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FOUNDATIONS OF SOFTWARE ENGINEERING

Methodologies & FAQ

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Coming up today....

- Frequently asked questions
- Emergence in software engineering
  - coping with the development of complex systems
- Methodology roundup & process models
  - common practices in software engineering

Jargon buster!

- Software, software engineering (not computer science)
- Software process, software process model
- Methodology, agile, emergence, iteration, prototype

What is "software"

- Easy - not hardware! :-) not quite that trivial
- *Computer programs and associated documentation such as requirements, design models and user manuals developed for a particular market*
- New software can be created by developing new programs, configuring generic software systems or reusing existing software.

Thus, software engineering is...

- Software engineering is an engineering discipline that is concerned with all aspects of software production.
- *"Software engineers should adopt a systematic and organised approach to their work and use appropriate tools and techniques depending on the problem to be solved, the development constraints and the resources available"*

Spot the difference

- Computer science is concerned with theory and fundamentals
  - concerned with the practicalities of developing and delivering useful software.
- Computer science theories are still insufficient to act as a complete underpinning for software engineering (unlike e.g. physics and electrical engineering) because of *users* and complexity

What is a software process

- A set of activities whose goal is the development or evolution of software.
- Generic activities in all software processes are:
  - **Specification** - what the system should do and its development constraints
  - **Development** - production of the software system
  - **Validation** - checking that the software is what the customer wants
  - **Evolution** - changing code in response to demands

A software process model (SPM)

- A simplified representation of a software process
  - Workflow perspective - sequence of activities;
  - Data-flow perspective - information flow;
  - Role/action perspective - who does what.

- Generic process models e.g.:
  - Waterfall;
  - Iterative development;
  - Component-based software engineering.

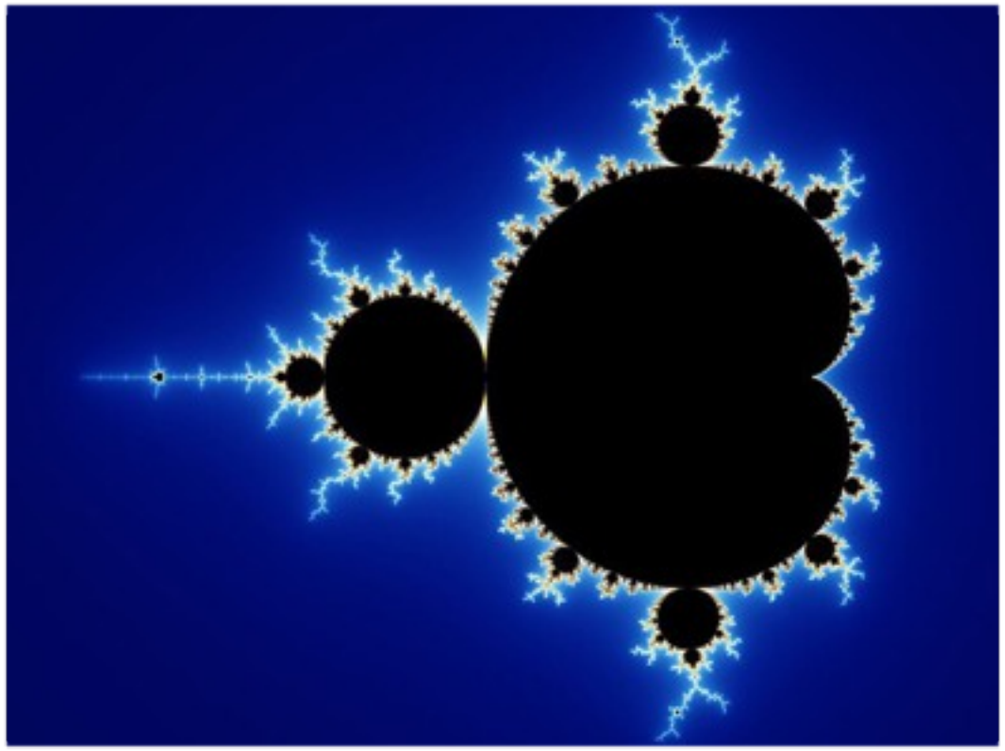
How much is the practical cost?

