Predictive Power: Harnessing AI to Forecast Anemia Outcomes

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ADMN5008 – Applied Artificial Intelligence and Machine Learning

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**Questions for Sujoy Project**

**Question 1: What problem your application solves?**

The AI tool we created helps find out if someone has a common health issue called anemia. Anemia can happen for different reasons, and it's important to catch it early so that doctors can take care of it properly.

**Market Size:**

Lots of people around the world have anemia, a common health problem. Our AI tool for predicting anemia could help many of them. The World Health Organization says about 25% of all people globally have anemia. Certain groups of people are more likely to have it. So, there's a big potential market for our AI tool to make a positive impact.

In the context of the Canadian healthcare system, the application of AI for anemia prediction can bring both benefits and challenges.

**Potential Savings:**

1. **Efficient Resource Allocation:** The AI model allows for smarter use of healthcare resources by pinpointing specific cases and minimizing unnecessary expenditures.
2. **Prevention of Severe Cases:** Early detection through the AI model helps in stopping anemia from getting worse, easing the burden on the healthcare system by avoiding expensive and intensive treatments.

**Risks and Challenges:**

**Patient Data Security:** Using AI in healthcare involves dealing with private patient information. It's crucial to establish strong data privacy and security measures to comply with Canadian healthcare rules and uphold patient confidence.

1. **Workflow Integration:** Effectively fitting the AI model into existing healthcare processes is vital. Overcoming resistance to change, training healthcare staff, and ensuring smooth integration pose potential challenges.
2. **Ethical Considerations:** When using AI in healthcare, ethical worries like biased predictions need careful attention. Ensuring fair and unbiased outcomes is essential for maintaining ethical standards.
3. **Regulatory Adherence:** Meeting Canadian healthcare regulations is a must. The AI model must align with Health Canada rules and other applicable guidelines to ensure regulatory compliance.

**Question 2 - The performance of our model and comparison between them was.**

As assessed by several criteria, including accuracy, precision, recall, and f1-score, the AI models' predictions of anaemia show a high degree of accuracy. These measures are essential for assessing the models because they reveal information about both the models' accuracy in making predictions and their capacity to generalise to new, untested data.

**Logistic Regression Model**

At 99.06% accuracy, the Logistic Regression model performed exceptionally well. The confusion matrix shows that there were just four incorrect positive predictions and no false negative predictions made by the model. This is crucial information for medical diagnosis since failing to identify anaemia could have major consequences. The precision of 0.98 for class 1 (anaemic) and 1.00 for class 0 (non-anemic) indicates that the model's predictions are extremely accurate. In a similar vein, the recall score shows how well the model identified every anaemic instance that was included in the test set. Consistently high cross-validation scores indicate that the model is stable and would function well across many data subsets.

**Support Vector Machine (SVM) Model**

The SVM model, which had an accuracy score of 99.06%, also outperformed the Logistic Regression model. A strong degree of predictive ability is demonstrated by the precision and recall scores, which are the same as those of the logistic regression model. Although there is a small variation in the cross-validation scores, the SVM model exhibits robustness over various data folds, with an average score of 0.9887.

**K-Nearest Neighbors (KNN) Model**

With an accuracy of 96.49%, the KNN model with five neighbours performed somewhat worse than the earlier models. The confusion matrix, which has nine false positives and six false negatives, reflects this decline. The somewhat lower precision and recall show that, compared to the Logistic Regression and SVM models, the KNN model is more prone to misclassification even if it is still very successful. Despite being less accurate than the other models, the cross-validation scores (average of 0.9592) nevertheless show a good degree of accuracy.

**Comparative Analysis**

Both the SVM and the logistic regression models perform better than the other when compared, with almost the same metrics. They show excellent recall and precision, suggesting that they can accurately detect anaemia while reducing false positives. Even with its accuracy, the KNN model is not as good as the other models. This could be because the algorithm is more sensitive to the dimensions of the feature space and the choice of neighbours.

In addition to demonstrating that the Logistic Regression and SVM models are more resilient than the KNN model, the cross-validation findings also imply that these models are less susceptible to overfitting. For applications in medicine, where an incorrect prediction could have serious consequences, this robustness is essential.

In summary, the KNN model has proven to be marginally less successful and dependable than the SVM and Logistic Regression models in terms of anaemia prediction. Selecting the optimal model for use in a clinical environment requires careful consideration of the trade-offs between the models, including complexity, interpretability, and computational efficiency.

**Question 3: What is the monetary value and Risks of your application after its performance?**

Assigning specific monetary values and quantifying the risks and savings for the application predicting anemia would depend on various factors, including the prevalence of anemia, the effectiveness of the model, and the healthcare system's dynamics.

