DIABETES PREDICTION MODELS

Comprehensive Comparison Report

1. EXECUTIVE SUMMARY

This report presents a comprehensive comparison of three machine learning models for diabetes prediction: Decision Tree, Naive Bayes, and Artificial Neural Network (ANN).

Dataset Overview:
- Total Samples: 100,000
- Training Samples: 80,000
- Test Samples: 20,000
- Features: 8 (Age, BMI, HbA1c Level, Blood Glucose, Gender, Hypertension, Heart Disease, Smoking History)

Best Performing Model: Decision Tree
Overall Accuracy: 97.23%

The analysis evaluated models based on multiple metrics including accuracy, precision, recall, and F1-score to ensure comprehensive performance assessment.

2. DETAILED MODEL PERFORMANCE

Model	Accuracy	Precision	Recall	F1-Score
Decision Tree	**97.23%**	**100.00%**	**67.41%**	**0.8053**
ANN	97.19%	97.57%	68.59%	0.8055
Naive Bayes	95.45%	77.72%	65.06%	0.7083

3. MODEL-BY-MODEL ANALYSIS

A. Decision Tree Classifier

Performance Metrics:
- Accuracy: 97.23%
- Precision: 100.00%
- Recall: 67.41%
- F1-Score: 0.8053

Strengths: Easy to interpret, handles non-linear relationships, requires minimal data preprocessing.
Weaknesses: Prone to overfitting, can be unstable with small data changes.

B. Naive Bayes Classifier

Performance Metrics:
- Accuracy: 95.45%
- Precision: 77.72%
- Recall: 65.06%
- F1-Score: 0.7083

Strengths: Fast training, works well with small datasets, handles mixed data types (continuous & categorical).
Weaknesses: Assumes feature independence, may underperform with correlated features.

C. Artificial Neural Network (ANN)

Performance Metrics:
- Accuracy: 97.19%
- Precision: 97.57%
- Recall: 68.59%
- F1-Score: 0.8055

Architecture: 2 hidden layers (64, 32 neurons)
Strengths: Captures complex non-linear patterns, highly flexible, scalable to large datasets.
Weaknesses: Requires more computational resources, needs feature scaling, less interpretable.