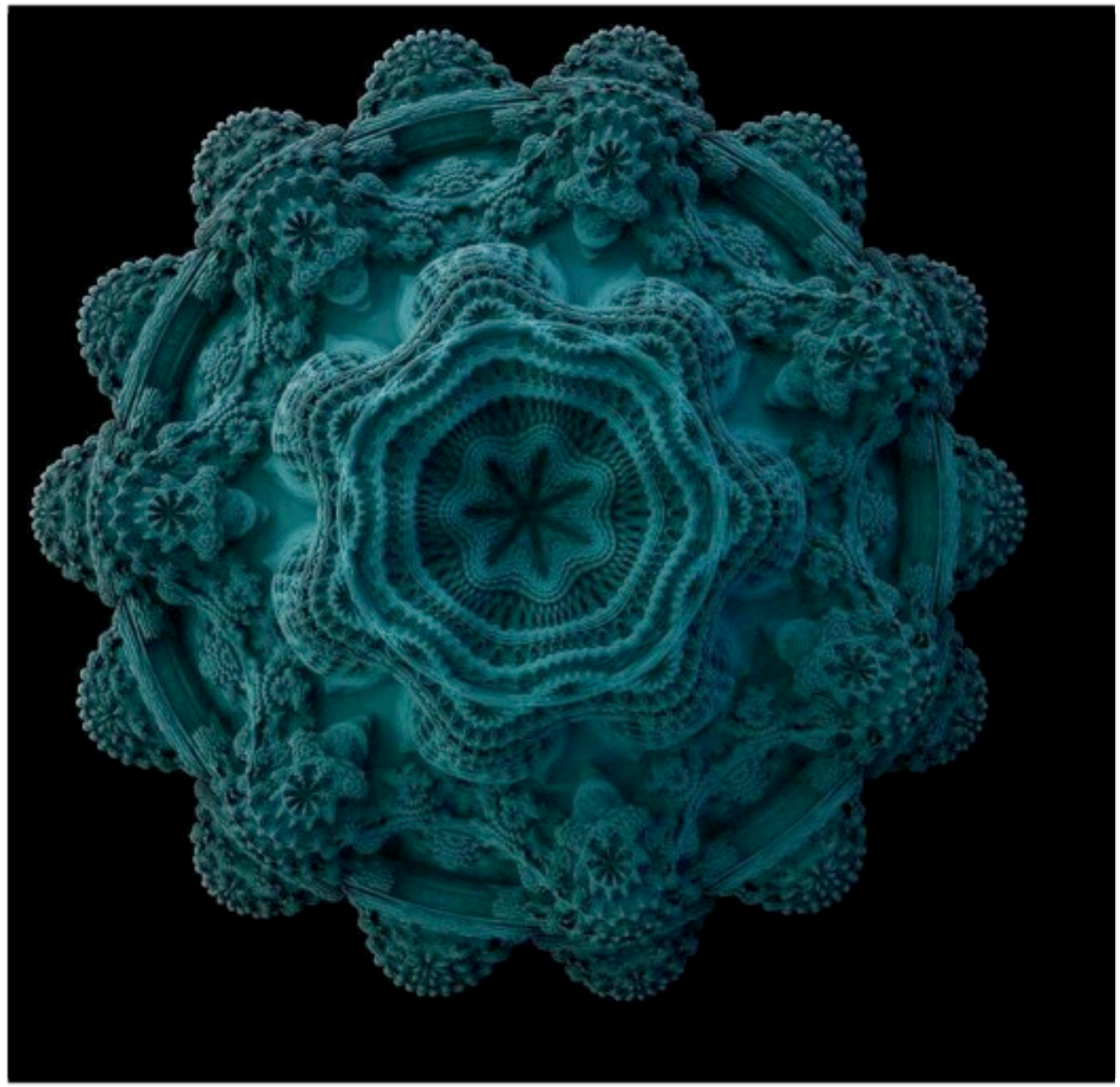
- ...it depends!
- Roughly 60% of costs are development costs, 40% are testing costs
  - for custom software, evolution costs often exceed development costs.
- Costs vary depending on the type of system being developed and the requirements of system attributes such as performance and system reliability.
- Distribution of costs depends on the development model that is used.

