**CPU (Central Processing Unit)**

The CPU, or Central Processing Unit, is the brain of the computer. It performs the basic arithmetic, logic, control, and input/output operations specified by the instructions in the program. CPUs and chips primarily operate using binary code, which consists of 1s and 0s. The integrated circuits within these chips use logic gates to process these binary instructions. Here is how it works:

### Binary Code

* **Binary**: The fundamental language of computers, using only two symbols: 1 and 0. Each binary digit (bit) represents a state of being on (1) or off (0).
* **Instructions**: Computer programs are translated into binary instructions that the CPU can understand and execute.

### Logic Gates

* **Logic Gates**: The basic building blocks of digital circuits. They perform logical operations on one or more binary inputs to produce a single binary output. The main types of logic gates are AND, OR, NOT, NAND, NOR, XOR, and XNOR.
* **Circuits**: By combining multiple logic gates, complex circuits are created that can perform a wide variety of tasks.

### CPU Execution Process

1. **Fetch**: The CPU fetches an instruction from memory, represented in binary.
2. **Decode**: The instruction is decoded into signals that can activate specific logic gates within the CPU.
3. **Execute**: The activated logic gates perform the operation specified by the instruction (e.g., adding two numbers, moving data).
4. **Store**: The result of the operation is stored back in memory or a register.

### Example: Adding Two Numbers

1. **Binary Representation**: Numbers and operations are represented in binary.
2. **Logic Gates**: The addition operation is performed using a combination of logic gates, such as AND, OR, and XOR gates, to carry out the addition.
3. **Result**: The sum is produced in binary and stored in a register or memory.

**CPU or Chips material**

CPUs and chips are made from a variety of materials, but the most important one is **silicon**. The country that produces the most silicon is **China**. In 2023, China produced approximately **6.6 million metric tons** of silicon, which is about 10 times higher than the production of the second-largest producer, Russia. Here's a breakdown of some of the key materials used in their manufacturing:

1. **Silicon**: The primary material used for the semiconductor wafers from which CPUs and chips are made. Silicon is abundant and has excellent electrical properties.
2. **Copper**: Used for wiring within the chip to connect different components.
3. **Gold**: Often used in the bonding wires and connectors because of its excellent conductivity and resistance to corrosion.
4. **Aluminum**: Sometimes used for wiring and other components.
5. **Dopants**: Elements like phosphorus, boron, and arsenic are added to the silicon to modify its electrical properties.
6. **Dielectrics**: Materials like silicon dioxide and silicon nitride are used as insulating layers.

These materials are carefully layered and patterned to create the intricate circuits that make up a CPU or chip. The process involves numerous steps, including photolithography, doping, etching, and layering, to produce the final product. While CPU and chips are small in size which using not too much material such as silicon, what causes CPU so expensive? CPUs and chips are small and use a relatively small amount of silicon, why the costs are so high? Their high cost is attributed to several factors beyond the raw materials:

### Research and Development

* **Innovation**: Developing new CPU architectures and improving performance requires extensive research and engineering. Companies invest billions of dollars in R&D to stay ahead in the competitive market.

### Manufacturing Complexity

* **Advanced Processes**: The process of making a CPU involves extremely advanced manufacturing techniques. Fabrication plants (fabs) need to be incredibly precise, operating in clean rooms to avoid any contamination.
* **Miniaturization**: Modern CPUs have billions of tiny transistors packed into a small area. Achieving this level of miniaturization requires state-of-the-art technology and equipment.

### Market and Economics

* **Demand**: High demand for advanced CPUs in various sectors (like gaming, AI, and data centers) can drive prices up.
* **Economic Factors**: Supply chain disruptions, geopolitical issues, and other economic factors can also influence the cost.

### Intellectual Property

* **Patents and Licensing**: Companies hold numerous patents and licenses that protect their intellectual property. Licensing fees and patent royalties can add to the overall cost.

Apart from CPU, there is another term name **GPU**,GPUs (Graphics Processing Units) and CPUs (Central Processing Units) are both critical components in a computer, they have different functions and architectures. Here are the key differences:

**CPU (Central Processing Unit)**

* **General Purpose**: Designed to handle a wide range of tasks, from running the operating system to executing applications and performing calculations.
* **Architecture**: Typically has a few powerful cores optimized for single-threaded performance.
* **Task Handling**: Good at handling complex and sequential tasks. Ideal for tasks that require high-speed execution of a single thread or a few threads.
* **Integrated Circuit**: Includes components like the Arithmetic Logic Unit (ALU), Control Unit (CU), registers, and cache memory.

### GPU (Graphics Processing Unit)

* **Specialized Purpose**: Primarily designed for rendering graphics and performing parallel processing.
* **Architecture**: Has many smaller cores optimized for parallel processing. **NVIDIA** GPUs, for example, have thousands of cores.
* **Task Handling**: Excellent at handling parallel tasks. Ideal for tasks that can be broken down into many smaller, simultaneous operations, such as rendering images, video processing, and complex computations in AI and machine learning.
* **Integrated Circuit**: Includes a large number of ALUs (much more than a CPU) and specialized hardware for rendering graphics (such as texture mapping units and shader processors).

