Chapter 3

Static Testing

1 Principles	2 Lifecycle	3 Static testing
4 Dynamic test techniques	5 Management	6 Tools

Contents

- Reviews and the test process
- Types of review
- Static analysis

People techniques

- individual:
  - desk-checking, data-stepping, proof-reading
- group:
  - Reviews (informal & formal): for consensus
  - Walkthrough: for education
  - Inspection (most formal): to find faults

Static techniques do not execute code

Benefits of reviews

- Development productivity improvement
- Reduced development timescales
- Reduced testing time and cost
- Lifetime cost reductions
- Reduced fault levels
- Improved customer relations

What can be Inspected?

Anything written down can be Inspected

- policy, strategy, business plans, marketing or advertising material, contracts
- system requirements, feasibility studies, acceptance test plans
- test plans, test designs, test cases, test results

- system designs, logical & physical
- software code
- user manuals, procedures, training material

What can be reviewed?

- anything which could be Inspected
  - i.e. anything written down
- plans, visions, “big picture”, strategic directions, ideas
- project progress
  - work completed to schedule, etc.
- “Should we develop this” marketing options

Costs of reviews

- Rough guide: 5%-15% of development effort
  - half day a week is 10%
- Effort required for reviews
  - planning (by leader / moderator)
  - preparation / self-study checking
  - meeting
  - fixing / editing / follow-up
  - recording & analysis of statistics / metrics
  - process improvement (should!)

Contents

Reviews and the test process

Types of review

Static analysis

Types of review of documents

Informal Review

undocumented

- widely viewed as useful and cheap (but no one can prove it!) A helpful first step for chaotic organisations.

Technical Review: (or peer review)

- includes peer and technical experts, no management participation. Normally documented, fault-finding. Can be rather subjective.

Decision-making Review:

- group discusses document and makes a decision about the content, e.g. how something should be done, go or no-go decision, or technical comments

Types of review of documents

Walkthrough

- author guides the group through a document and his or her thought processes, so all understand the same thing, consensus on changes to make

Inspection:

- formal individual and group checking, using sources and standards, according to generic and specific rules and checklists, using entry and exit criteria, Leader must be trained & certified, metrics required

Reviews in general 1

- Objectives / goals
  - validation & verification against specifications & standards
  - achieve consensus (excluding Inspection)
  - process improvement (ideal, included in Inspection)

Reviews in general 2

- Activities
  - planning
  - overview / kick-off meeting (Inspection)
  - preparation / individual checking
  - review meeting (not always)
  - follow-up (for some types)
  - metrics recording & analysis (Inspections and sometimes reviews)

Reviews in general 3

- Roles and responsibilities
  - Leader / moderator - plans the review / Inspection, chooses participants, helps & encourages, conducts the meeting, performs follow-up, manages metrics
  - Author of the document being reviewed / Inspected

- Reviewers / Inspectors - specialised fault-finding roles for Inspection
- Managers - excluded from some types of review, need to plan project time for review / Inspection
- Others: e.g. Inspection/ review Co-ordinator

Reviews in general 4

- Deliverables
  - Changes (edits) in review product
  - Change requests for source documents (predecessor documents to product being reviewed / Inspected)
  - Process improvement suggestions
    - to the review / Inspection process
    - to the development process which produced the product just reviewed / Inspected
  - Metrics (Inspection and some types of review)

Reviews in general 5

- Pitfalls (they don’t always work!)
  - lack of training in the technique (especially Inspection, the most formal)
  - lack of or quality of documentation - what is being reviewed / Inspected

- Lack of management support - “lip service” - want them done, but don’t allow time for them to happen in project schedules
- Failure to improve processes (gets disheartening just getting better at finding the same thing over again)

Inspection is different

- the document to be reviewed is given out in advance
- typically dozens of pages to review
- instructions are "please review this"

- ***not just product, sources***
- ***chunk or sample***
- ***training, roles***

Inspection is different

- some people have time to look through it and make comments before the meeting (which is difficult to arrange)
- the meeting often lasts for hours

- ***entry criteria to meeting, may not be worth holding***
- ***2 max., often much shorter***

Inspection is different

- "I don't like this"
- much discussion, some about technical approaches, some about trivia
- don't really know if it was worthwhile, but we keep doing it