What makes good software?

- The software should deliver the required functionality and performance to the user:
  - Maintainability: software must evolve to meet changing needs
  - Dependability: software must be *trustworthy*
  - Efficiency: software should not make wasteful use of system resources
  - Acceptability: software must accepted by its users and be understandable, usable and compatible with related systems

Emergence!





The most fundamental thing

- Software engineering is the process of creating and deploying a system with a specified usage
- A system is a collection of interrelated components, working together to achieve a goal
- Components interact with each other to form the overall system behaviour
- You cannot always predict the behaviour of a system!

An unpredictable system

- Meet my cat, Taz
- A collection of components in the form of cells, molecules & organs
- Can predict some of his behaviour...but not always!

Types of system

- A system can be either purely technical or socio-technical
- Technical systems:
  - a system which operates without human input
- Socio-technical systems
  - involve the intervention of users
- *Can you think of examples of each?*

Socio-technical system features

- They have emergent properties
  - properties of the system of a whole that depend on the system components and their relationships.
- They are non-deterministic
- They are interlinked with institutional aims
- The extent to which the system supports the aims is dependent on both the system itself and its users

Constant battle with emergence

- Properties of the system as a whole rather than properties that can be derived from the properties of components of a system
- They can only be assessed and measured once the components have been integrated into a system
- Components can work together to produce good properties - synergy
- This can turn bad producing unpredictable effects

Systems can be unreliable

- Because of component inter-dependencies, faults can be propagated through the system.
- System failures often occur because of unforeseen inter-relationships between components.
- It is probably impossible to anticipate all possible component relationships.
- Software reliability measures may give a false picture of the system reliability.

How do we get round this?

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Methodology Roundup

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To reinforce...

