THE HEART OF INNOVATION: HOW AI IS TRANSFORMING CARDIOVASCULAR CARE

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INTRODUCTION

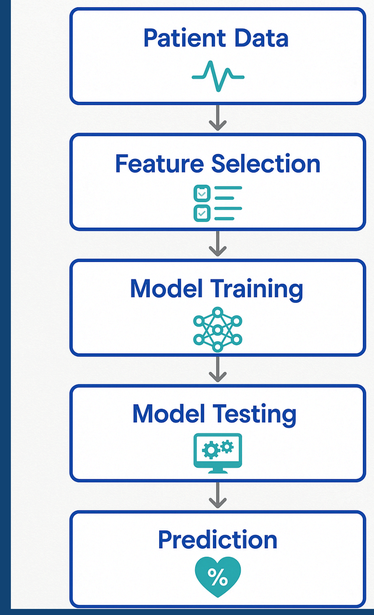
HEART DISEASE IS A LEADING CAUSE OF DEATH WORLDWIDE. WHILE TRADITIONAL METHODS LIKE THE FRAMINGHAM RISK SCORE RELY ON FACTORS SUCH AS BLOOD PRESSURE, CHOLESTEROL, AND SMOKING HISTORY, THEY CAN MISS COMPLEX PATTERNS IN DATA.

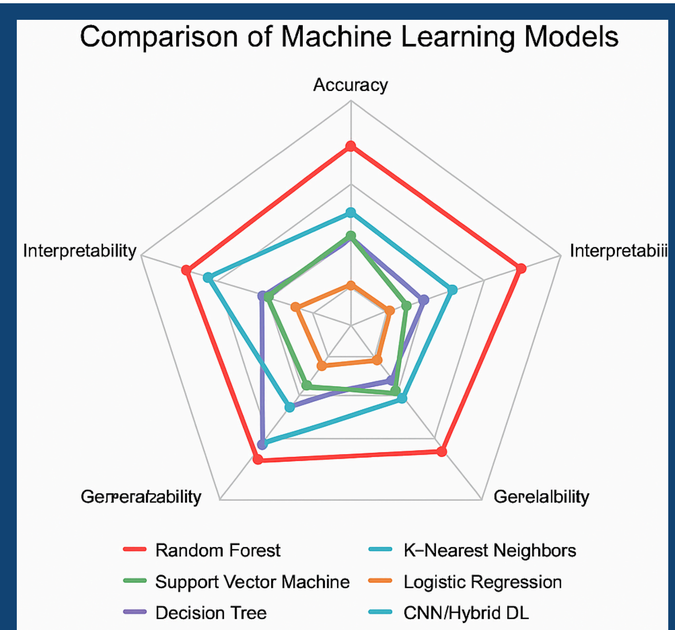
WITH THE RISE OF MACHINE LEARNING (ML), WE NOW HAVE TOOLS THAT CAN ANALYZE LARGE, COMPLEX DATASETS LIKE ELECTRONIC HEALTH RECORDS (EHRS), GENETIC INFORMATION, AND IMAGING DATA IN ORDER TO DETECT HEART DISEASE EARLIER AND MORE ACCURATELY.

RECENT MODELS RANGING FROM LOGISTIC REGRESSION TO ADVANCED NEURAL NETWORKS AND ENSEMBLE METHODS HAVE SHOWN IMPROVED ACCURACY OVER TRADITIONAL RISK CALCULATORS LIKE THE ACC/AHA GUIDELINES (WENG ET AL., 2017; RAJKOMAR ET AL., 2018). WITH SO MANY OPTIONS WE MUST CONDUCT TESTS TO DETERMINE WHICH MODEL IS THE MOST ACCURATE. ESTABLISHING THIS ALLOWS FOR MORE ACCURATE DIAGNOSIS AND RESEARCH FOCUS.