- ***Rule violations, objective, not subjective***
- ***no discussion, highly focused, anti-trivia***
- ***only do it if value is proven (continually)***

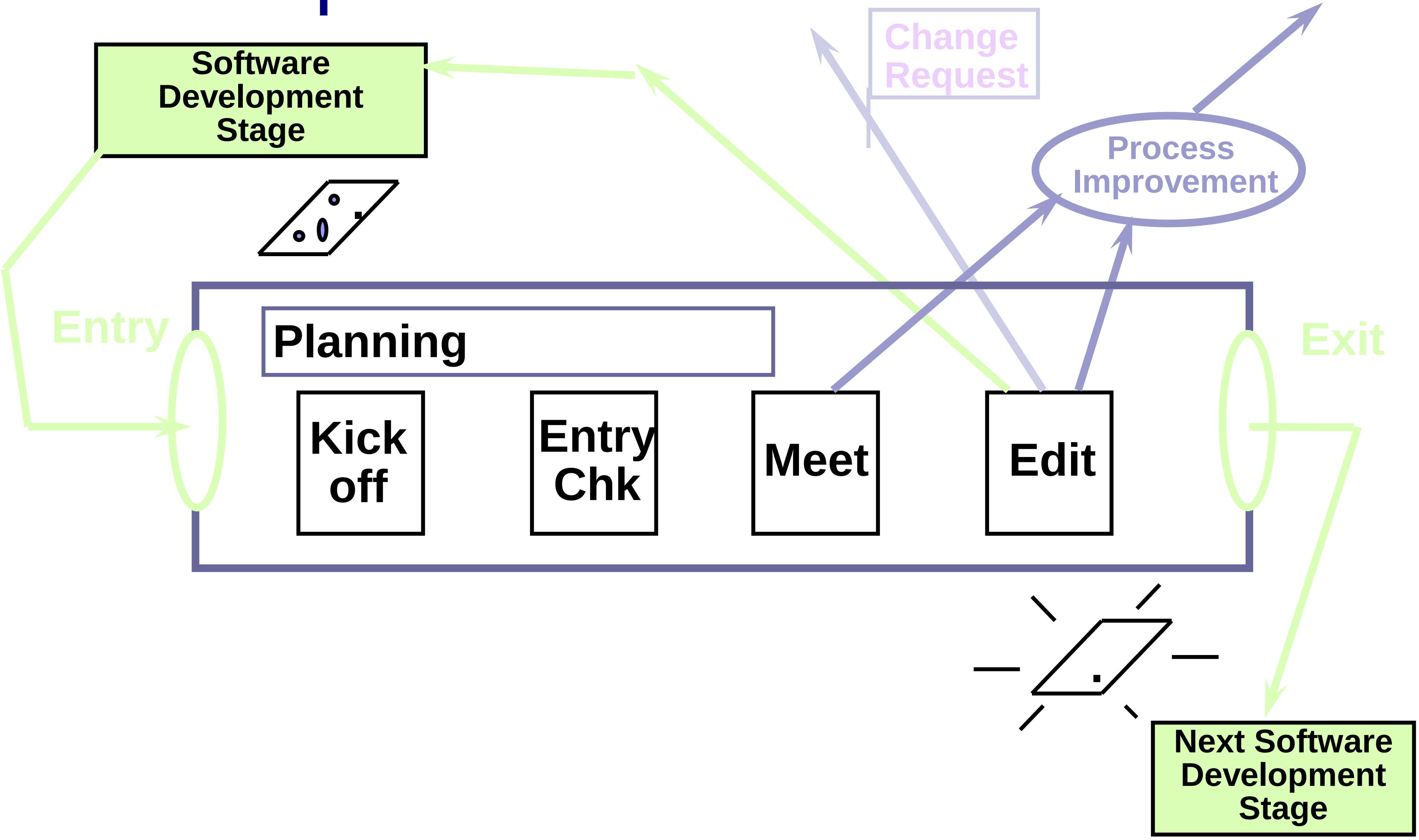
Inspection is more and better

- entry criteria
- training
- optimum checking rate
- prioritising the words
- standards

