Introduction

Agenda:
- HC/LS need for a paradigm shift
- Why Federated Learning matters
- Introduction to Elevated Compute
- Industry next steps

Mike McCoy
Philadelphia, PA
Director, Platform Integration & Technical Partnerships at ConsenSys Health
Adjunct Professor, Emerging Technologies at Thomas Jefferson University
Increased focuses on AI and research capabilities create new challenges for healthcare and life sciences organizations

<table>
<thead>
<tr>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater and greater storage and computing capacity needed</td>
</tr>
<tr>
<td>Increasing scrutiny of privacy as variety of data types increase</td>
</tr>
<tr>
<td>Growing cybersecurity attacks and risks</td>
</tr>
<tr>
<td>Increased cost of compliance, proper management of PHI</td>
</tr>
<tr>
<td>Increased cost of data sources, intermediaries, and data-related services</td>
</tr>
</tbody>
</table>
COVID-19 Crisis Emphasizes the Need for Accelerated Insights & Analytics

“The research community is currently striving to sift through more than 100 potential preventives and therapeutics for COVID-19.”

SOLUTIONS FOR A GLOBAL PANDEMIC MUST PRIORITIZE

Collaboration
Drive faster and more accurate insights into patient populations with multiple organizations without sacrificing privacy

Privacy
Patient data remains within local infrastructures secured by blockchain-based access management and zero-knowledge proofs
Current methods of analytics struggle to deal with a patient’s journey across the healthcare system

**Patient’s journey**

- Site
- Provider #1
- Provider #2
- Payer

Siloed de-identified data

... leads to siloed analytics
Current methods of analytics struggle to deal with a patient’s journey across the healthcare system.

By enabling analytics without needing to share data we can derive exponentially better analytics across the patient’s journey.
Data Value is Maximized, While Staying Protected

Source Data Remains **Fully-Identified** and **Clinically-Actionable** without exposing, sharing, or transferring PHI or sensitive Source Data

- **Enterprise Source Data Stays Behind Firewalls**
- **Patients Retain Personal Source Data Sovereignty**
- **Analysis is Performed in Federated Networks**
Federated learning is the future of insight
A path to real-time, real world insights and analysis

Access to more data and expanded types of data
Surfacing insights without sacrificing data privacy
Decreasing bias with more diverse patient populations
Lowering compliance burdens by avoiding taking custody of data
Lowering dependencies on intermediaries and data suppliers

Data Veracity + Data Variety + Data Volume = Value + Velocity

Moving from Competition → Compensated Collaboration
Generate additional organizational value by monetizing network contributions while leveraging the progress and pace of a wide network
A New Scope for ‘Blockchain’ and ‘Web3’

1. Old tech used in a new way
2. Creates potential for entirely new business models
3. Opportunity to apply game theory and behavioral economics at scale
4. AI for optimization of incentives
5. New converging innovations, “Privacy-in-Depth” and “Decentralized AI”

Decentralized Apps (“dApps”)
Web3 User Experience

Optional Tokenized Assets
Secured and Transferred

Smart Contracts
Secure Automation Across Organizational Boundaries

Blockchain Networks
Public, Private, and Hybrid

Privacy-in-Depth
- Zero-Knowledge Proofs (ZKPs)
- Trusted Execution Environments (TEEs)
- Secure Encrypted Virtualization (SEV)
- Blind Computation
- Verifiable Computation
- Secure Multi-Party Computation
- Differential Privacy
- Homomorphic Encryption
- Quantum-Resistant Encryption

Decentralized AI
- Federated learning in blockchain networks
- Intelligent agent-based automation
- Optimization w/agent-based simulation
- New paradigm in training data provenance

Web2 or Today’s Mainstream Modern Web
A Paradigm Shift in Value Creation

Moving copies of data is no longer the only way to create value from that data.