**Monetary Value:**

1. **Cost Savings from Early Detection:** The monetary value would include the savings from preventing the progression of anemia to more severe stages, reducing the need for costly treatments, hospitalizations, and other healthcare resources.
2. **Optimized Resource Allocation:** Efficient use of healthcare resources could lead to cost savings, as the AI model facilitates targeted interventions and avoids unnecessary tests or treatments.
3. **Preventing Complications:** By preventing complications associated with severe anemia, the application could save on long-term healthcare costs and improve the overall quality of life for affected individuals.

**Risks:**

1. **Misdiagnosis and Treatment Costs:** If the AI model provides inaccurate predictions, leading to unnecessary treatments or missed cases, it could result in increased healthcare costs and potential legal liabilities.
2. **Data Security Measures:** Failure to maintain robust data privacy and security measures may lead to financial losses due to legal consequences, reputational damage, and potential regulatory fines.
3. **Implementation Costs:** The initial costs associated with developing, integrating, and maintaining the AI application should be considered against the potential savings to determine the overall financial impact.
4. **Ethical and Legal Risks:** Ethical concerns or legal issues related to bias, fairness, and informed consent could result in financial repercussions, including legal fees and penalties.

**Question 4: Other risk and benefits**

**Risks:**

**Misdiagnosis:** There's a risk of the AI model providing incorrect predictions, leading to misdiagnosis, and potentially causing harm if not cross-verified by healthcare professionals.

1. **Limited Accessibility:** If the AI tool requires advanced technology or resources, there's a risk that it may not be accessible to all segments of the population, potentially exacerbating healthcare disparities.
2. **Algorithmic Bias:** The AI model may exhibit bias, leading to disparities in predictions based on factors like ethnicity or gender, which could result in unequal healthcare outcomes.
3. **Dependency on Technology:** Over-reliance on the AI model might reduce the emphasis on clinical judgment, potentially impacting the quality of patient care.

**Benefits:**

1. **Improved Outcomes:** Early detection facilitated by the AI model can lead to better patient outcomes through timely intervention and treatment.
2. **Cost-Efficiency:** Beyond direct cost savings, the model may contribute to overall cost-efficiency by streamlining processes and minimizing unnecessary tests or treatments.
3. **Population Health Management:** The AI model can aid in population-level health management by identifying trends and patterns in anemia prevalence, enabling targeted public health interventions.
4. **Enhanced Research Opportunities:** Aggregated and anonymized data from the AI model can contribute to medical research, fostering a better understanding of anemia and related health issues.

**Conclusions and Recommendations:**

Our exploration of AI models like Logistic Regression, SVM, and KNN has revealed their potential in effectively predicting anemia with impressive accuracy and dependability. These AI-powered tools bring significant benefits, notably in early detection and improved patient outcomes, which can lead to cost-efficient healthcare delivery and offer deeper insights for managing population health. Yet, the successful implementation of such technology within the healthcare system demands rigorous safeguards for patient data security, strict adherence to ethical standards, and smooth integration into existing workflows, all within the framework of Canadian regulatory guidelines. This innovative approach is set to transform the landscape of anemia diagnosis and also heralds a new era of expansive AI applications in healthcare, fostering a synergy between technology and medical practice that promises to substantially elevate both patient care and the effectiveness of treatments.

Strategic Recommendations for AI Deployment in Healthcare

**Strengthening Data Security and Privacy Measures:**

It is imperative to build a strong cybersecurity infrastructure designed to shield patient data, ensuring compliance with the stringent privacy regulations of Canadian healthcare. A commitment to regular security updates and audits, combined with thorough training in data privacy best practices for healthcare staff, will fortify the trust and safety necessary for the adoption of AI technologies.

**Cultivating Interdisciplinary Collaboration:**

We recommend fostering strong alliances among AI developers, healthcare providers, and policymakers. Such partnerships are essential for the AI model's continual enhancement, with a keen focus on maintaining accuracy and addressing ethical concerns. Leveraging feedback from medical personnel and patients is vital for refining the AI system to meet the real-world needs of healthcare delivery.

**Ensuring Ongoing Monitoring and Evolution of AI Algorithms:**

To guarantee the AI model's precision and ethical application, ongoing monitoring is crucial. We advocate for the periodic updating of algorithms to reflect the latest medical research and patient data trends. Moreover, it is crucial to remain flexible and responsive to the rapidly evolving landscape of AI and medical technology, ensuring that the healthcare sector can capitalize on new advancements to deliver the highest quality of care.

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**Githubs:**

Radhika’s Github Repository: <https://github.com/Radhika13100/Anemia-Dataset>

Vandit’s Github Repository: <https://github.com/Vandit1906/Anemia>