# Data Analytics and Reporting (DAR) – Modular Assignment 5

# Module 5: Reports for Data Analysis

**Duration: 4 hours**

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## Problem Statement

Create a comprehensive suite of analytical reports demonstrating the four levels of analytics: descriptive, diagnostic, predictive, and prescriptive. Develop specialized reports including KPI dashboards, diagnostic drill-downs, predictive models, and AI/ML-based prescriptive recommendations.

You are required to build an end-to-end analytics reporting system that progresses from basic descriptive statistics to advanced AI-driven recommendations.

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## Data Sources

Choose ONE comprehensive business scenario:

### Analytics-Rich Domains:

1. **Customer Analytics Platform**
   - Customer transaction history
   - Behavioral data (web clicks, app usage)
   - Demographics and preferences
   - Support interactions and satisfaction scores
   - Kaggle: Customer Behavior, E-commerce datasets
2. **Supply Chain Analytics**
   - Inventory levels and movements
   - Supplier performance data
   - Demand forecasting variables
   - Logistics and delivery metrics
   - Kaggle: Supply Chain, Manufacturing datasets
3. **Marketing Campaign Analytics**
   - Campaign performance metrics
   - Customer acquisition costs
   - Conversion funnels
   - Attribution data across channels
   - Kaggle: Marketing Analytics, Digital Marketing datasets

4. **Financial Risk Analytics**
   - Loan default data
   - Credit scores and financial ratios
   - Market indicators
   - Regulatory compliance metrics
   - Kaggle: Credit Risk, Financial datasets

### Required Data Characteristics:

- Time series data for trend analysis (minimum 2 years)
- Multiple dimensions for drill-down analysis
- Target variables for predictive modeling
- Business KPIs that can be calculated and monitored

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## Assignment Requirements

### Part A: Descriptive Analysis and KPI Dashboards (60 minutes)

#### *Tasks:*

1. **KPI Dashboard Development (35 minutes)**
   - Identify and define key business KPIs:
     - Primary KPIs (revenue, growth, efficiency metrics)
     - Secondary KPIs (quality, satisfaction, operational metrics)
     - Leading and lagging indicators
   - Create interactive KPI dashboard with:
     - Real-time KPI monitoring
     - Trend visualization over time
     - Target vs. actual comparisons
     - Alert mechanisms for threshold breaches
     - Implement KPI hierarchies and relationships
2. **Periodic Reporting System (25 minutes)**
   - Design automated periodic reports:
     - Daily Reports: Operational metrics and alerts
     - Weekly Reports: Performance summaries and trends
     - Monthly Reports: Comprehensive business review
     - Quarterly Reports: Strategic performance analysis
   - Create report templates with consistent formatting
   - Implement automated report generation and distribution
   - Add executive summary sections with key insights

#### *Expected Deliverables:*

- Interactive KPI dashboard with real-time updates
- Automated periodic report templates

- KPI definition document with business context
- Alert and notification system documentation

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### Part B: Diagnostic Analysis and Root Cause Investigation (70 minutes)

***Tasks:***

1. **Drill-Down Analysis Framework (40 minutes)**
   - Implement multi-dimensional drill-down capabilities:
     - Geographic drill-downs (region → country → city)
     - Time-based drill-downs (year → quarter → month → day)
     - Product/service drill-downs (category → subcategory → item)
     - Customer segment drill-downs (demographics, behavior, value)
   - Create interactive filtering and slicing mechanisms
   - Develop comparative analysis tools (period-over-period, segment comparison)
   - Build exception reporting for anomaly detection
2. **Root Cause Analysis Tools (30 minutes)**
   - Design diagnostic workflows for common business problems:
     - Revenue decline investigation
     - Customer churn analysis
     - Operational efficiency issues
     - Quality problems identification
   - Implement statistical correlation analysis
   - Create cause-and-effect visualization tools
   - Develop hypothesis testing frameworks
   - Build automated diagnostic recommendations

***Expected Deliverables:***

- Multi-dimensional drill-down interface
- Root cause analysis workflow documentation
- Diagnostic report templates with statistical analysis
- Exception and anomaly detection system
- Correlation analysis tools and visualizations

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### Part C: Predictive Analytics and Forecasting (70 minutes)

***Tasks:***

1. **Predictive Model Development (45 minutes)**
   - Build forecasting models for key business metrics:
     - Sales/revenue forecasting (time series analysis)
     - Customer lifetime value prediction
     - Demand forecasting for inventory management

        - Risk assessment models (churn, default, fraud)
    - Implement multiple modeling approaches:
        - Statistical models (ARIMA, exponential smoothing)
        - Machine learning models (regression, decision trees, ensemble methods)
        - Deep learning models (neural networks for complex patterns)
    - Create model validation and performance tracking
    - Develop confidence intervals and uncertainty quantification
2. **Predictive Reporting System (25 minutes)**
    - Design forward-looking reports and dashboards:
        - Forecast accuracy tracking and model performance
        - Scenario analysis and what-if modeling
        - Early warning systems for business risks
        - Predictive insights integration with operational reports
    - Create automated model retraining and updating processes
    - Implement model explainability and interpretation tools
    - Build forecast vs. actual comparison reports