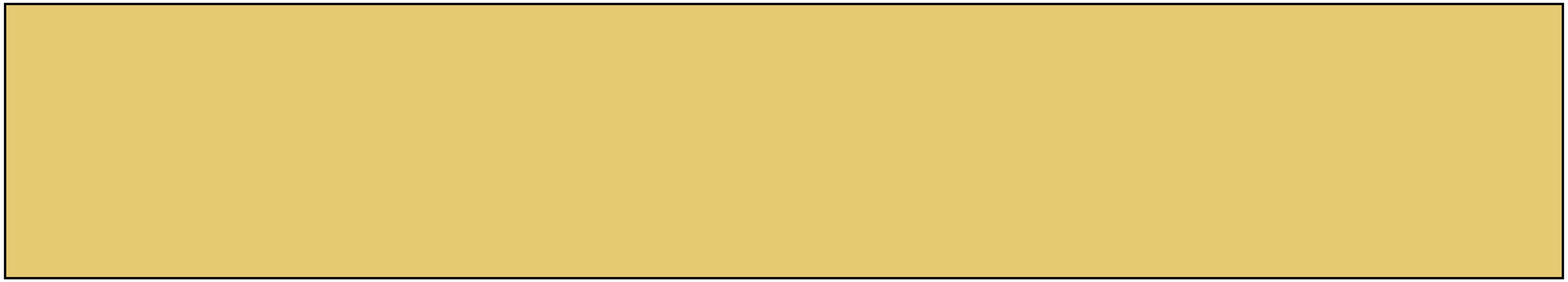
- process improvement
- exit criteria
- quantified estimates of remaining major faults per page

	effectiveness	return on investment
typical review	10 - 20%	unknown
early Inspection	30 - 40%	6 - 8 hrs / Insp hr
mature Inspection	80 - 95%	8 - 30 hrs / Insp hr

The Inspection Process

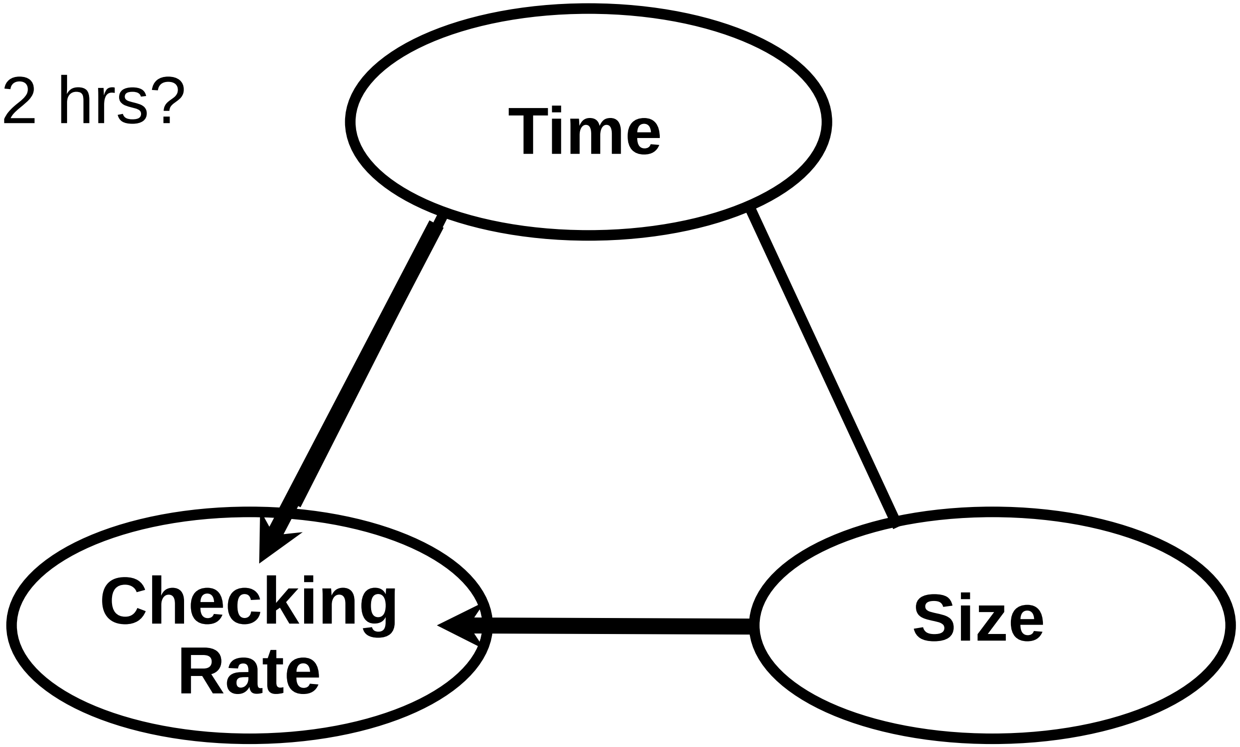


At first glance ..