METHODOLOGY

THIS RESEARCH ADOPTS A COMPREHENSIVE, APPROACH TO ASSESS THE RELIABILITY AND ACCURACY OF MACHINE LEARNING (ML) MODELS IN PREDICTING HEART DISEASE. A SYSTEMATIC REVIEW OF EXISTING STUDIES WILL BE CONDUCTED TO UNDERSTAND THE CURRENT LANDSCAPE OF MACHINE LEARNING APPLICATIONS IN HEART DISEASE PREDICTION. THE REVIEW WILL FOCUS ON IDENTIFYING COMMON MACHINE LEARNING ALGORITHMS USED IN HEART DISEASE PREDICTION, THE DATASETS USED ACROSS STUDIES AND THEIR QUALITY (SIZE, COMPLETENESS, DIVERSITY), AND COMMON CHALLENGES THAT OCCUR WHEN USING ML TO PREDICT HEART DISEASE. THIS STEP WILL INVOLVE SOURCING ARTICLES FROM PEER-REVIEWED JOURNALS, CONFERENCE PAPERS, AND ONLINE DATABASES LIKE PUBMED, IEEE XPLORE, AND GOOGLE SCHOLAR, FOCUSING ON WORKS PUBLISHED WITHIN THE LAST FIVE YEARS TO ENSURE THE REVIEW REFLECTS THE LATEST TRENDS IN THE FIELD. THE GOAL WILL BE TO ASSESS MULTIPLE LEARNING MODELS TO DETERMINE WHICH MODEL IS THE MOST ACCURATE BASED ON THE CURRENT LITERATURE AVAILABLE. BASED ON THESE INSIGHTS, THE HOPE IS FOR THIS RESEARCH TO PROVIDE ACTIONABLE RECOMMENDATIONS FOR IMPROVING MACHINE LEARNING APPLICATIONS IN HEART DISEASE PREDICTION.





FINDINGS/ CONCLUSION

RANDOM FOREST CONSISTENTLY HAD THE HIGHEST LEVELS OF ACCURACY ACROSS STUDIES, WITH ONE ACHIEVING 100% ACCURACY AND ANOTHER REPORTING 90% ACCURACY USING THE UCI DATASET. THIS MODEL USES AN ENSEMBLE METHOD, WHICH COMBINES THE PREDICTIONS OF MULTIPLE DECISION TREES, PROVIDES STRONG RESISTANCE TO OVERFITTING AND MAKES IT HIGHLY ROBUST. KNN ALSO PERFORMED WELL, WITH ONE STUDY REPORTING 99.04% ACCURACY, AND WAS ESPECIALLY EFFECTIVE IN CLEAN, PREPROCESSED DATASETS, THOUGH IT IS KNOWN TO BE INEFFICIENT ON LARGER DATASETS AND SENSITIVE TO DATA SCALING. SVM MODELS WERE RECOGNIZED FOR THEIR ABILITY TO WORK WELL IN HIGH-DIMENSIONAL SPACES AND PERFORMED STRONGLY IN METRICS SUCH AS AUC, WITH POOLED VALUES AS HIGH AS 0.92, THOUGH THEY OFTEN REQUIRE CAREFUL PARAMETER TUNING AND MAY STRUGGLE WITH NOISY DATA.

LOGISTIC REGRESSION AND DECISION TREES OFFERED SPEED AND INTERPRETABILITY, BUT THEY GENERALLY SHOWED LOWER ACCURACY IN COMPARISON TO THE MORE COMPLEX MODELS, DUE TO THEIR LINEAR AND INDIVIDUAL-TREE NATURE, RESPECTIVELY. DEEP LEARNING APPROACHES, PARTICULARLY CNNS AND HYBRID MODELS COMBINING DEEP LEARNING WITH FEATURE SELECTION TECHNIQUES, SHOWED VERY PROMISING RESULTS IN TERMS OF ACCURACY, THOUGH THEY REQUIRED LARGE DATASETS, EXTENSIVE COMPUTATIONAL RESOURCES, AND LACKED THE INTERPRETABILITY NEEDED FOR CLINICAL APPLICATION. OVERALL, RANDOM FOREST EMERGED AS THE MOST ACCURATE AND RELIABLE MODEL ACROSS THE STUDIES REVIEWED, WITH KNN AND SVM ALSO DEMONSTRATING STRONG PERFORMANCE DEPENDING ON THE DATASET. WHILE DEEP LEARNING OFFERS EXCITING POTENTIAL, ITS PRACTICAL USE IN HEART DISEASE PREDICTION REMAINS LIMITED BY DATA DEMANDS AND LACK OF TRANSPARENCY IN DECISION-MAKING, WHICH ARE CRUCIAL IN MEDICAL CONTEXTS.

SOURCES

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