CARDIOAI-DSS DASTURIY TIZIMIDA YURAK-QON TOMIR KASALLIKLARI XAVFINI SUN'IY INTELLEKT ASOSIDA BAHOLASh

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ОЦЕНКА РИСКА СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ НА ОСНОВЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В CARDIOAI-DSS

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AI-BASED CARDIOVASCULAR DISEASE RISK ASSESSMENT IN CARDIOAI-DSS

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Tayanch so'zlar: sun'iy intellekt, yurak-qon tomir kasalliklari, qaror qabul qilishni qo'llab-quvvatlash tizimi, CNN, ECG, SHAP, mashinali o'qitish.

Rezyume. Maqolada yurak-qon tomir kasalliklari xavfini baholashga mo'ljallangan CardioAI-DSS dasturiy tizimi bayon qilinadi. Tizim klinik ma'lumotlar, Cardiovascular Disease datasetlari va ECG signallarini tahlil qilish uchun klassik mashinali o'qitish hamda CNN modellaridan foydalanadi. Natijalar Accuracy, Precision, Recall, F1-score, AUC, confusion matrix va SHAP izohi orqali baholandi. Dastur shifokor tashxisini almashtirmaydi, balki dastlabki riskni baholashda yordamchi vosita sifatida qaraladi.

Ключевые слова: искусственный интеллект, сердечно-сосудистые заболевания, система поддержки принятия решений, CNN, ECG, SHAP, машинное обучение.

Резюме. В статье рассматривается CardioAI-DSS для оценки риска сердечно-сосудистых заболеваний. Система применяет модели машинного обучения и CNN для анализа клинических данных, Cardiovascular Disease dataset и ECG сигналов. Результаты оценивались метриками Accuracy, Precision, Recall, F1-score, AUC, confusion matrix и SHAP. Программа является вспомогательным инструментом и не заменяет диагноз врача.

Key words: artificial intelligence, cardiovascular diseases, decision support system, CNN, ECG, SHAP, machine learning.

Summary. The article presents CardioAI-DSS for cardiovascular disease risk assessment. The system applies machine learning and CNN models to clinical data, Cardiovascular Disease datasets, and ECG signals. The models were evaluated using Accuracy, Precision, Recall, F1-score, AUC, confusion matrix, and SHAP explanations. The software supports preliminary risk assessment and does not replace physician diagnosis.

Kirish. Yurak – qon tomir kasalliklari erta aniqlanishi lozim bo'lgan muhim tibbiy muammolardan biridir. Klinik ko'rsatkichlar va ECG signallaridan samarali foydalanish shifokorga qo'shimcha tahliliy yordam beradi. Katta hajmdagi ma'lumotlarni qayta ishlashda sun'iy intellekt algoritmlari yashirin bog'liqliklarni aniqlash va yakka bemor uchun risk ehtimolini hisoblash imkonini beradi [1].

Mazkur tadqiqotning maqsadi CardioAI-DSS dasturiy tizimini ishlab chiqish, unda UCI Heart Disease, Cardiovascular Disease, MIT-BIH va PTBDB datasetlari asosida modellarni sinovdan o'tkazish hamda natijalarni baholashdan iborat.

Materiallar va usullar. Tadqiqotda UCI Heart Disease turidagi 1025 ta yozuvli klinik dataset, tozalashdan keyin 68597 ta yozuvli Cardiovascular Disease dataset, shuningdek MIT-BIH va PTBDB ECG datasetlaridan foydalanildi [1-3]. UCI dataset age, sex, cp, trestbps, chol, fbs, restecg, thalach, exang, oldpeak, slope, ca, thal va target ustunlaridan iborat. Cardiovascular dataset esa age, gender, height, weight, ap_hi, ap_lo, cholesterol, gluc, smoke, alco, active va cardio ko'rsatkichlarini o'z ichiga oladi.

Klinik ma'lumotlar uchun Logistic Regression, KNN, SVM, Decision Tree, Random Forest, Extra Trees, Gradient Boosting, Hist Gradient Boosting, AdaBoost va XGBoost modellaridan foydalanildi [4, 5]. Model qarorini tushuntirishda SHAP usuli qo'llanildi [6].

ECG tahlilida CNN modeli ishlatildi. Har bir ECG yozuvi 187 ta signal qiymati va bitta label ustunidan iborat. CNN signal ichidagi lokal morfologik belgilarni avtomatik topadi: Conv1D qatlamlari kichik signal fragmentlaridan QRS kompleksiga o'xshash patternlarni ajratadi, MaxPooling1D muhim belgilarni saqlagan holda o'lchamni kamaytiradi, Dense qatlamlar esa yakuniy sinfni aniqlaydi [7]. MIT-BIH 5 sinfli, PTBDB esa normal/abnormal binary klassifikatsiya sifatida ko'rildi.