Sunsetting Paradigm

- **Copy and Move** Source Data
- Beyond Firewalls
- Analysis Performed on Limited Source Data
  - Often: De-Identify

  - Normalize

  - Analyze

  **Value Creation**

Emerging Paradigm

- Enterprise Source Data Stays Behind Firewalls
- Patients Retain Personal Source Data Sovereignty
- Analysis is Performed in Federated Networks

  - Source Data Remains Fully-Identified and Clinically-Actionable
  - **without** exposing, sharing, or transferring PHI or sensitive Source Data

  - Normalize Locally via Distributed Rulesets & Automation

  - Analyze Locally and Combine Derived Insights with Federated Learning Network Participants

  **Value Creation**
**Phase 1: Elevated Compute Networks**

**Elevated Compute**: Federated queries, analytics, learning models with digitally identifiable verification

Bringing together medical research network pilot participants that require internal clearances

**Goal**: Answer prioritized, public health-oriented research questions in the fight against COVID-19 and beyond
Roadmap to Supervised Federated Learning
Activates & Integrates Patient-Sovereign Data Sets via B2B2C Strategy

1. Blockchain-Facilitated Federated Analytics and Learning
   - Protects Source Data

2. Blockchain-Facilitated Federated Analytics and Learning
   - Protects both Source and Derived Data

3. Supervised Federated Learning
   - Protects both Source and Derived Data and Activates Parallel, Complementary Consumer Engagement Strategy for End User Data inclusion
   - Crypto-Economic Incentives Accelerate and Amplify Learning
   - Incentivized Distributed Trusted Compute (Distinct from Data Owners, Scales Compute Capacity without Sacrificing Cybersecurity)

TODAY
- Federated Analytics (Criteria Matching, Statistical Analysis up to and including Unsupervised Learning)
- Federated Learning, Supervised Learning
- Weighted Attribution and Tokenized Incentivization

Private Network, Enterprise-Only, Nothing Patient-Facing

Unsophisticated Current-State Industry Identity Construct

Sophisticated Fully Realized New Identity Paradigm
Industry Next Steps

Join Elevated Compute Networks for research for treatments, vaccines and clinical care

➔ **Stage 1 (NOW):** COVID-19 focus -- driving design of federated queries and machine learning objectives

➔ **Stage 2:** Pragmatic clinical trials -- real world evidence derived from the treatment prescribed in course of care

➔ **Stage 3:** New research network for multi-site clinical trials -- dynamic, digital, adaptive, able to match with fully-identified data
Thank you.
Federated Healthcare Learning Platform

Accelerating Efficacy and Time to Development of Analytics, AI and Machine Learning Solutions with Enhanced Data Integrity, Privacy Preservation, and Increased Trust across Distributed Networks

Collaborative Mechanisms Drive Participation and Usage
- Collective ownership and licensing of intellectual property
- Decentralized governance and shared decision-making
- Ability to use tokenization for incentivized collaboration

Guarantees of Integrity
- Tamper proof, with a unified audit trail and oversight of data use

Identity & Access Management
- Discovery of workers, client-specific encryption and decryption of content

Traceability
- Verifiable model performance, experiment tracking for reproducibility, verifiable compliance

Researchers define a learning objective and request access to datasets

Data processing and analytics programs are submitted to the Orchestrator smart contract

Researchers remotely monitor the performance metrics

Researchers analyze results and iterate procedure until objective is reached

Blockchain Network

The Orchestrator smart contract maintains registry for data & compute discovery

Proceed if there is consensus

The Auditor smart contract tracks experiments, records data access and model performance

Proceed if there is consensus

The Licensing smart contract calculates contributions and distributes reimbursement and/or ownership shares, enforces governance of IP.

Researchers analyze results and iterate procedure until objective is reached

Collaborators register their data and compute resources

Collaborators register their permissions and privacy policies with the Orchestrator smart contract

Collaborators receive programs from the smart contract and execute on local dataset

Collaborators execute a multi-stakeholder Intellectual property licensing agreement (Licensing Smart Contract)

Machine Learning Analyst

Researchers remotely monitor the performance metrics

The Auditor smart contract tracks experiments, records data access and model performance

Proceed if there is consensus

The Licensing smart contract calculates contributions and distributes reimbursement and/or ownership shares, enforces governance of IP.

Data owners

Collaborators register their data and compute resources

Collaborators register their permissions and privacy policies with the Orchestrator smart contract

Collaborators receive programs from the smart contract and execute on local dataset

Collaborators execute a multi-stakeholder Intellectual property licensing agreement (Licensing Smart Contract)

Coupling FL with blockchain & verifiable off-chain compute provides trust that the privacy of the data will not be compromised. By including incentives, and accounting for reputation trust could be built up by a data source over time.