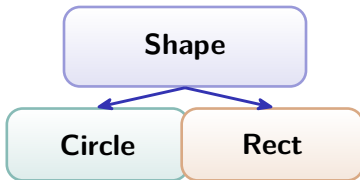


Further Programming

A-Level Computer Science ■ Topic 20

A-Level Computer Science



What we will cover

- 1 Programming paradigms
- 2 Object-oriented pillars
- 3 File processing
- 4 Exception handling
- 5 Recap

1

Paradigms

A paradigm is a style of programming

Four paradigms sit in this syllabus.

low-level

低级

machine code or assembly; registers and addresses; drivers, firmware

imperative

命令式

a sequence of commands that change state – Topics 9 and 11

object-oriented

面向对象

objects bundle data and methods; instances of classes

declarative

声明式

say *what*, not *how* – SQL, Prolog, Haskell

Programming paradigms

Imperative programming 命令式编程 says *how*, **declarative programming** 声明式编程 says *what*, and splits into **functional programming** 函数式编程 and **logic programming** 逻辑编程.

low-level

close to the hardware

imperative

a sequence of commands

object-oriented

objects with data + methods

declarative

say what, not how

Low-level and imperative

Low-level programming – **assembly language** 汇编语言 working directly with **memory addresses** 内存地址 – is close to the hardware. Each instruction maps to what the CPU runs. Addressing modes: immediate, direct, indirect, indexed, relative. Fast and compact; architecture-specific and hard to maintain.

Imperative (procedural / structured): assignments, conditionals, loops, function calls. **Variables** 变量 hold state; statements change it. Strong when the algorithm has clear sequential steps. Python, C.

Declarative – what, not how

Two kinds:

- **functional** 函数式 – **pure functions** 纯函数 with no **side effects** 副作用 (Haskell, Lisp)
- **logic** 逻辑 – facts and rules; the engine answers a goal (Prolog)

SQL is the familiar example: `SELECT * FROM Customer WHERE Country = 'UK'` says what you want, not how to walk the records.

Modern languages **mix** paradigms. Python supports procedural, OOP and functional. Pick the one that fits the problem.

The paradigms, and what each is for

low-level	maximum control and speed – assembly
imperative	a sequence of statements changing state – most general-purpose languages
object-oriented	objects holding data and behaviour together – large systems, GUIs, simulations and games
declarative	state <i>what</i> , not <i>how</i> – logic programming
database	data queries – SQL
the point	a paradigm is a style , not a language: many languages support several

Choose by the problem's shape. A query belongs in SQL, a simulation in objects, a device driver in something low-level – and the mark is for saying why.

2

OOP

The four pillars of object-oriented programming

encapsulation

封装

data is hidden behind methods;
a `BankAccount` hides `balance`
behind `deposit()`

inheritance

继承

a **subclass** 子类 specialises a **superclass** 父类, **overriding** 重写
what it needs. Models *is-a*.