### Key Differences

* **Performance Focus**: CPUs focus on single-threaded performance, while GPUs focus on multi-threaded, parallel performance.
* **Complexity**: CPUs are more complex in terms of control logic and general-purpose processing. GPUs are more complex in terms of parallelism and specialized graphics processing.
* **Use Cases**: CPUs are used for general computing tasks, while GPUs are used for tasks that require massive parallelism, such as gaming, 3D rendering, scientific simulations, and AI computations.

Compare to CPU, GPU are more complex due to parallel tasks execution. The price of GPU is much higher than traditional CPU. Here are some key reasons why GPUs can be more expensive than CPUs:

### Complexity and Performance

* **Parallelism**: GPUs are designed to handle thousands of simultaneous operations, which requires a highly complex architecture. The large number of cores and specialized components increase the manufacturing complexity.
* **High Performance**: GPUs are optimized for high-performance tasks such as graphics rendering, scientific simulations, and AI computations. This specialization often involves cutting-edge technology and materials.

### Manufacturing and Technology

* **Advanced Manufacturing**: The process of making GPUs involves advanced lithography techniques and precise fabrication processes. This requires specialized equipment and facilities.
* **Smaller Nodes**: GPUs often use smaller manufacturing nodes (e.g., 7nm, 5nm), which are more challenging and expensive to produce.

### Research and Development

* **Innovation**: Developing new GPU architectures and improving performance requires extensive research and engineering. Companies invest heavily in R&D to push the boundaries of what GPUs can do.
* **Software Optimization**: GPUs rely on sophisticated software frameworks (like CUDA for NVIDIA GPUs) to leverage their parallel processing capabilities. Developing and maintaining this software adds to the cost.

**Market Dynamics**

* **High Demand**: GPUs are in high demand for various applications, including gaming, professional graphics, AI, and cryptocurrency mining. This demand can drive prices up.
* **Supply Chain**: Any disruptions in the supply chain, such as shortages of raw materials or production capacity, can affect GPU prices.

### Specialized Components

* **Memory**: High-end GPUs often come with large amounts of high-speed memory (like GDDR6 or HBM2), which adds to the cost.
* **Cooling Solutions**: Powerful GPUs generate significant heat and require advanced cooling solutions, which also contribute to the overall price.

Apart from tasks execution which needs a CPU, nowadays cryptocurrency like bitcoin when perform mining operation requires high speed GPUs, which add additional costs for bitcoin mining. Bitcoin miners, usually install high-end GPU display card like NVidia. Why do cryptocurrency users need to install high-end “Display Card” rather than just purchasing much cheaper high-end CPU for bitcoin mining operations. The reason is for Bitcoin mining, using a high-performance GPU is generally more effective than using a high-performance CPU.

### Performance

* **Hash Rate**: GPUs have a higher hash rate compared to CPUs. This means they can process more transactions and solve complex mathematical problems faster.
* **Parallel Processing**: GPUs are designed for parallel processing, which is ideal for the repetitive calculations required in Bitcoin mining.

### Efficiency

* **Energy Consumption**: While GPUs consume more power than CPUs, their higher efficiency in processing transactions can lead to a better return on investment.
* **Cost-Effectiveness**: Although setting up a GPU mining rig is more expensive initially, the increased efficiency can translate into higher profits over time.

GPU is related to bitcoin mining and the GPU fundamental functionality is based on video and graphics rendering, how does the system differentiate the instruction of which chips to choose (such as CPU or GPU) when performing tasks operation such as calculation, video and graphics rendering or even bitcoin mining operations. If so, why we won't we just use GPU not CPU?

### Why Not Just Use GPUs?

1. **System Balance**: The CPU still plays a vital role in managing the overall system, running the operating system, and handling tasks that are not suitable for the GPU. Using both CPU and GPU ensures a balanced and efficient system.
2. **Different Use Cases**: While GPUs are excellent for mining and other parallel processing tasks, CPUs are still essential for a wide range of general-purpose computing tasks. Eliminating CPUs entirely would hinder the performance of other important functions.

After discuss about the reason why not just using GPU. How does the system direct the tasks or instruction to which chips to process. Below briefly describe the task or instruction direct process:

1. **Task Assignment**: The system assigns tasks based on the type of operation required. Tasks that benefit from parallel processing, such as hashing, are directed to the GPU. Tasks that require sequential processing, such as certain control functions, are directed to the CPU.
2. **Software Optimization**: Mining software is designed to recognize the capabilities of the hardware and allocate tasks accordingly. For example, the software will use the GPU for hashing operations and the CPU for managing and orchestrating the mining process.

After discussing what is a CPU and how it differs from GPU. The next is to discuss ways of **lowering** the manufacturing costs for chips. We all know most of the chip’s cost mainly base on the machine to fabricate a chip. Modern CPUs have billions of tiny transistors packed into a small area. Achieving this level of miniaturization requires state-of-the-art technology and equipment. Yes! That is the main reason of why making chips is so expensive. We can base on this issue to figure out how to fabricate a cheaper chip:

**Increase the surface area size of the chips**

By Increasing the surface area size of the chips or GPU but still maintaining the integrated circuit complex design can be an option. As the surface size of the chips become larger, the requirement of achieving the level of miniaturization is greatly reduced. The cons of this approach are there is no standard of the size of the chips. Mother board or display card needs to be redesign and standardize.

**Create a dual or triple Chips sets**

A single chip requires certain level of miniaturization when fabricate. What if we fabricate dual chips or even triple chips set still achieving the same performance result. We can use the technology as before to fabricate 2 to 3 set of chips working in parallel but still achieving the same result.