***Expected Deliverables:***

- Predictive models with documented methodology
- Forecast accuracy tracking system
- Scenario analysis tools and what-if modeling interface
- Early warning system with automated alerts
- Model performance monitoring dashboard
- Predictive insights integration documentation

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### Part D: Prescriptive Analytics and AI-Driven Recommendations (40 minutes)

***Tasks:***

1. **Optimization and Recommendation Engine (25 minutes)**
    - Develop prescriptive analytics solutions:
        - Resource allocation optimization
        - Pricing strategy recommendations
        - Marketing campaign optimization
        - Inventory management recommendations
    - Implement decision support systems:
        - Multi-criteria decision analysis
        - Constraint-based optimization
        - Simulation-based optimization
        - AI-powered recommendation algorithms
    - Create action-oriented insights and recommendations

- Build ROI calculation for recommended actions

2. **AI-Enhanced Reporting and Insights (15 minutes)**
   - Integrate AI/ML capabilities into reporting:
     - Natural language generation for automated insights
     - Intelligent data storytelling
     - Automated pattern recognition and insight discovery
     - Personalized reporting based on user roles and preferences
   - Implement advanced analytics features:
     - Automated anomaly explanation
     - Trend significance testing
     - Predictive alerts with recommended actions
     - Dynamic report generation based on data patterns

***Expected Deliverables:***

- Optimization models and recommendation engine
- Decision support system with action recommendations
- ROI calculation framework for recommended actions
- AI-enhanced reporting system with natural language insights
- Automated insight discovery and explanation tools
- Personalized reporting interface

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## Evaluation Rubrics (Total: 100 Marks/Points)

### Part A: Descriptive Analysis and KPI Dashboards (25 Points)

#### *KPI Dashboard Development (15 Points)*

- **Excellent (13-15 points)**: Comprehensive KPI identification with clear business context, interactive dashboard with real-time updates, proper KPI hierarchies, and effective alert mechanisms
- **Good (10-12 points)**: Good KPI selection with adequate dashboard functionality, some interactive features, basic alert system
- **Satisfactory (7-9 points)**: Basic KPI dashboard with limited interactivity, minimal alert functionality
- **Needs Improvement (4-6 points)**: Incomplete KPI identification, static dashboard with poor functionality
- **Unsatisfactory (0-3 points)**: Missing or non-functional dashboard, inappropriate KPI selection

#### *Periodic Reporting System (10 Points)*

- **Excellent (9-10 points)**: Well-designed automated reports for all periods, consistent formatting, executive summaries with actionable insights

- **Good (7-8 points)**: Good report templates with automation, adequate formatting and insights
- **Satisfactory (5-6 points)**: Basic report templates with limited automation
- **Needs Improvement (3-4 points)**: Incomplete reporting system, poor formatting
- **Unsatisfactory (0-2 points)**: Missing or inadequate reporting system

### Part B: Diagnostic Analysis and Root Cause Investigation (25 Points)

#### *Drill-Down Analysis Framework (15 Points)*

- **Excellent (13-15 points)**: Comprehensive multi-dimensional drill-down with smooth navigation, effective filtering, comparative analysis tools, and exception reporting
- **Good (10-12 points)**: Good drill-down capabilities with adequate filtering and comparison features
- **Satisfactory (7-9 points)**: Basic drill-down functionality with limited dimensions
- **Needs Improvement (4-6 points)**: Incomplete drill-down system with poor navigation
- **Unsatisfactory (0-3 points)**: Missing or non-functional drill-down capabilities

#### *Root Cause Analysis Tools (10 Points)*

- **Excellent (9-10 points)**: Sophisticated diagnostic workflows, statistical correlation analysis, automated recommendations, effective visualization
- **Good (7-8 points)**: Good diagnostic tools with adequate statistical analysis
- **Satisfactory (5-6 points)**: Basic root cause analysis with limited statistical support
- **Needs Improvement (3-4 points)**: Incomplete diagnostic tools, poor analysis quality
- **Unsatisfactory (0-2 points)**: Missing or inadequate root cause analysis

### Part C: Predictive Analytics and Forecasting (25 Points)

#### *Predictive Model Development (15 Points)*

- **Excellent (13-15 points)**: Multiple sophisticated models with proper validation, uncertainty quantification, excellent performance tracking, and comprehensive methodology documentation
- **Good (10-12 points)**: Good predictive models with adequate validation and performance tracking
- **Satisfactory (7-9 points)**: Basic predictive models with limited validation
- **Needs Improvement (4-6 points)**: Incomplete models with poor validation or documentation
- **Unsatisfactory (0-3 points)**: Missing or non-functional predictive models

#### *Predictive Reporting System (10 Points)*

- **Excellent (9-10 points)**: Comprehensive forecast tracking, scenario analysis, early warning systems, model explainability
- **Good (7-8 points)**: Good predictive reporting with adequate tracking and scenario analysis

- **Satisfactory (5-6 points)**: Basic predictive reports with limited functionality
- **Needs Improvement (3-4 points)**: Incomplete predictive reporting system
- **Unsatisfactory (0-2 points)**: Missing or inadequate predictive reporting