polymorphism

多态

the same call runs different code:
every `Shape` has `Area()`

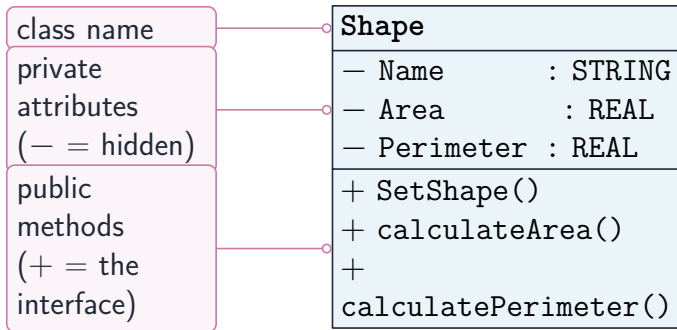
abstraction

抽象

show a simple interface; hide the
implementation

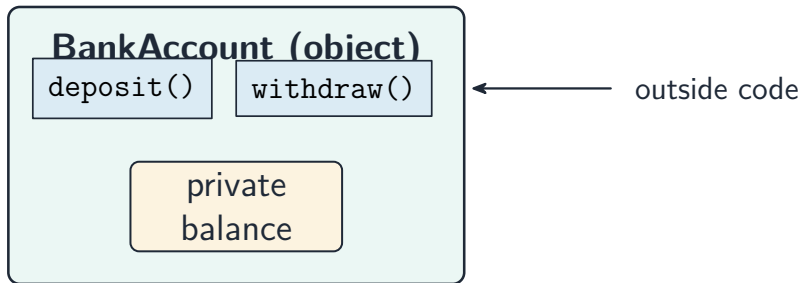
A class diagram

A class diagram for a Shape: private attributes and public methods



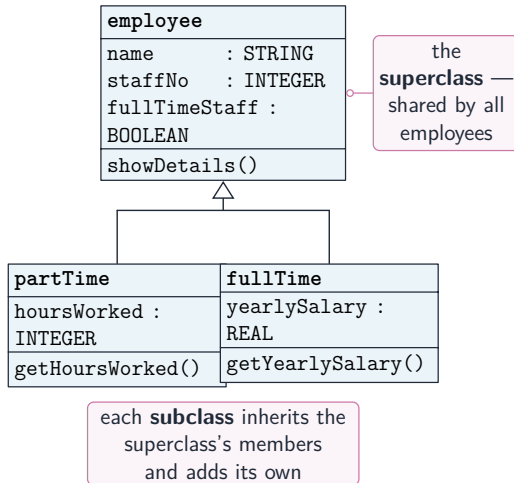
Encapsulation

Encapsulation: an object's data is private, reached only through its public methods



the data is reached only through the public methods

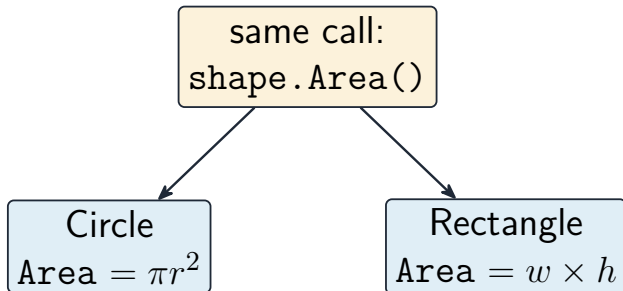
Inheritance: a subclass extends a class



Inheritance: `partTime` and `fullTime` are subclasses of `employee`

Polymorphism

Polymorphism: the same method call runs each object's own code



same method name — different code runs

Class vocabulary

class

the template; an object is an **instance** 实例 of it

constructor

a special method that sets up attributes on creation

getters **setters**

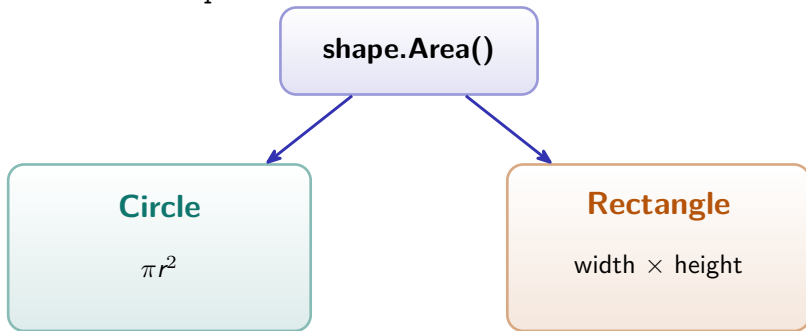
read and write attributes through methods

aggregation

a “has-a”; **containment** 包含 is the stronger form where the part cannot outlive the whole

Polymorphism in one picture

The caller writes `shape.Area()` – it does not need to know the exact type.



3

Files

File operations in pseudocode

Extends Topic 10. Modes: READ (existing), WRITE (create/overwrite), APPEND (add at the end).

```
OPENFILE "names.txt" FOR READ
WHILE NOT EOF(``names.txt'') DO
  READFILE ``names.txt'', thisName
  OUTPUT thisName
ENDWHILE
CLOSEFILE ``names.txt''
```

Always **open**, process, then **close**.
Forgetting to close can lose data.
WRITE when you meant APPEND
overwrites everything.

You cannot overwrite a line in place

A members file needs one phone number changed. Why not just overwrite that line?

Lines have **different lengths**. A longer replacement would run into the next record; a shorter one would leave part of the old line behind.

Pattern: open the original for READ and a **temporary** file for WRITE; write the new version of the changed line and the original of every other; close both; **replace** the original with the temp file.