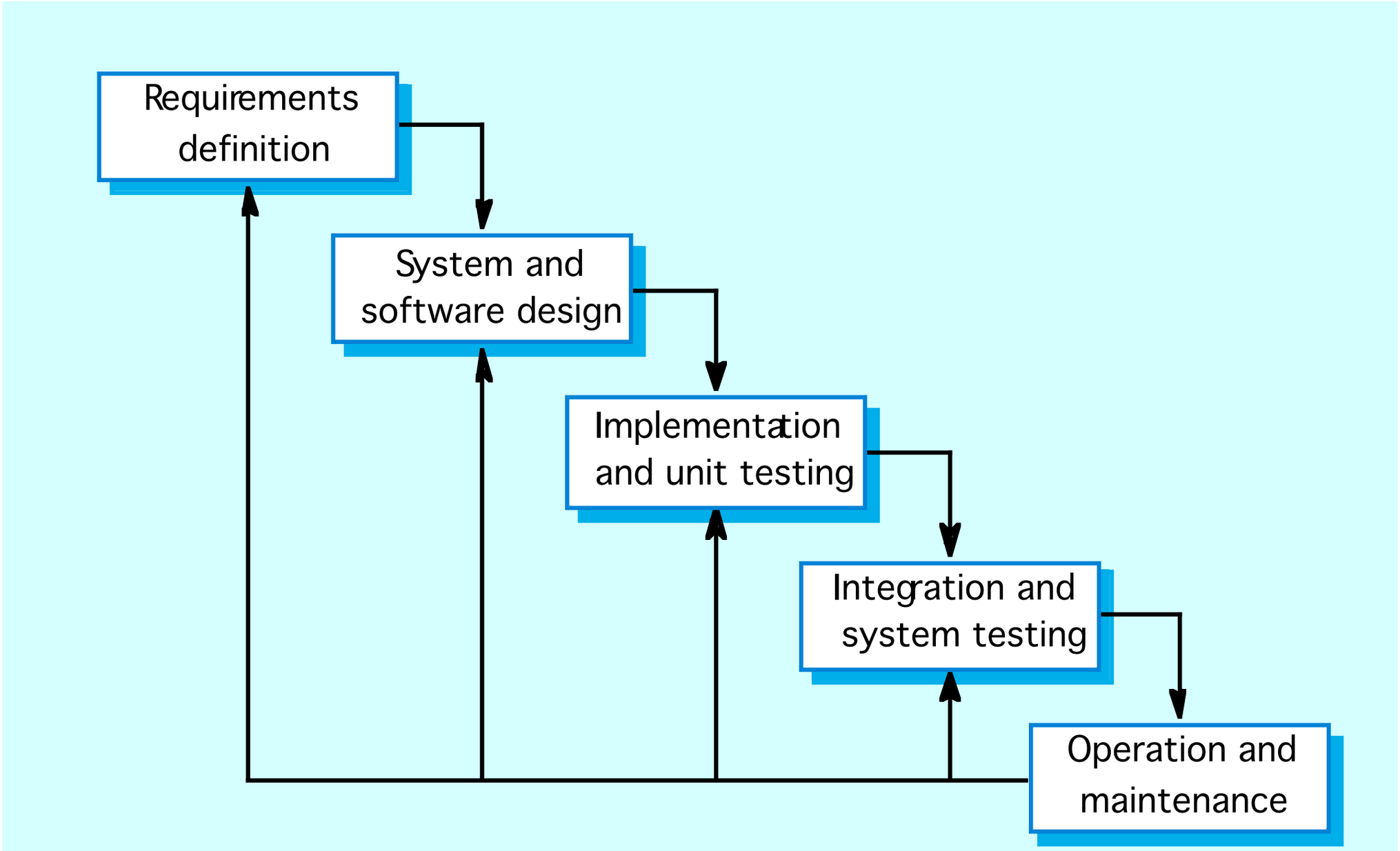
- A methodology is " *a set or system of methods, principles, and rules for regulating a given discipline, as in the arts or sciences*"
- A software engineering methodology is "a set or system of methods, principles, and rules for regulating the process of creating and deploying software
- Techniques which are the methodologies are also called software process models

Generic Software Process Models

- The waterfall model
  - Separate and distinct phases of specification and development.
- Iterative/Evolutionary development
  - Specification, development and validation are interleaved.
- Component-based software engineering
  - Systems assembled from pre-existing components

