

Class Notes

What's blockchain? It's a decentralized digital ledger with no central control. Its core uses Distributed Ledger Technology (DLT) to sync data across nodes, and blocks store timestamped transactions tied together with cryptography like hashes and Merkle trees.

- Key Components:
 - Nodes: Maintain blockchain
 - Blocks: Hold transaction data
 - Cryptography: Secures everything
 - Smart Contracts: Auto-execute agreements

Traditional systems and blockchain differ sharply. Centralized setups have one authority and are prone to tampering, while blockchain's decentralized nodes ensure trust and transparency, showing up in data structure, security, and scalability.

- Consensus Mechanisms:
 - Proof of Work (PoW): Miners solve puzzles, energy-heavy (e.g., Bitcoin)
 - Proof of Stake (PoS): Validators use holdings, efficient
 - Others: DPoS, PBFT for scalability

Security is where blockchain shines. Cryptography locks data with hashes, making it authentic and unchangeable—immutable—and decentralization spreads it across nodes to avoid single failures.

- Blockchain + AI:
 - Data integrity for AI models
 - Audit trails for accountability
 - Decentralized tasks for scalability

In the real world, this duo transforms industries. Healthcare pairs secure data sharing with AI diagnostics, finance uses transparency for AI fraud detection, and Walmart tracks food safety with blockchain while AI optimizes inventory—tracing issues in seconds.

- Challenges:
 - Scalability: Slow with high volumes
 - Interoperability: No universal standards
 - Ethics: Privacy vs. transparency

Looking forward, trends are promising. Decentralized AI marketplaces could securely trade models, federated learning might train AI privately on blockchain, and edge computing could blend local AI with blockchain security.

- Ethical Considerations:
 - AI bias reduction via transparency
 - Data privacy with cryptography
 - Global governance needs

In summary, blockchain's decentralized transparency is a game-changer. It gives AI a secure foundation, and together they drive innovation and trust across industries.