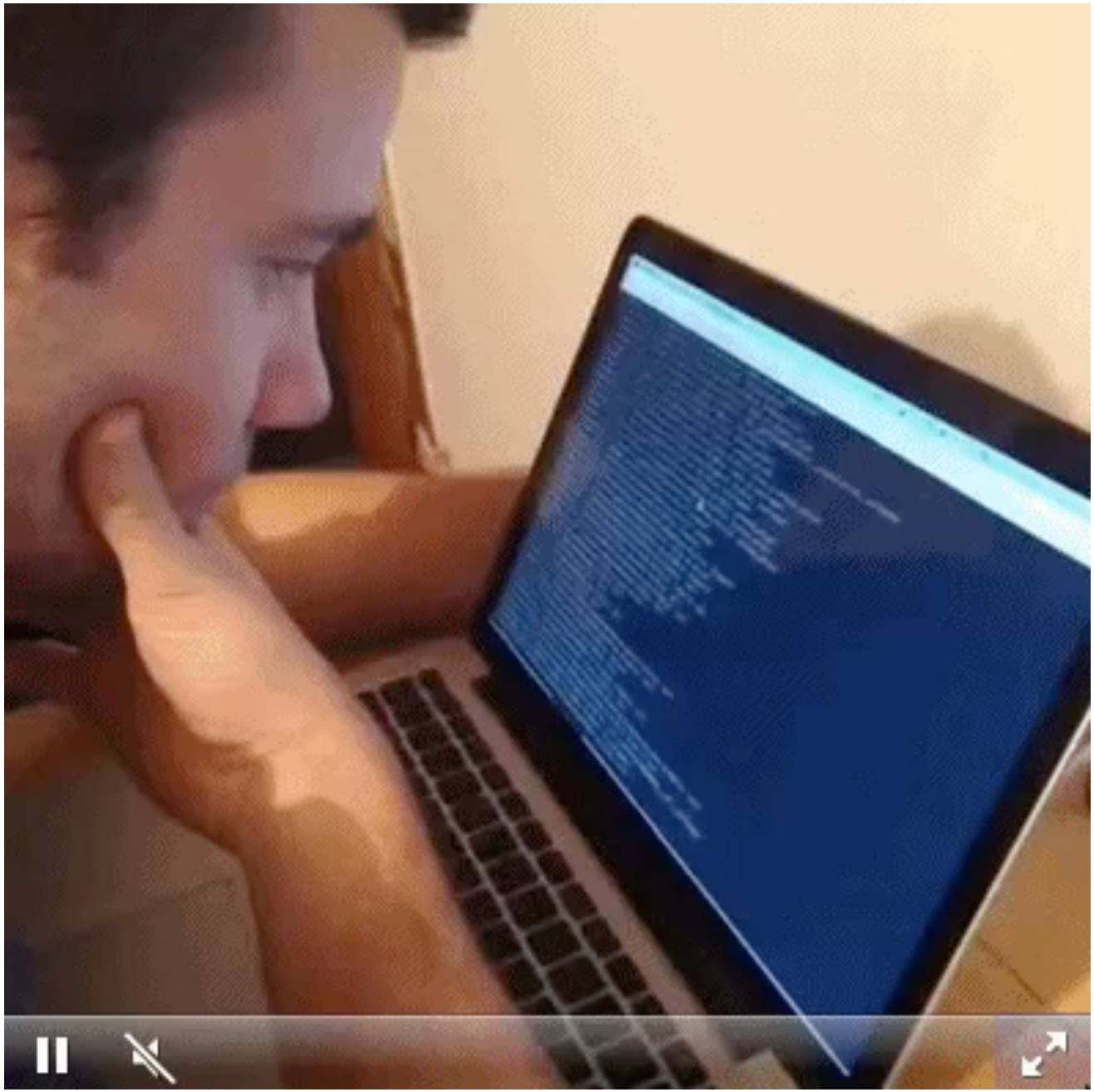
- Data Collection
  - ◊ Observation
    - real work (30 minute session)
    - use same tools and techniques?
    - artificial tasks
  - ◊ Automated logging of tool use

WESS '97 Paper

- Data Interpretation
  - ◊ Small group of engineers
    - statistical sample?
    - defined process
    - domain specific (complex real-time software)
  - ◊ larger and more diverse groups?

WESS '97 Paper

- Observations
  - ◊ Most used tools - editors
  - ◊ Second most used tools - searching tools
  - ◊ Explore software as much as edit software
  - ◊ Wish list - analysis tools
    - statistical sample?