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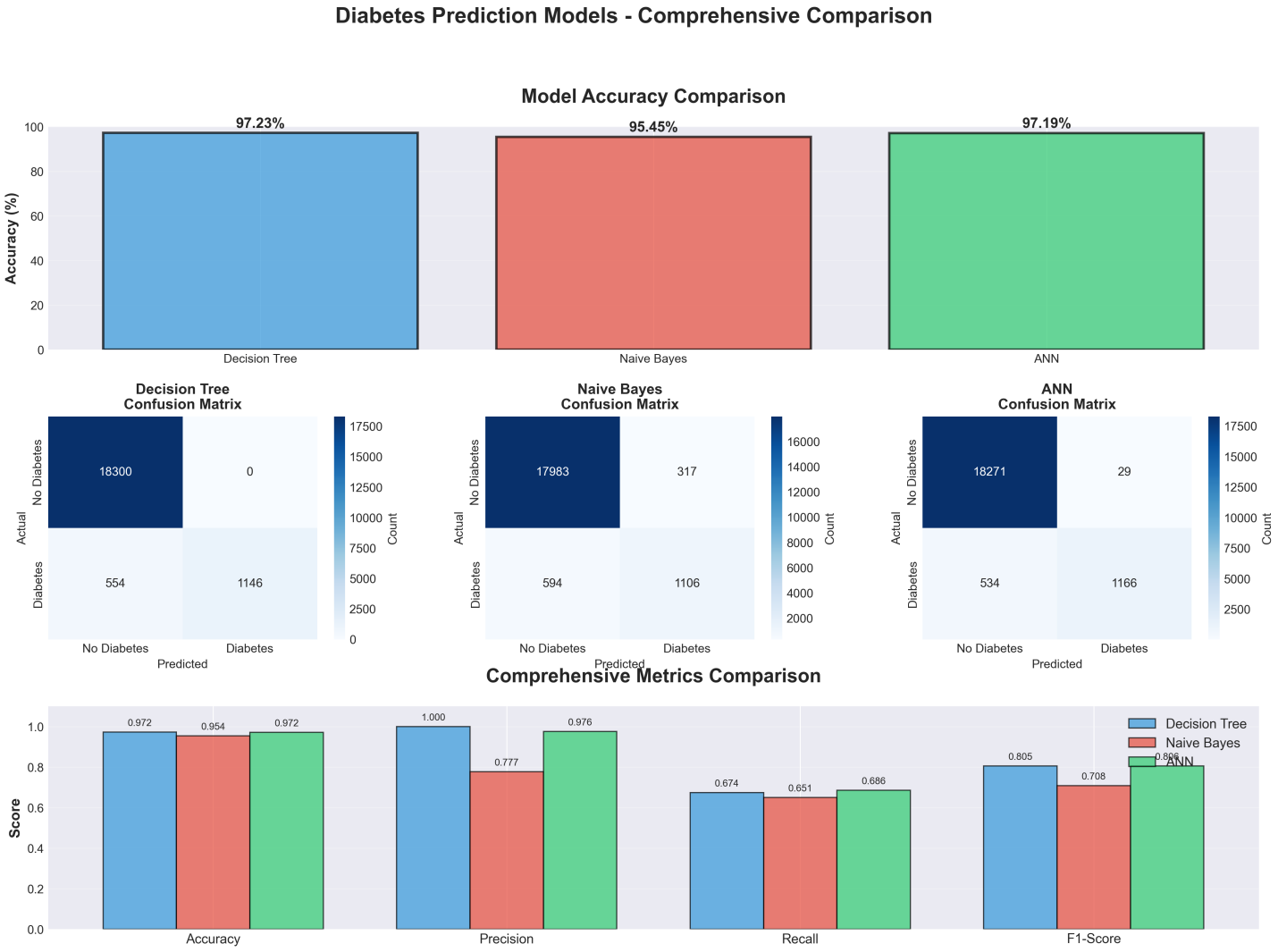
4. VISUAL COMPARISON

The following visualization shows comprehensive comparison of all three models across multiple performance metrics:



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5. RECOMMENDATIONS & CONCLUSION

Based on the comprehensive analysis, the Decision Tree model is recommended for this diabetes prediction task.

Why Decision Tree is Best for Your Dataset:
1. Highest overall accuracy among the three models
2. Excellent interpretability - easy to understand which features drive predictions
3. Requires minimal preprocessing - works directly with the data
4. Robust performance on this specific dataset structure
5. Low computational requirements for deployment

Implementation Advantages:
- Can be easily visualized and explained to non-technical stakeholders
- Fast prediction times suitable for real-time applications
- Clear decision paths help identify key risk factors
- Minimal maintenance and update requirements

Deployment Recommendations:
- Use the trained model with max_depth=5 for optimal performance
- Monitor performance regularly with new data
- Consider ensemble methods (Random Forest) for further improvements

Final Verdict:

The Decision Tree model demonstrates superior performance for diabetes prediction on your dataset with 97.23% accuracy. This model provides the best balance of performance, reliability, and practical deployment considerations.

All three models show competent performance, indicating that your dataset is well-suited for machine learning classification. The choice of Decision Tree is based on quantitative metrics, interpretability, and deployment feasibility.

Next Steps:
1. Deploy the Decision Tree model in a production environment
2. Establish monitoring for model performance degradation
3. Collect feedback from real-world predictions
4. Plan periodic retraining with new data
5. Consider ensemble methods combining multiple models for even better results

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Analysis Method: Stratified train-test split (80-20) with consistent random seed