

Data

AP Computer Science Principles ■ Unit 2

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What we will cover

- 1 Binary numbers
- 2 Data compression
- 3 Extracting information
- 4 Using programs with data

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bits

Everything is bits

A **bit** 位 is a single 0 or 1. **Binary** 二进制 (base 2) uses place values that are **powers of two** 2 的幂.

128	64	32	16	8	4	2	1	
0	0	1	0	1	1	0	1	= 45

$32 + 8 + 4 + 1 = 45$. Read binary $\rightarrow$ decimal by adding the place values where a bit is 1.

place value	128	64	32	16	8	4	2	1
bits	1	0	0	1	0	1	1	0

$$150 = 128 + 16 + 4 + 2 \Rightarrow 10010110$$

Fixed bits, overflow & sampling

Convert & overflow

1011_2 : place values 8, 4, 2, 1; bits at 8, 2, 1 give $8 + 2 + 1 = 11$.

With n bits you can make 2^n values, 0 to $2^n - 1$. Exceeding it is an **overflow error** 溢出错误 (4 bits max 15; $15 + 1$ overflows).

Analog 模拟 signals become **digital** 数字 by **sampling** 采样 – many quick measurements. Eight bits group into one **byte** 字节.

Data compression

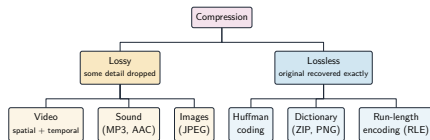
Compression 压缩 stores the same data in **fewer bits** – less space, faster transmission.

Lossless 无损

every bit restored exactly (text, code)

Lossy 有损

discards unnoticed data;
much smaller (photos, music)



Lossy trades **size 大小** against **quality 质量**. Many methods remove **redundancy 冗余** – e.g. “100 white pixels” → “white, 100 times”.

Extracting information from data

Programs turn raw **data sets** 数据集 into **information** 信息, finding **patterns** 模式 and **trends** 趋势.

Filtering 筛选

keep the rows you want

Cleaning 清洗

fix duplicates, blanks, errors

Beware: a **correlation** 相关 never proves **causation** 因果, and **bias** 偏差 in how data was collected can mislead. **Metadata** 元数据 & **visualization** 可视化 help.

Using programs with data

A program **processes** 处理 data: records in, new information out.

Iterate to summarise

A loop uses **iteration** 迭代 to visit each **element** 元素: summing 70, 85, 90, 60, 95 gives 400; $\div 5 = 80$ (the average).

A **filter** 过滤器 keeps a **subset** 子集 that meets a condition; programs also **combine** 合并 sources, **transform** 转换 values, and **clean** 清洗 first – dirty data gives a wrong answer.

Worked example – choosing a compression

**Which compression for a source-code file?
For a holiday photo?**

Code → **lossless**. Every bit matters – a single changed character breaks the program. Restoring the **exact** original is non-negotiable. **Photo** → **lossy**. A small quality loss is invisible, and the file gets **much** smaller.

The trade is **size** against **fidelity**. Lossy loss is **permanent** – you can never get the discarded data back.

Key points

Binary place values are powers of two; watch **overflow**

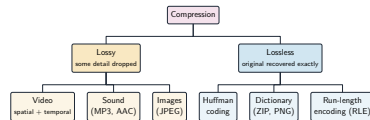
Lossless keeps every bit; **lossy** trades quality for size

Correlation is not **causation**; clean data first

Programs **iterate**, **filter** & transform data

Check yourself

- 1 Convert 1011_2 to decimal.
- 2 How many values can n bits represent?
- 3 Lossless or lossy for a program file – and why?
- 4 Does a correlation in the data prove causation?



Answers 1. 11 2. 2^n (from 0 to $2^n - 1$) 3. lossless – every bit must be restored exactly 4. no