WESS '97 Paper

- Positive Features of Tools
  - ◊ Ease of use
  - ◊ Useful tools
  - ◊ speed of tools

- Generic positive NF requirements

WESS '97 Paper

- Negative Features of Tools
  - ◊ lack of integration
    - don't want to manually transfer data between tools
  - ◊ wrong mix of features
- Difficulty introducing new tools
  - ◊ resistance to new tools
  - ◊ significant effort to learn new tool
    - will it be worth it?
  - ◊ train a single individual to act as consultant within user group

WESS '97 Paper

- Future Studies
  - ◊ collaboration between researchers (spread effort and cost)
  - ◊ questionnaires and logging tools in more companies (contacts)
  - ◊ observe different engineers in different environments using same tools
  - ◊ interviews with different groups of SEs
- Issues
  - ◊ Same questionnaires and interview protocols
  - ◊ similar methodologies - training/experience/ presentation

CASCON '97 Paper

- Same Research, more Depth
  - ◊ identifies some problems with traditional ESP approaches
  - ◊ understanding how programmers solve problems does not necessarily lead to better tools
- Usability vs Useful
  - ◊ Usability - clarity of interface
  - ◊ done in an artificial environment
    - isolated from other factors
    - user forced to use tool
  - ◊ does not guarantee that the software is useable
    - would he use the software

CASCON '97 Paper

- Telecommunications company
  - ◊ several million lines of code (16k funcs, 8k files)
  - ◊ well defined process
- Survey
  - ◊ Reading Documentation tops the list
  - ◊ look at source
  - ◊ design near bottom of list
  - ◊ 57% of time fixing bugs, 35% of time making enhancements
    - differs from published norms, survey effect or difference in business?
  - ◊ Validity of surveys?

CASCON '97 Paper

- Individual Study
  - ◊ new employee (experienced)
  - ◊ weekly meetings at start
  - ◊ 3 weeks apart later
  - ◊ mental model of system
  - ◊ tasks, "new" information
  - ◊ shadow user, record activities
    - observer effect?
  - ◊ search is most frequent activity

CASCON '97 Paper

- Group Study
  - ◊ mental model of system
  - ◊ interviews
  - ◊ shadow user, record activities
  - ◊ looking at source, searching is most frequent activities
  - ◊ reading docs low on list (although high on survey)

CASCON '97 Paper

- Company Study
  - ◊ company uses custom tools
  - ◊ tool group collects statistics on tool usage (tools log their usage)
  - ◊ compiles - 41% most often
    - nightly builds
    - testing groups
    - excluded
  - ◊ search most frequent activity
  - ◊ editors low - why?

CASCON '97 Paper

- Results
  - ◊ search seems to be where SEs spend most of their time
  - ◊ improving search seems to present the greatest opportunity for support
- Just In Time Comprehension
  - ◊ system too large to comprehend
    - general understanding
    - task determines what is comprehended
    - ignore rest of problem

CASCON '97 Paper

- Tool Functional Requirements
  - ◊ search for semantic entities in source code
  - ◊ display results of search and relationships
  - ◊ searches are repeated (history)
- Non-functional requirements
  - ◊ system size
  - ◊ performance
  - ◊ more than one language
  - ◊ interoperability
  - ◊ independent interfaces (research)
  - ◊ support JIC

