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Federated Learning for the Future of Healthcare

Secure, Scalable, Smart

By: Muhaib Ferooz, Asif Ali Baska

Redefine healthcare with federated learning. Build secure, intelligent AI systems without compromising patient privacy by training models on localized data. This guide integrates research and case studies to help design trustworthy AI systems.

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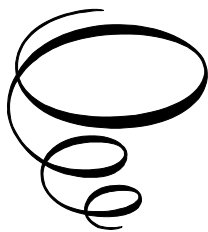


TABLE OF CONTENTS

Chapter 1	1
Introduction to Federated Learning in Healthcare	
Asifa Nazir, Ahsan Hussain, Mandeep Singh, Assif Assad	
Chapter 2	29
AI-Driven Healthcare and Patient Privacy: Navigating Challenges and Building Resilient Frameworks	
Shabana Nargis Rasool	
Chapter 3	49
Deep Reinforcement and Federated Learning in Medical Decision Making: Methods, Applications and Challenges Ahead	
Tabasum Majeed, Nusrat Mohi Ud Din, Shehla Rafiq, Saqib Ul Sabha, Assif Assad	
Chapter 4	63
Scalable Federated Genomic Analysis for Precision Medicine	
Venkatesan C, Jeevanantham S, Rebekka B	
Chapter 5	98
Federated Genomic Data Integration: Paving the Way for Scalable Precision Medicine	
Shehla Rafiq, Saqib Ul Sabha, Tabasum Majeed, Nusrat Mohi Ud Din, Assif Assad	
Chapter 6	114
Smart Federated EHR Analysis for Secure Healthcare	
Shah Raashed Ul Shams	
Chapter 7	149
Disease Classification using Federated Learning	
Saqib Ul Sabha, Amir Ahmad Dar, Nusrat Mohi Ud Din, Tabasum Majeed, Shehla Rafiq, Jawad Ahmad Dar	

CHAPTER 1

INTRODUCTION TO FEDERATED LEARNING IN HEALTHCARE

ASIFA NAZIR^A, AHSAN HUSSAIN^A,
MANDEEP SINGH^B, ASSIF ASSAD^C

Department of Computer Science & Engineering^a,
Department of Physics^b,
Centre for Artificial Intelligence^c
Islamic University of Science & Technology, Kashmir, 192122

Abstract

Federated learning (FL) is an emerging approach in Artificial Intelligence (AI) that allows joint model training across decentralized data sources, eliminating the need to share the original datasets. In medical applications, FL supports leveraging data from multiple sources without compromising the security of personal health records. This chapter presents the conceptual background of FL, outlines its key components in medical contexts, and categorizes FL based on data distribution patterns. It then examines how and why FL is a game-changer for healthcare, with emphasis on its integration with Explainable AI (XAI) to improve model transparency and clinical trust. This study addresses the research gap concerning the incorporation of FL with advanced imaging techniques such as holography, which combines high-resolution, three-dimensional medical imaging with privacy-preserving, multi-institutional collaboration. The chapter examines major healthcare applications, including “predictive modelling”, “medical image diagnostics”, “genomics”, and “personalized medicine”, and evaluates challenges such as “data heterogeneity”, “communication limitations”, and “ethical considerations”. Future research priorities include “model personalization”, “communication-efficient learning”, “enhanced privacy safeguards”, and the “development of explainable lightweight models”. The chapter concludes by identifying