Indian Inventions

Binary Numbers

From Ancient India to Digital India

When you send a WhatsApp message, crush a level in a video game, or stream your favourite song, you are using a language that is over 2,000 years old.

It might surprise you, but the idea behind digital computing didn't start in Silicon Valley. It began in ancient India. Around **200 BCE**, the scholar **Acharya Pingala** described the earliest form of binary in his Sanskrit text, the Chanda Shastra.

> ***The Poet's Code:*** *Long before electricity existed, Pingala showed how the rhythm of poetry - using patterns of short and long syllables - could be mathematically calculated. He essentially created a system of two states, which we now recognize as the ancestors of **0** and **1**.*

It is a matter of immense pride that India gave the world both **Zero** and **Binary code** - the very DNA of the digital age.

What Exactly Are Binary Numbers?

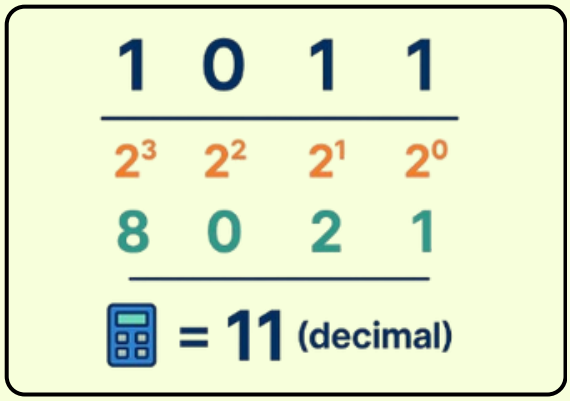
We are used to the **Decimal System** (Base-10), which uses ten digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

The **Binary System** (Base-2) is different. It is a "secret language" that uses only two digits: **0** and **1**.

In the decimal system, position matters (ones, tens, hundreds). In binary, position also matters, but each step is a **power of 2** (1, 2, 4, 8, 16, etc.).

Decoding the Matrix

Here is how a computer reads the binary number **1011.** Binary to Decimal Conversion (Example: 1011 = 11)



Why Do Computers Love Binary?

Why don't computers just use 0-9 like us? It comes down to hardware.

Computers are made of billions of tiny switches called **transistors**. A switch is either **ON** or **OFF**. It's very hard for a switch to be "slightly on" or "halfway off".

- **0** = Switch is OFF (No electricity)
- **1** = Switch is ON (Electricity flows)

Because of this, binary is the most reliable way to store and send data. It creates a clear, unambiguous signal that doesn't get confused by noise.

Binary in Action

Everything on your screen is actually just a pile of 0s and 1s disguised as something else:

- **Text:** Each letter you type has a binary ID card. In ASCII code, the letter 'A' is stored as 01000001.
- **Images:** A photo is a grid of pixels. Each pixel's colour is defined by a string of binary code.

- **Music & Video:** Your MP3s and MP4s are just massive streams of bits (binary digits) that your phone decodes into sound and light.

Math with Only Two Numbers

Just like you learn addition in school, computers do math in binary. The rules are surprisingly simple:

- 0 + 0 = 0
- 1 + 0 = 1
- 1 + 1 = 10 (Write 0, carry the 1)

Your computer's processor does billions of these little calculations every single second to run your apps and games!

Try It Yourself!

Want to convert a regular number into binary? Use the **"Divide by 2"** trick.

Let's convert the number 13:

1. 13÷2 = 6 (Remainder **1**)
2. 6÷2 = 3 (Remainder **0**)
3. 3÷2 = 1 (Remainder **1**)
4. 1÷2 = 0 (Remainder **1**)

Now, read the remainders from bottom to top: 1101.

That is 13 in binary!

India: The Past and Future of Binary

India is not just the birthplace of binary; it is currently one of its biggest power users. The code that Pingala hinted at is now running the nation:

- **Aadhaar:** Your digital identity uses binary to store biometric data (fingerprints and iris scans) for over a billion people.
- **Space Tech:** When ISRO's Chandrayaan-3 landed on the Moon, it communicated with Earth using streams of binary data.
- **UPI Payments:** Every time you scan a QR code to pay, binary data travels securely between banks to make the transaction happen instantly.

Pros and Cons of the System

Advantages

- **Simplicity:** Only two states (On/Off) to manage.
- **Reliability:** Works well even with electrical interference.
- **Scalability:** Works for tiny sensors and massive supercomputers.

Challenges

- **Not Human-Readable:** A string like 1101001 is hard for us to read quickly.
- **Length:** Binary numbers get very long, very fast.
- **Complex Translation:** Real-world data (like colours) must be carefully converted.

Conclusion: The Power of Two

From the ancient verses of Varanasi to the server rooms of Bengaluru, the journey of binary is incredible. It teaches us that you don't need complexity to build something magnificent. You just need a solid foundation—even if that foundation is just a **0** and a **1**.