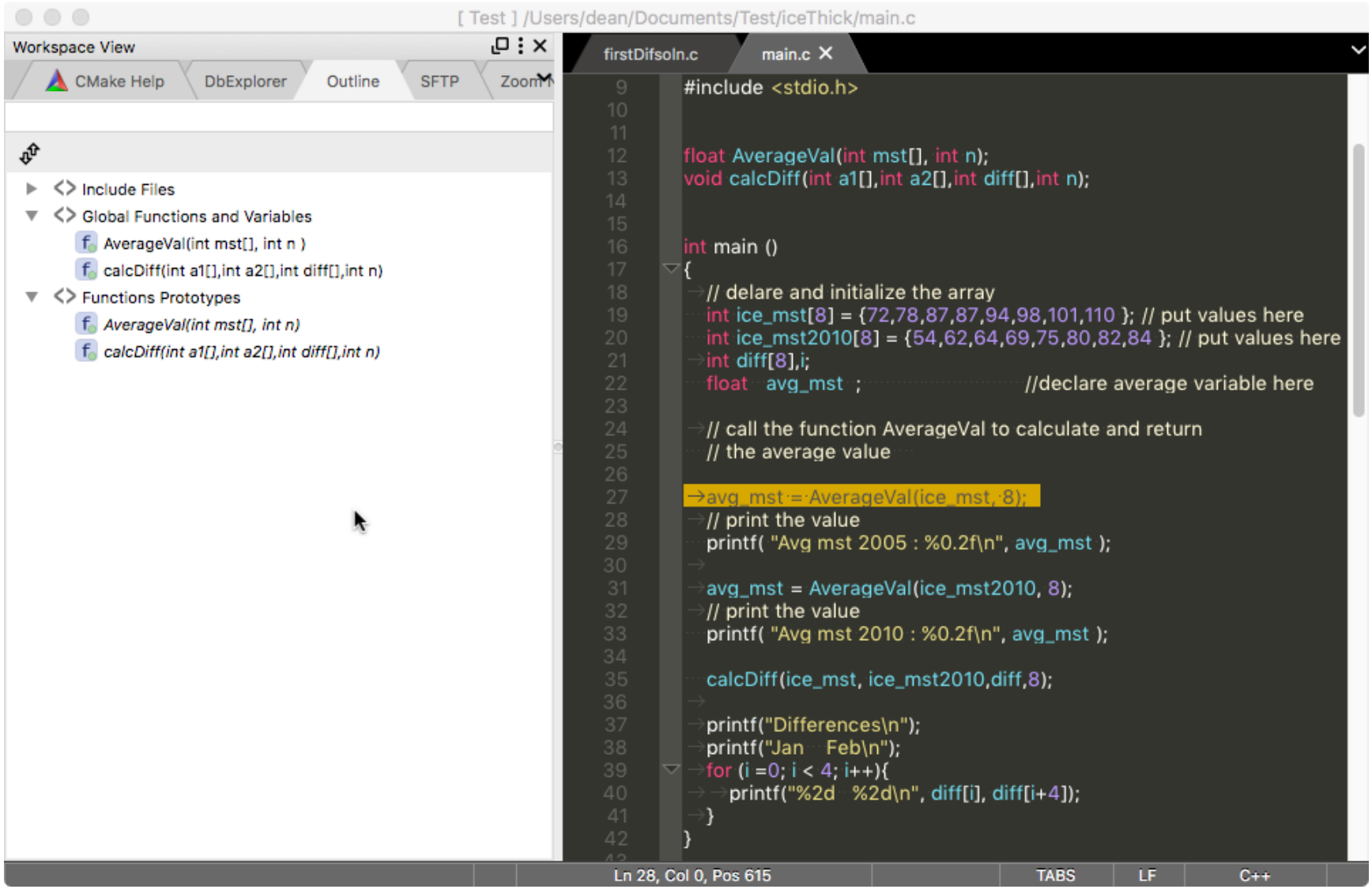
CASCON '97 Paper

- Problems with Existing Tools
  - ◊ grep
    - no syntax or semantics
    - does not understand relationships
    - time
  - ◊ editor searches
    - no semantics
  - ◊ IDEs
    - more semantics, limited languages
    - eclipse?
  - ◊ analysis tools
    - integration?