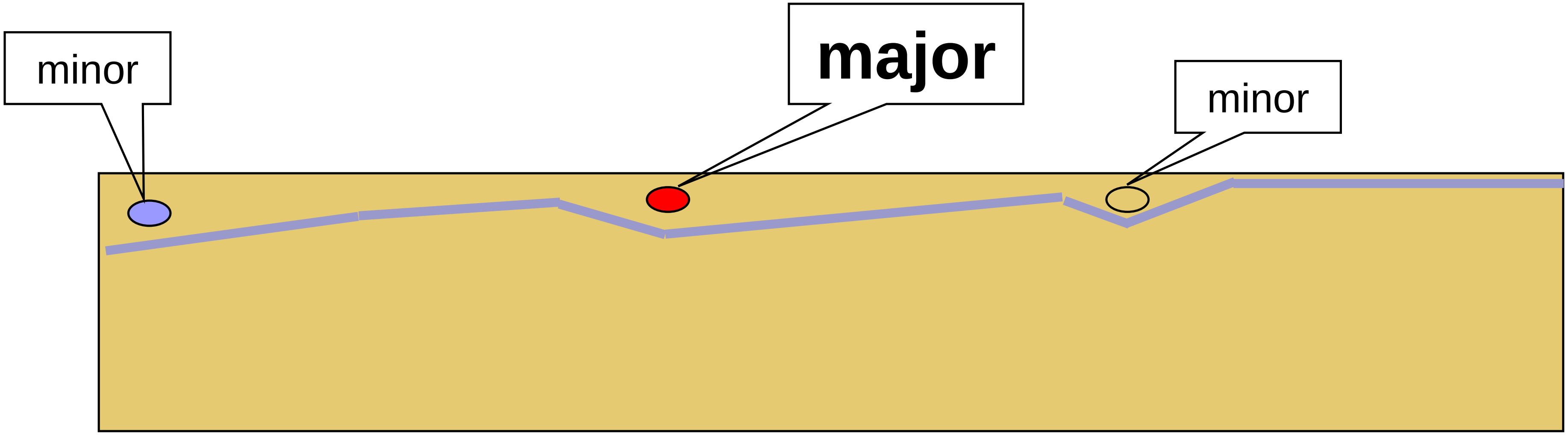
Here’s a document: review this (or Inspect it)

Reviews: time and size determine rate



50 pages per hour

Review “Thoroughness”?