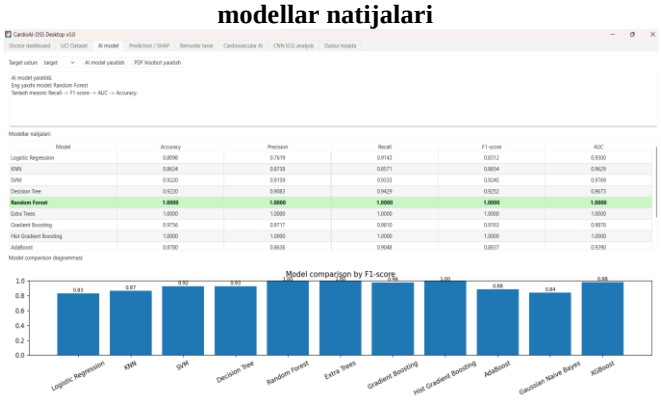
Dastur Python tilida ishlab chiqildi. Interfeys uchun PyQt6, ma'lumotlarni qayta ishlash uchun pandas va numpy, modellar uchun scikit-learn, XGBoost va Tensor-Flow/Keras, grafiklar uchun matplotlib, bemorlar tarixini saqlash uchun SQLite ishlatildi.

Natijalar. CardioAI-DSS dasturida UCI dataset yuklash, model o'qitish, yakka bemor riskini aniqlash, SHAP izohi, Cardiovascular AI, CNN ECG analysis va

bemorlar tarixi modullari yaratildi. UCI dataset bo‘yicha Logistic Regression, SVM, Random Forest, Gradient Boosting va Hist Gradient Boosting ichki testda 1.0000 F1-score ko‘rsatdi. KNN 0.9266, Extra Trees 0.9863, AdaBoost 0.9302 F1-score berdi. Bu natijalar ichki test natijalari bo‘lib, kross-validatsiya bilan qo‘shimcha tekshirishni talab qiladi.

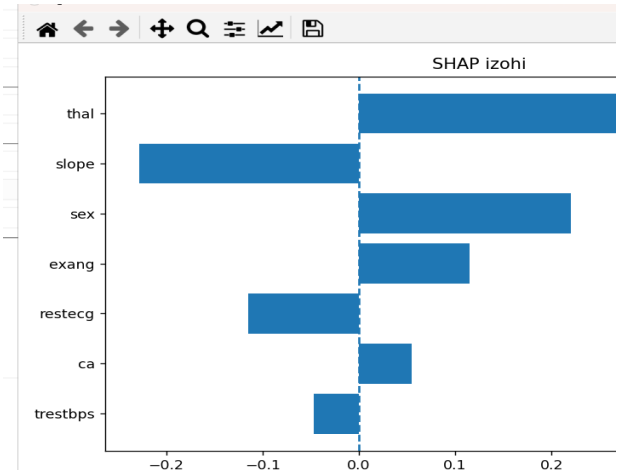
Model	Accuracy	Precision	Recall	F1-score	AUC
Logistic Regression	1.0000	1.0000	1.0000	1.0000	1.0000
KNN	0.9220	0.9182	0.9352	0.9266	0.9874
SVM	1.0000	1.0000	1.0000	1.0000	1.0000
Decision Tree	0.9317	0.9123	0.9630	0.9369	0.9925
Random Forest	1.0000	1.0000	1.0000	1.0000	1.0000
Extra Trees	0.9854	0.9730	1.0000	0.9863	1.0000
AdaBoost	0.9268	0.9346	0.9259	0.9302	0.9882

1-jadval. UCI Heart Disease dataset bo‘yicha modellar natijalari



1-rasm. UCI dataset bo‘yicha modellarni F1-score mezoni asosida solishtirish

Yakka bemor uchun SHAP diagrammasi model qaroriga thal, slope, sex, exang, restecg va ca belgilarining sezilarli ta’sir qilganini ko‘rsatdi. Sinovda 50 yoshli bemor uchun risk 99.38% bo‘lib, natija “Yuqori xavf” sifatida baholandi.



2-rasm. Yakka bemor bo‘yicha AI qarorini SHAP orqali izohlash

Cardiovascular Disease datasetida Hist Gradient Boosting 0.7345 accuracy va 0.8029 AUC, XGBoost esa 0.7340 accuracy va 0.8033 AUC ko‘rsatdi. Tanlash mezoni Recall -> F1-score -> AUC -> Accuracy bo‘yicha Extra Trees modeli amaliy dasturda eng yaxshi model sifatida belgilandi. Sinovda 49 yoshli ayol bemor uchun risk 18.67% bo‘lib, “Past xavf” natijasi olindi.