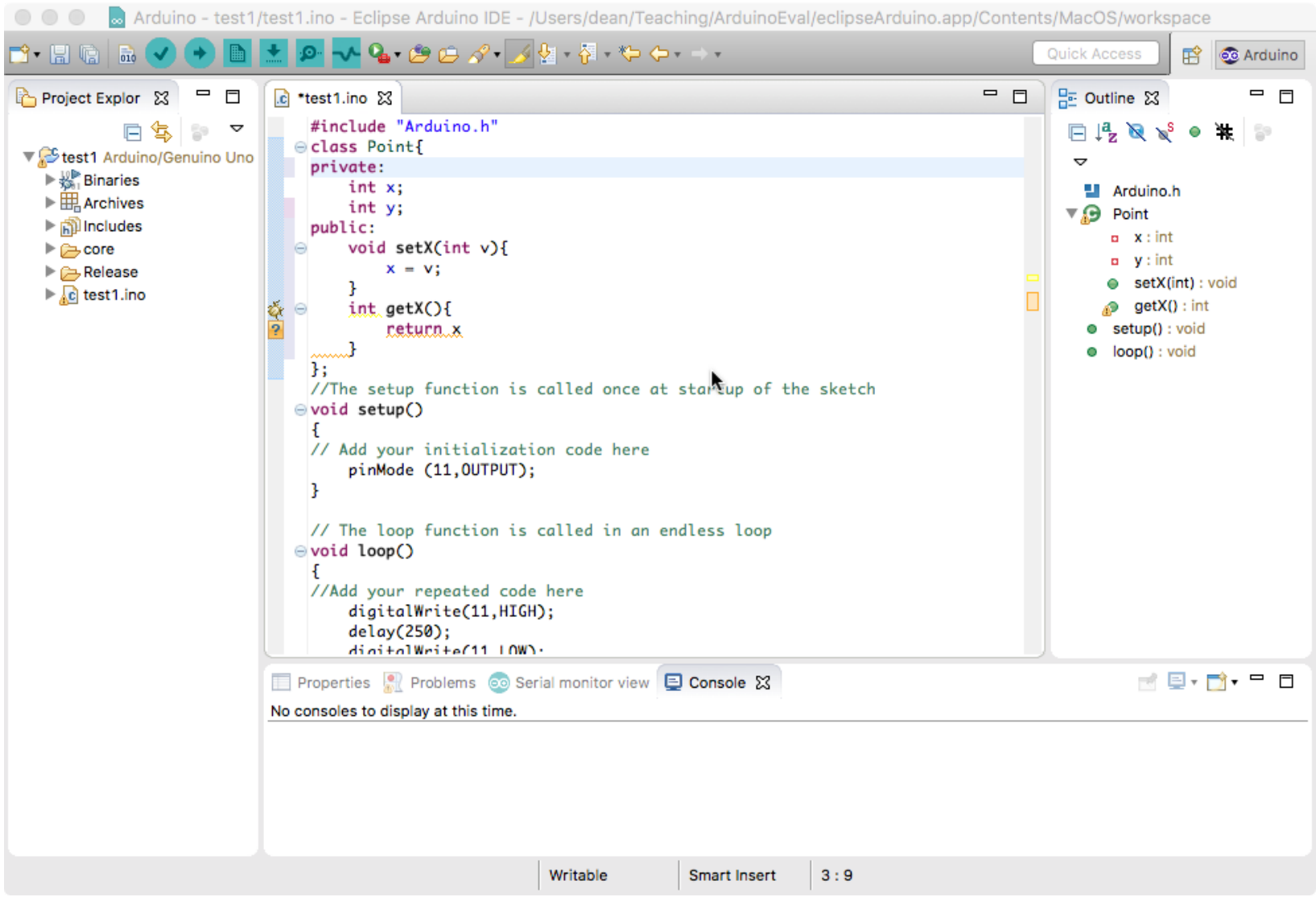
IDE

```
grep -i parse *.h *.cpp *.c


igmp.cpp:bool parseV2Report(PDU * thePDU, HeaderInfo * header, char *name) {
igmp.cpp:    tmp->parseType = V2REPORT;

pmain.cpp:       //parse the first (ethernet) header, grabbing the type field
pmain.cpp:       //parse the IP header
pmain.cpp:           parsedPDU = parseIGMPPacket(thePDU, header, argv[1]);

pmain.cpp:   fprintf(stdout, "\nPackets Parsed: %llu\nPackets Failed: %llu\nTotal
Packets: %llu\nFailure rate: %0.2f%%\n", count-failed, failed, count, ((float)failed/
count) * 100);
```

IDE - CodeLite



IDE - Eclipse


Arduino - test1/test1.ino - Eclipse Arduino IDE - /Users/dean/Teaching/ArduinoEval/eclipseArduino.app/Contents/MacOS/workspace
Quick Access
Arduino
Project Explor
test1 Arduino/Genuino Uno
Binaries
Archives
Includes
core
Release
test1.ino
*test1.ino
#include "Arduino.h"
class Point{
private:
int x;
int y;
public:
void setX(int v){
x = v;
}
int getX(){
return x
}
};
//The setup function is called once at startup of the sketch
void setup()
{
// Add your initialization code here
pinMode (11,OUTPUT);
}
// The loop function is called in an endless loop
void loop()
{
//Add your repeated code here
digitalWrite(11,HIGH);
delay(250);
Outline
Arduino.h
Point
x : int
y : int
setX(int) : void
getX() : int
setup() : void
loop() : void
Properties
Problems
Serial monitor view
Console
No consoles to display at this time.
Writable
Smart Insert
3 : 9

CASCON '97 Paper

- Problems with Existing Tools
  - ◊ commercial browsing tools
    - sometimes no multiple languages (e.g. JNI)
      - some do support this
    - often limited integration
  - ◊ academic
    - problems with integration, speed, automation