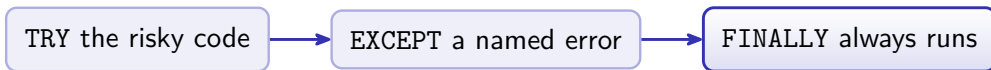
The same shape handles deleting (skip the line) and inserting. Every line gets written – writing only the new record and losing the rest is the classic slip.

4

Exceptions

Handle the errors you cannot prevent

An **exception** 异常 is a runtime error: divide by zero, file not found, index out of range. **Exception handling** 异常处理 lets the program respond instead of crashing.



A file may be deleted between “exists?” and “open”. You cannot prevent that – only handle it. Do not swallow exceptions silently.

Why exception handling exists

the situation	real programs face errors that cannot be prevented up front – files moved, networks down, bad input
without handling	the program crashes , losing unsaved work and telling the user nothing useful
TRY	the code that might fail
EXCEPT	what to do when it does – retry, use a default, or report clearly
FINALLY	cleanup that must run either way – closing a file, releasing a lock
the discipline	catch only what you can actually do something about ; let the rest propagate

Validation prevents the errors you can foresee; exception handling copes with the ones you cannot. Both are needed, and neither replaces the other.

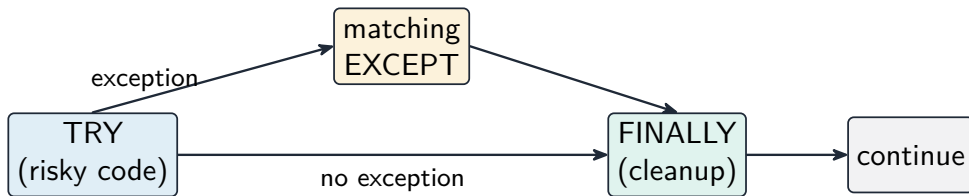
Raising, and where to catch

A subroutine that detects an error can **raise** 抛出 it so the caller handles it: IF b = 0 THEN
 RAISE DivideByZero
ENDIF Handle close to the error if the response is simple, or higher up the **call stack** 调用栈 if only the outer code knows what to do.

Common names: FileNotFound, IOError, DivisionByZero, IndexError, InvalidArgument, NullReference, OutOfMemory.

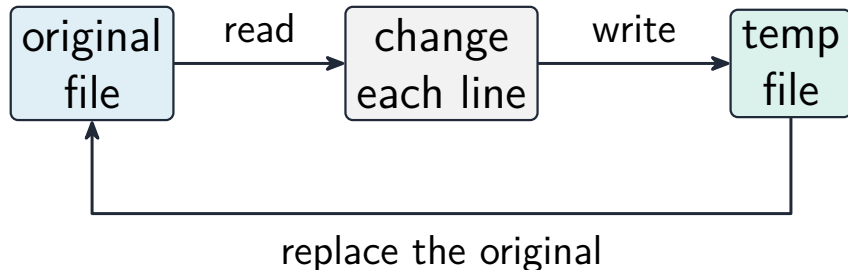
The exception pattern: TRY, EXCEPT, FINALLY

Exception flow: an exception jumps to the matching EXCEPT; FINALLY always runs before the program continues



Updating a file in place

Updating a file in place: read the original, write changes to a temp file, then replace the original



Three file-handling pitfalls

Mistake	Effect	Fix
forgetting <code>CLOSEFILE</code>	buffered data may be lost	close every file you open
<code>WRITE</code> instead of <code>APPEND</code>	the whole file is overwritten	<code>APPEND</code> adds to the end
reading past the end	run-time error	loop <code>WHILE NOT EOF(...)</code>

Exam tips

- Distinguish the **paradigms** (procedural, object-oriented, declarative, low-level) and when each suits a problem.
- For OOP, define **class**, **object**, **inheritance**, **encapsulation** and **polymorphism** with a short example.
- Explain **exception handling** (try/catch) and why it beats letting the program crash.

5

Recap

Topic 20 – key takeaways

1 Paradigms

low-level, imperative, OOP,
declarative

2 OOP

encapsulate, inherit, polymorph,
abstract

3 Files

open / process / close; update
via a temp file

4 Exceptions

TRY / EXCEPT / FINALLY;
never swallow

Check yourself

- 1 Which paradigm says *what* to compute, not *how*?
- 2 Inheritance models which relationship?
- 3 Why write an update to a temporary file?
- 4 Which block always runs, exception or not?

Answers 1. declarative 2. is-a 3. variable-length lines cannot be overwritten in place
4. FINALLY