Model	Accuracy	Precision	Recall	F1-score	AUC
Logistic Regression	0.7250	0.7476	0.6706	0.7070	0.7923
Random Forest	0.7108	0.7126	0.6962	0.7043	0.7732
Extra Trees	0.7010	0.6973	0.6993	0.6983	0.7539
Hist Gradient Boosting	0.7345	0.7540	0.6877	0.7193	0.8029
XGBoost	0.7340	0.7538	0.6868	0.7187	0.8033

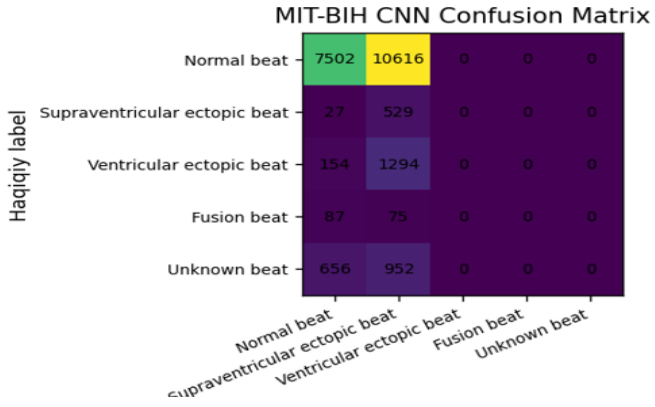
2-jadval. Cardiovascular Disease dataset bo‘yicha modellar natijalari

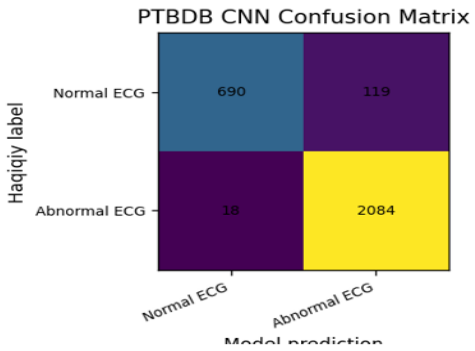
3-rasm. Cardiovascular AI bo‘limida model solishtirish va yakka bemor riskini baholash.

ECG bo‘limida PTBDB datasetida CNN modeli 0.9529 Accuracy, 0.9539 Precision, 0.9529 Recall va 0.9519 F1-score natijasiga erishdi. MIT-BIH datasetida esa 5 sinfli klassifikatsiyada 0.3668 Accuracy va 0.4697 F1-score olindi. Bu MIT-BIH uchun modelni yanada takomil-lashtirish zarurligini ko‘rsatadi.

Dataset	Model	Train	Test	Acc.	Prec.	Recall	F1
MIT-BIH	CNN	87554	21892	0.3668	0.7378	0.3668	0.4697
PTBDB	CNN	11641	2911	0.9529	0.9539	0.9529	0.9519

3-jadval. ECG CNN modeli natijalari





4-rasm. MIT-BIH va PTBDB datasetlari bo‘yicha CNN confusion matrix natijalari

Muhokama. UCI dataset bo‘yicha ayrim modellarda juda yuqori natija kuzatildi. Bunday holat datasetning ichki xususiyatlari, takrorlanishlar yoki train/test ajratish xususiyatlari bilan bog‘liq bo‘lishi mumkin. Shu sababli natijalar ichki test sifatida talqin qilinib, kross-validatsiya keyingi bosqich sifatida belgilandi.

Cardiovascular datasetda natijalar barqarorroq bo‘ldi. AUC bo‘yicha XGBoost va Hist Gradient Boosting ustunlik qildi, Recall mezoni bo‘yicha esa Extra Trees tanlandi. Tibbiy AI tizimlarida Recall muhim, chunki kasallik xavfi bor bemorni sog‘lom deb baholash klinik jihatdan xavfli xatolikdir.

PTBDB datasetidagi CNN natijasi ECG binary klassifikatsiyasida samarali bo‘ldi. MIT-BIH natijasi cheklov sifatida ko‘rsatildi: model ayrim sinflarni yetarlicha ajrata olmadi. Kelgusida focal loss, data augmentation, class balancing va chuqurroq 1D-CNN yoki ResNet arxitekturalari sinovdan o‘tkaziladi.

Xulosa. CardioAI-DSS dasturiy tizimi yurak-qon tomir kasalliklari xavfini baholash, klinik ma’lumotlarni tahlil qilish, ECG signallarini CNN orqali klassifikatsiya qilish va natijalarni bemorlar tarixida saqlash imkoniyatiga ega. Tizim shifokor tashxisini almashtirmaydi, balki dastlabki risk baholash va qaror qabul qilishni qo‘llab-quvvatlovchi yordamchi vosita sifatida foydalanilishi mumkin.

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