Waterfall Model

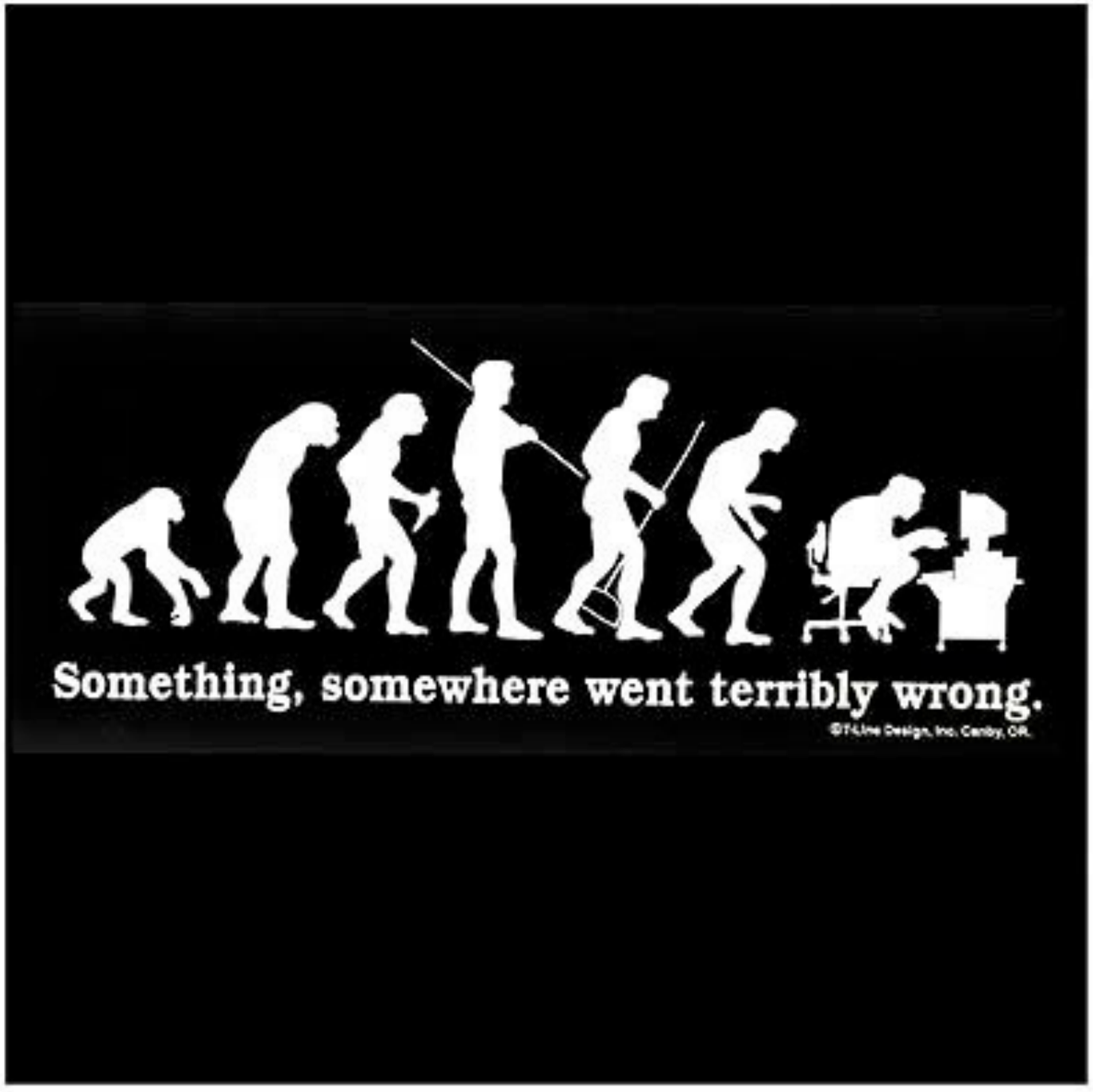
The oldest trick in the book



Many problems!

- Needs stable and "perfect" requirements
  - cant always anticipate what you are going to have to do
- Does not account for revision or refactoring
- Too inflexible and static
- Depends on getting each stage exactly right
  - changes can have untoward knock-on effects

Iterative and Evolutionary



Prototyping approaches

Agile Methods

- A contrast to the waterfall
- A bottom up approach
- Rapid prototyping
- Iterative design
- Based on five principles
- Includes Xtreme Programming

Spiral Model

Criticisms of iterative approaches

- Lack of process visibility
- Systems are often poorly structured
  - too much bottom up and not enough planning
- Special skills (e.g. in languages for rapid prototyping) may be required
- Lightweight documentation taken to mean no documentation

Component-based

- Modular design build on verified existing code
- Linux kernel and UNIX philosophy built on this
- Spend time explicitly testing the interactions between components
- Builds on a platform of previously tested code
- Has more problems akin to the integration stage

And Many More....

- Behaviour Driven Development
- The Boehm-Spiral Methodology
- The Booch Methodology
- Object Modeling Technique (OMT)
- Rational Objectory Methodology
- WinWin Spiral Methodology
- Test Driven Development

Will cover each one of these methods in detail

What we looked at

- Frequently asked questions
- Emergence in software engineering
  - coping with the development of complex systems
- Methodology roundup & process models
  - Waterfall, iterative and component based
- 3D mandelbrot sets and my cat Taz