### Part D: Prescriptive Analytics and AI-Driven Recommendations (25 Points)

#### *Optimization and Recommendation Engine (15 Points)*

- **Excellent (13-15 points)**: Sophisticated optimization models, comprehensive recommendation engine, ROI calculations, effective decision support system
- **Good (10-12 points)**: Good optimization tools with adequate recommendation capabilities
- **Satisfactory (7-9 points)**: Basic optimization with limited recommendation features
- **Needs Improvement (4-6 points)**: Incomplete optimization system, poor recommendations
- **Unsatisfactory (0-3 points)**: Missing or non-functional optimization and recommendations

#### *AI-Enhanced Reporting and Insights (10 Points)*

- **Excellent (9-10 points)**: Advanced AI integration, natural language generation, automated insight discovery, personalized reporting
- **Good (7-8 points)**: Good AI features with adequate automation and personalization
- **Satisfactory (5-6 points)**: Basic AI integration with limited automation
- **Needs Improvement (3-4 points)**: Incomplete AI features, poor automation
- **Unsatisfactory (0-2 points)**: Missing or inadequate AI-enhanced features

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## Technical Requirements

### Tools and Technologies:

- **Data Analysis**: Python (pandas, numpy, scipy) or R
- **Visualization**: Tableau, Power BI, or Python (matplotlib, seaborn, plotly)
- **Machine Learning**: scikit-learn, TensorFlow, or similar frameworks
- **Database**: SQL-compatible database for data storage
- **Reporting**: Jupyter Notebooks, R Markdown, or similar documentation tools
- **Dashboard Development**: Streamlit, Dash, Shiny, or BI tools

### Data Requirements:

- Minimum 10,000 records with temporal dimension
- At least 5 key performance indicators
- Multiple categorical and numerical variables
- Historical data spanning minimum 24 months
- Clear business context and domain knowledge

### Performance Standards:

- Dashboard response time < 3 seconds
- Report generation time < 30 seconds
- Model training time < 10 minutes
- Forecast accuracy > 80% for validation period
- System uptime > 99% during demonstration

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## Submission Requirements

### Deliverable Package:

1. **Complete Analytics Platform** (working system/application)
2. **Technical Documentation** (15-20 pages)
   - System architecture and design decisions
   - Data preprocessing and cleaning procedures
   - Model development methodology and validation
   - Dashboard and reporting system documentation
   - User guide and system administration manual
3. **Business Report** (10-15 pages)
   - Executive summary with key findings
   - Business insights and recommendations
   - ROI analysis for implemented solutions
   - Future enhancement roadmap
   - Risk assessment and mitigation strategies
4. **Presentation Materials** (15-20 slides)
   - System demonstration script
   - Key features and capabilities overview
   - Business value proposition
   - Technical architecture highlights
   - Implementation timeline and milestones
5. **Source Code and Configuration**
   - Well-commented source code
   - Configuration files and setup instructions
   - Data schemas and sample datasets
   - Deployment and installation guides
   - Testing procedures and validation scripts

### Demonstration Requirements:

- **Live System Demo** (15 minutes): Full system walkthrough
- **Q&A Session** (10 minutes): Technical and business questions
- **Performance Testing** (5 minutes): System responsiveness and accuracy

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## Assignment Guidelines

### Time Management:

- **Part A**: 60 minutes (25% of total time)
- **Part B**: 70 minutes (29% of total time)
- **Part C**: 70 minutes (29% of total time)
- **Part D**: 40 minutes (17% of total time)

### Quality Standards:

- **Code Quality**: Clean, well-documented, modular code
- **User Experience**: Intuitive interface design and navigation
- **Performance**: Responsive system with acceptable load times
- **Accuracy**: Validated models with documented performance metrics
- **Business Relevance**: Clear connection to business value and ROI

### Evaluation Criteria:

- **Technical Implementation** (40%): System functionality and code quality
- **Business Value** (30%): Practical applicability and ROI demonstration
- **Innovation and Creativity** (15%): Novel approaches and advanced features
- **Documentation and Presentation** (15%): Clear communication and documentation

### Success Metrics:

- All four analytics levels successfully implemented
- Functional end-to-end system with user-friendly interface
- Documented business value and ROI justification
- Scalable architecture supporting future enhancements
- Comprehensive testing and validation procedures

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## Support Resources

### Learning Materials:

- Course lecture notes and video recordings
- Recommended textbooks and online resources
- Sample datasets and code templates
- Best practices documentation
- Industry case studies and examples

### Technical Support:

- Office hours with instructors and TAs
- Online discussion forums and Q&A sessions
- Technical documentation and troubleshooting guides
- Peer collaboration and study groups

- External resource recommendations

### Business Context:

- Industry expert guest lectures
- Real-world case study analysis
- Business stakeholder interview opportunities
- Professional networking events
- Career guidance and mentorship programs

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**Note**: This assignment is designed to provide comprehensive experience in building end-to-end analytics solutions that deliver measurable business value. Focus on creating practical, scalable systems that demonstrate mastery of all four levels of analytics while maintaining strong business relevance and user experience.