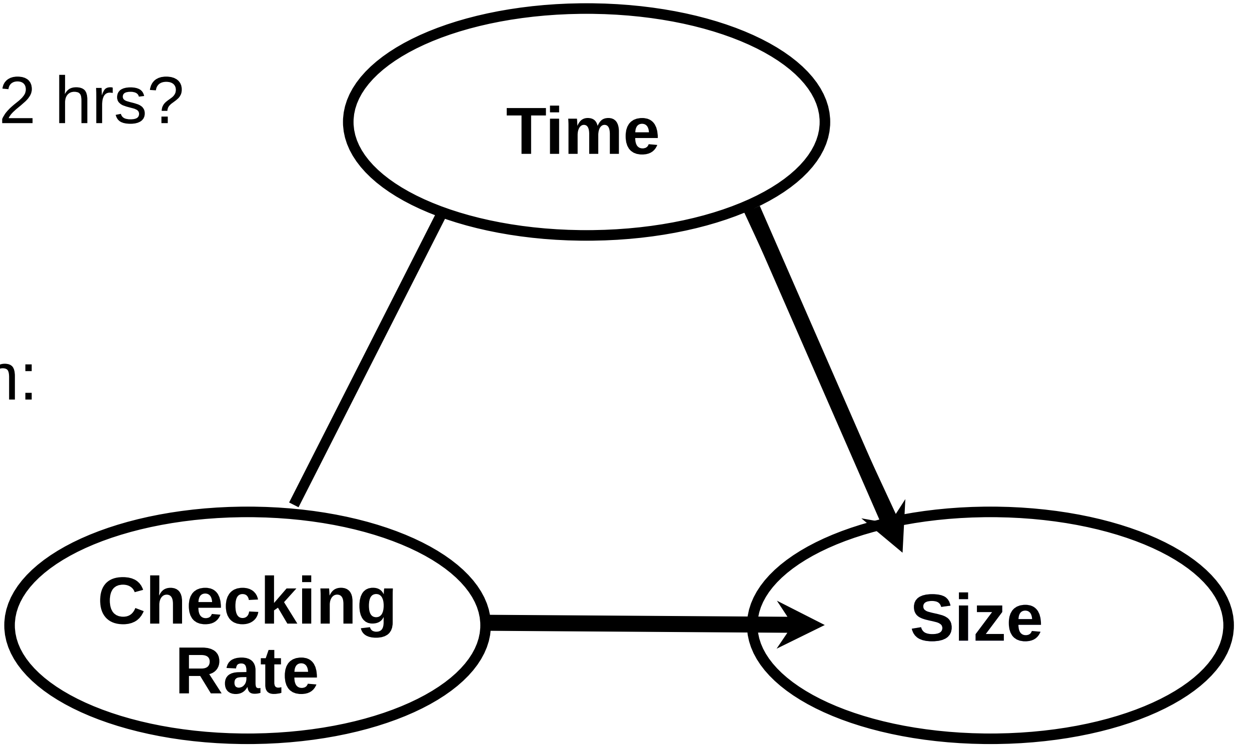


ordinary “review” - finds some faults, one major, fix them, consider the document now corrected and OK

Inspection: time and rate determine size

2 hrs?

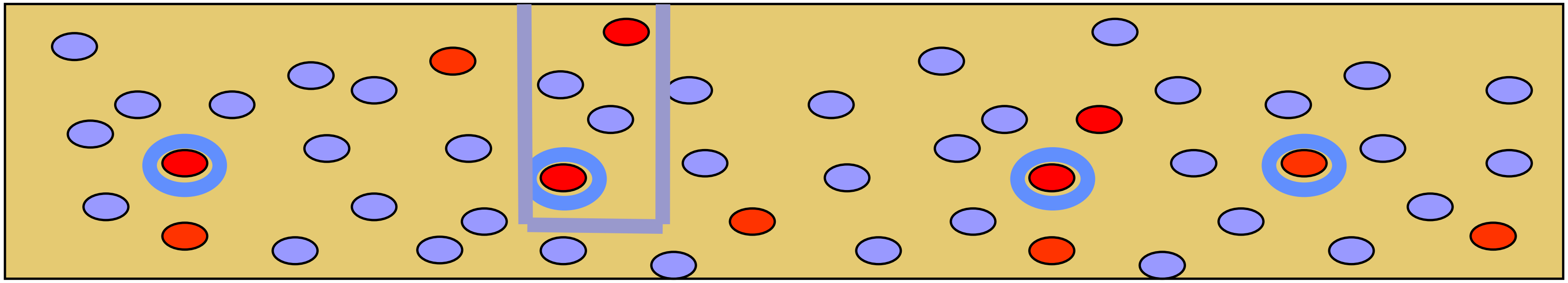
Optimum:
1 page*
per hour



2 pages (at optimum rate)

* 1 page = 300 important words

Inspection Thoroughness



Inspection can find deep-seated faults:

- all of that type can be corrected
- but needs optimum checking rate

Inspection surprises

- Fundamental importance of Rules
  - democratically agreed as applying
  - define major issues / faults
- Slow checking rates
- Strict entry & exit criteria
- Fast logging rates
- Amount of responsibility given to author

Contents

- Reviews and the test process
- Types of review
- Static analysis

What can static analysis do?

Remember: static techniques do not execute the code

- A form of automated testing
  - check for violations of standards
  - check for things which may be a fault

- Descended from compiler technology
  - a compiler statically analyses code, and “knows” a lot about it, e.g. variable usage; finds syntax faults
  - static analysis tools extend this knowledge
  - can find unreachable code, undeclared variables, parameter type mis-matches, uncalled functions & procedures, array bound violations, etc.

