Using Esri's GeoAI Capabilities for the Charlotte Risk Intelligence Dashboard

1. Introduction

The Charlotte Risk Intelligence Dashboard aims to visualize and assess emergency risk across Charlotte, NC, by integrating interactive maps with fire station coverage, environmental factors, and potentially historical call data. As the project expands, incorporating **artificial intelligence (AI)** can significantly enhance prediction, analysis, and decision-making.

Esri, the global leader in Geographic Information Systems (GIS), offers robust AI-powered mapping tools that could be directly applied to this project. This document explores **Esri's GeoAI capabilities** and proposes how they can be adapted for intelligent risk analysis in Charlotte.

---

2. What is GeoAI?

GeoAI (Geospatial Artificial Intelligence) refers to the integration of AI techniques (such as machine learning and deep learning) with geographic data to identify patterns, make predictions, and support decision-making in spatial contexts.

Esri enables GeoAI through its **ArcGIS platform**, offering tools for:

- Training custom models
- Analyzing spatial trends
- Detecting anomalies in real time
- Visualizing AI outcomes on maps

---

3. Core Esri AI Tools

3.1 ArcGIS GeoAnalytics + Machine Learning

- Allows you to apply ML models to large-scale geospatial data

- Integrates with **scikit-learn**, **TensorFlow**, and **PyTorch**
- Examples: Predict areas of high incident risk, classify zones by call volume or response time

3.2 Deep Learning with ArcGIS Pro

- Train deep learning models (e.g., CNNs) to detect and classify map features from imagery
- Use tools like:
    - Object detection (e.g., rooftops, roads)
    - Image classification (e.g., land cover, urban vs. rural)

3.3 ArcGIS Notebooks

- A hosted Jupyter Notebook environment inside ArcGIS
- Combines **Python + GIS** for data science
- Ideal for scripting models to analyze CFD incident patterns or simulate emergencies

3.4 ArcGIS Velocity

- Handles **real-time data ingestion and AI analysis**
- Can consume weather feeds, sensor data, or 911 call data (if available)
- Automatically triggers alerts based on AI risk detection models

3.5 Esri ModelBuilder

- A no-code tool for building visual data workflows
- Useful for training CFD staff to use AI without writing code

---

4. Proposed Applications for the Charlotte Risk Intelligence Dashboard

Feature	Esri AI Capability	Use Case
Risk Prediction Model	ArcGIS GeoAnalytics + ML	Predict which census tracts are most likely to experience fire-related incidents using 20+ years of call history
Environmental Risk Layer	ArcGIS Velocity + Weather APIs	Ingest real-time weather (heatwaves, storms) and evaluate population vulnerability
Incident Simulation	ArcGIS Notebooks + Deep Learning	Simulate emergency scenarios to assess how response time changes based on traffic, location, or weather
AI Chatbot Integration	ArcGIS Notebooks + OpenAI API	Embed a chatbot to answer safety questions and explain risk patterns
Dynamic Fire Station Zones	ModelBuilder + GeoAI	Use AI to redraw response zones based on recent incident data, population growth, or building development

---

5. Data Sources Required

To fully leverage Esri's AI:

- **20 years of CFD incident data**
- **Census + demographic data**
- **Weather and climate feeds (e.g., NOAA, AccuWeather APIs)**
- **Zoning/building permit data**
- **Infrastructure and traffic flow maps**

---

6. Integration Strategy

1. **Import historical and real-time data into ArcGIS Online**
2. **Use ArcGIS Notebooks** to preprocess and explore patterns
3. **Train AI models** to detect high-risk areas or classify event types
4. **Embed models and outputs in the Charlotte dashboard**
5. **Optional**: Integrate chatbot support to allow natural language queries like "Where is fire risk highest right now?"

---

7. Benefits for the Charlotte Fire Department

- **Proactive risk management** based on forecasted conditions
- **Smarter resource deployment** using AI-predicted hotspots
- **Improved public safety** by identifying vulnerable communities
- **Real-time situational awareness** during large-scale incidents

---

8. Challenges & Considerations

- **Data access**: Incident and real-time data must be available and formatted correctly
- **Training**: CFD staff may require onboarding for Esri's AI tools
- **Costs**: Advanced Esri AI features may require licensing (ArcGIS Pro, ArcGIS Velocity, etc.)

---

9. Conclusion

Integrating Esri's GeoAI tools into the Charlotte Risk Intelligence Dashboard represents a powerful step toward a **smarter, AI-driven public safety ecosystem**. With the CFD's extensive historical data and Esri's advanced modeling and visualization capabilities, this project can become a national example of AI-powered emergency planning.

Integrating Esri's GeoAI with the Charlotte Risk Intelligence Dashboard

---

What is GeoAI?

GeoAI = Geospatial + Artificial Intelligence
Esri's GeoAI blends machine learning with map-based data to:

- Analyze spatial trends
- Predict high-risk zones
- Automate decisions based on real-time feeds

🛠 Esri AI Tools Overview

Tool	What It Does	Use Case
ArcGIS GeoAnalytics	Run ML models on spatial data	Predict hotspots
ArcGIS Pro + Deep Learning	Train custom vision models	Image analysis (e.g., building density)
ArcGIS Notebooks	Python + GIS scripting	Automate incident simulations
ArcGIS Velocity	Real-time data + AI	Monitor weather/sensor feeds
ModelBuilder	No-code workflows	Teach AI to non-programmers

How It Applies to Charlotte

Dashboard Feature	Esri AI Feature	Description
Risk Forecasting	GeoAnalytics + ML	Train on 20+ years of CFD data to predict high-risk tracts
Live Weather Risk	ArcGIS Velocity	Auto-update maps with heatwaves, floods
Emergency Simulations	ArcGIS Notebooks	“What if” tools for command planning
Dynamic Zone Mapping	Deep Learning	Re-draw fire station zones based on updated threats
AI Assistant (future)	OpenAI + Esri Chatbot	Ask: “Where is the highest risk now?”

Data Sources You’ll Need

- Historical 911 call & incident data
- Weather feeds (NOAA, AccuWeather APIs)
- Population/demographics (Census Bureau)
- Zoning + traffic data (City of Charlotte GIS)
- Charlotte Fire Station response zones

Benefits for CFD

- **Predictive deployments** before emergencies happen
- **Real-time awareness** of conditions (heat, storms, flooding)
- **Smart simulations** for training and planning

- **Community transparency** and trust via public dashboards

Challenges

- Accessing & cleaning historical data
- Budgeting for ArcGIS Pro or Velocity licenses
- Training staff to manage and update models
- Need for responsible AI validation before public use

Sources & References

- Esri: Integrating AI with GIS
- Esri GeoAI Hub
- ArcGIS Velocity Overview
- ArcGIS Notebooks
- Esri Deep Learning Tools
- Charlotte Open Data Portal
- NOAA APIs for historical and real-time weather: https://www.ncdc.noaa.gov/cdo-web/webservices/v2