Data flow analysis

- This is the study of program variables
  - variable defined* where a value is stored into it
  - variable used where the stored value is accessed
  - variable is undefined before it is defined or when it goes out of scope

x is defined, y and z are used

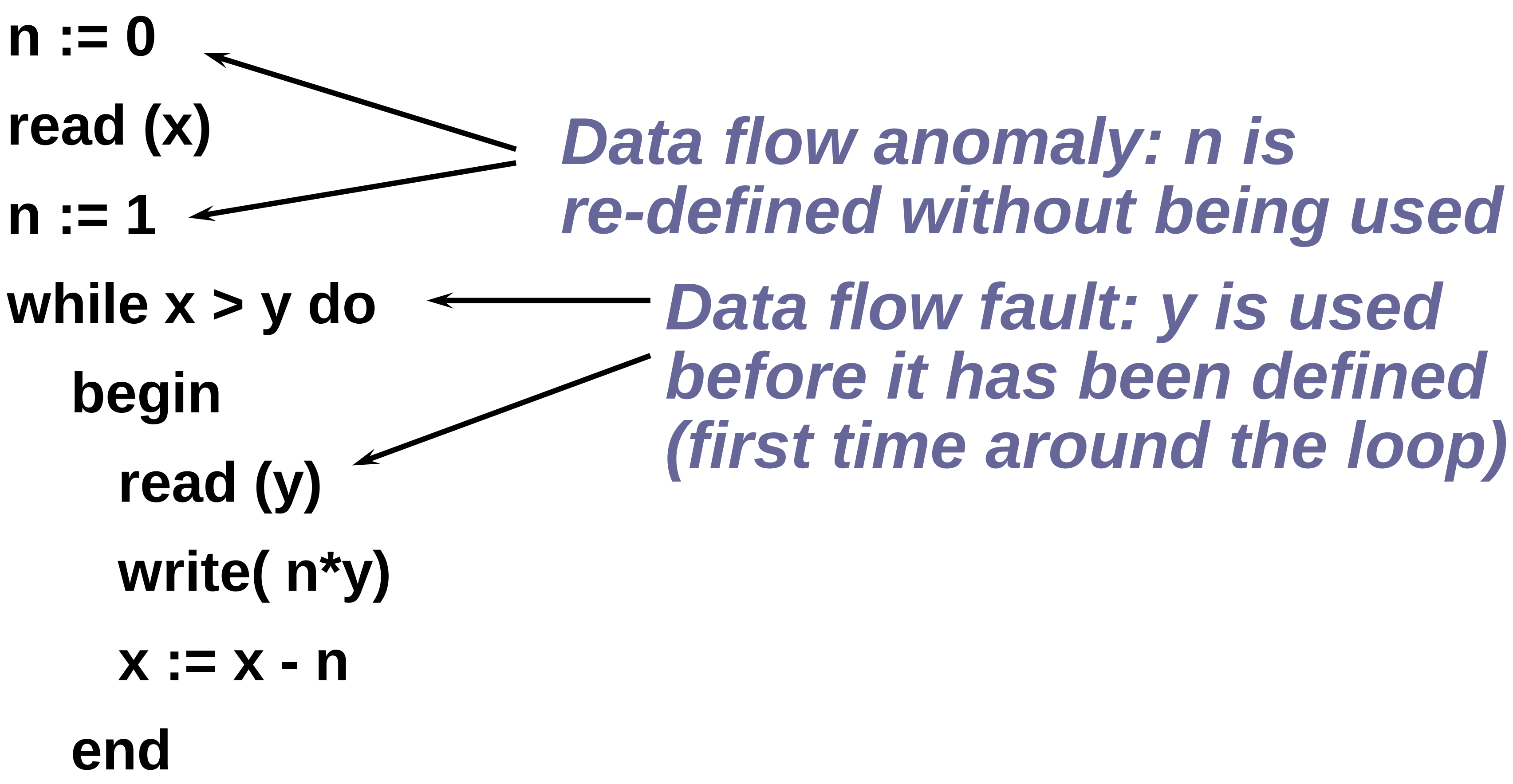
```
x = y + z

IF a > b THEN read(S)
```

a and b are used, S is defined

defined should not be confused with declared

Data flow analysis faults



```
n := 0
read (x)
n := 1
while x > y do
    begin
      read (y)
      write( n*y)
      x := x - n
    end
```

Data flow anomaly: n is re-defined without being used

Data flow fault: y is used before it has been defined (first time around the loop)

Control flow analysis

- Highlights:
  - nodes not accessible from start node
  - infinite loops
  - multiple entry to loops
  - whether code is well structured, i.e. reducible
  - whether code conforms to a flowchart grammar
  - any jumps to undefined labels
  - any labels not jumped to
  - cyclomatic complexity and other metrics

Unreachable code example

- Macro definitions
  (different for different platforms the code runs on)

```
Buffsize: 1000
Mailboxmax: 1000
IF Buffsize < Mailboxmax THEN
        Error-Exit
ENDIF
```

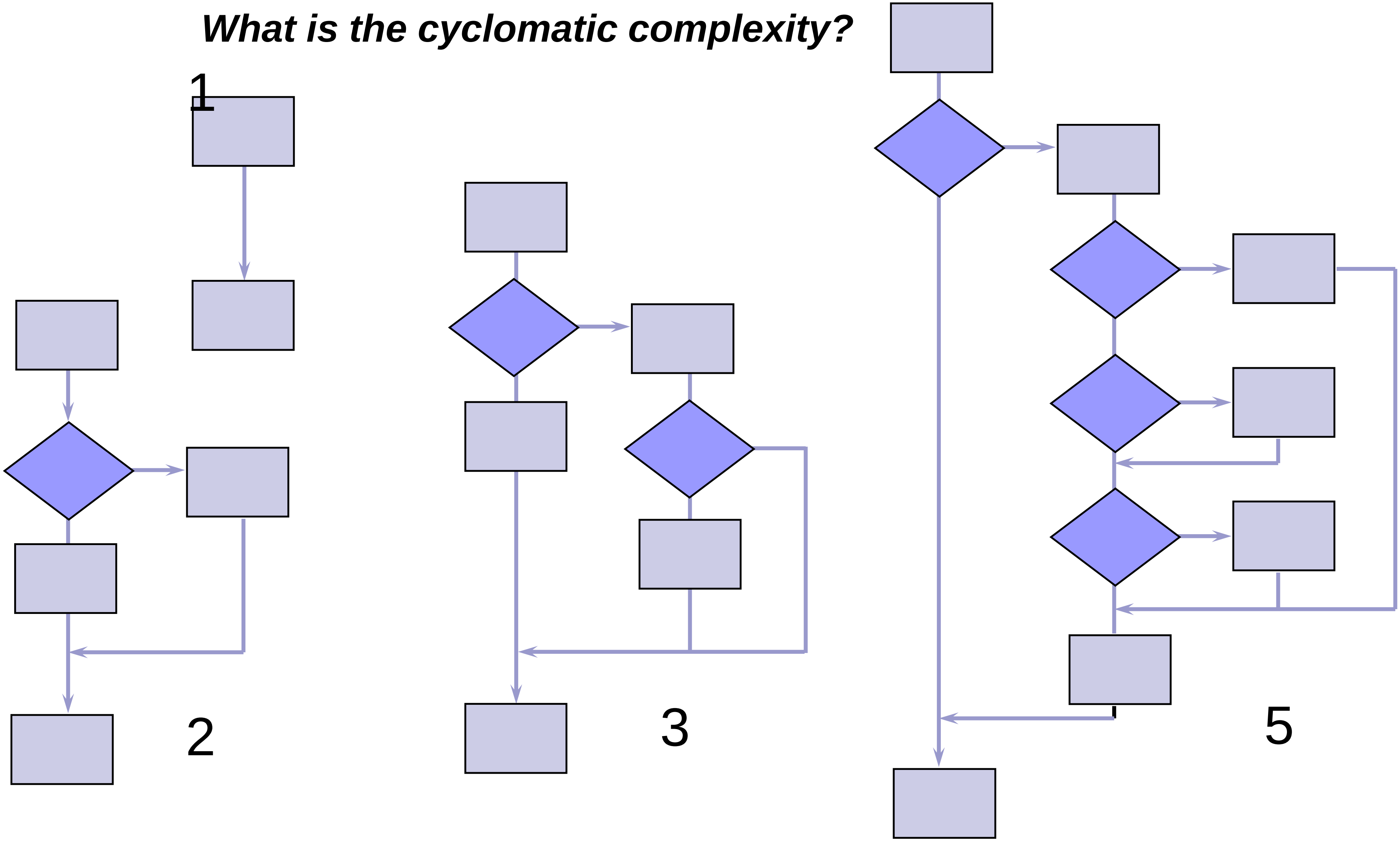
- Static Analysis finds the THEN clause unreachable, so will flag a fault

Cyclomatic complexity

- cyclomatic complexity is a measure of the complexity of a flow graph
  - (and therefore the code that the flow graph represents)
- the more complex the flow graph, the greater the measure
- it can most easily be calculated as:
  - complexity = number of decisions + 1

Which flow graph is most complex?

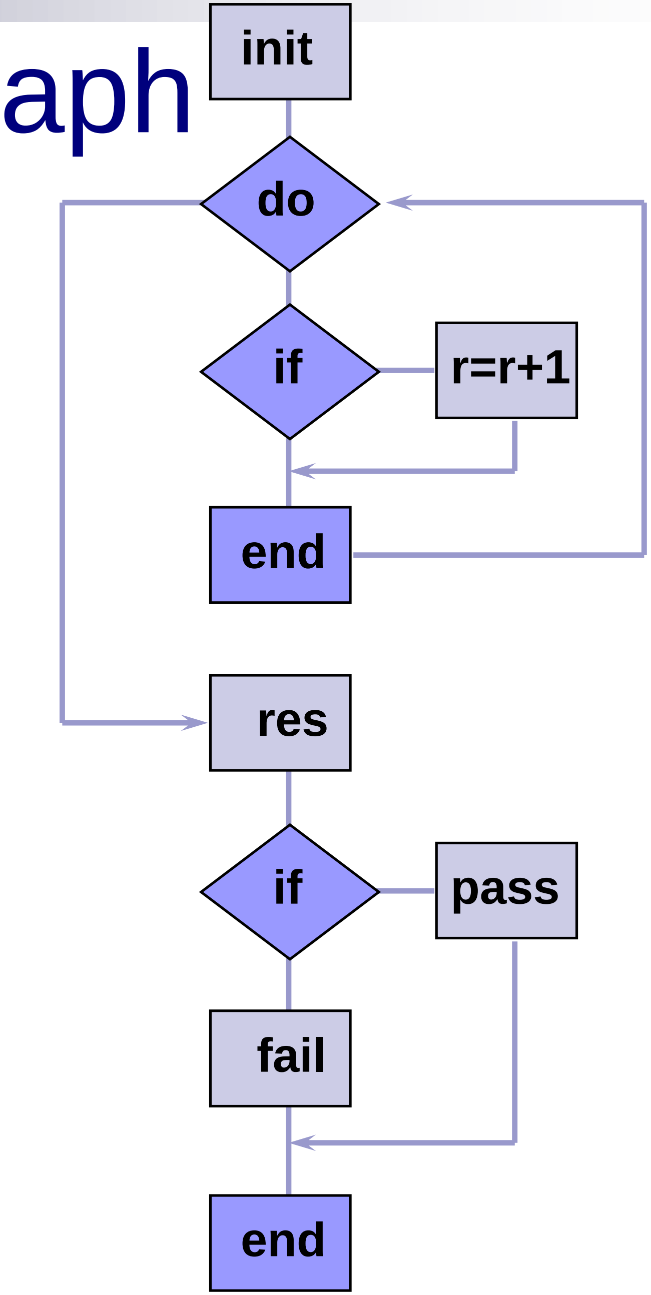
What is the cyclomatic complexity?



Example control flow graph

Pseudo-code:

```
Result = 0
Right = 0
DO WHILE more Questions
    IF Answer = Correct THEN
        Right = Right + 1
    ENDIF
END DO
Result = (Right / Questions)
IF Result > 60% THEN
   Print "pass"
ELSE
   Print "fail”
ENDIF
```



Other static metrics

- lines of code (LOC)
- operands & operators (Halstead’s metrics)
- nesting levels
- function calls

Limitations and advantages

- Limitations:
  - cannot distinguish "fail-safe" code from programming faults or anomalies (often creates overload of spurious error messages)
  - does not execute the code, so not related to operating conditions
- Advantages:
  - can find faults difficult to "see"
  - gives objective quality assessment of code

Summary: Key Points

- Reviews help to find faults in development and test documentation, and should be applied early
- Types of review: informal, walkthrough, technical / peer review, Inspection
- Static analysis can find faults and give information about code without executing it