PARTNER: A Geospatial Solution for Evidence-Based Police Patrolling

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Background:
Project idea

- Personal Interest
  - Undergrad capstone was international money laundering scenarios
  - Close work with Department of State Diplomatic Security as an Embassy Guard

- Professional Interest
  - Imagery Analyst by trade
  - Recently completed Deployment to EUCOM building web applications
Background:
Problem Development

- Aid law enforcement in the following:
  - Community Transparency
  - Provide intelligence centered on historic data
  - Alleviate bias through evidence-based decision making

- Solution:
  - Develop a tool that leverages historical analysis to provide a patrol solution that allows information to be used in conjunction with a patrol officer’s expertise.
    - A tool that performs route development based on hotspot analysis to “link” high-density crime areas
Project Area:
22401 - Fredericksburg, VA

- Fredericksburg is located 48 miles south of Washington, D.C. and 53 miles north of Richmond.
- Total area is approximately 10.5 square miles.
- As of the 2021 census, the population was 28,367.
- There are four zones that the police department uses as patrolling areas - not depicted.
Goals and objectives

- Transparency of the Local Police Force
  Community access to the tool and the underlying crime data
- Further hotspot analysis conducted for crime in an area
  Typical analysis develops the hotspots and zonal analysis but does little to combine the results of analysis into something actionable
- Develop a solution that is mobile and repeatable
  Design will need to include the various ways to share the output OR the tool
  Automate the geoprocessing steps to minimize user input to facilitate user analysis
  Design has the option to be applied to any police department or jurisdiction
METHODOLOGY

“The application of GIS is limited only by the imagination of those who use it”. ~ Jack Dangermond, Esri
Methodology: Data Acquisition

- Step 1: minimal data layers to start are required
- A road network
  - Road network provided by City GIS
- Crime points
  - Crimes were extracted from Police communication records provided by FOIA request

<table>
<thead>
<tr>
<th>Report #</th>
<th>Call Time</th>
<th>Nature</th>
<th>Location</th>
<th>Prime Unit</th>
<th>Disp.</th>
<th>Close Time</th>
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<td>MENTAL HEALTH</td>
<td>1225 PARCELL ST</td>
<td>COM</td>
<td>03/09/2022 11:06:06</td>
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<td>03/09/2022 11:53</td>
<td>VEHICLE STOP</td>
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<td>VVR</td>
<td>03/09/2022 11:55:35</td>
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<td>03/09/2022 11:08</td>
<td>ASSIST</td>
<td>2200 COWAN BLVD</td>
<td>ASTD</td>
<td>03/09/2022 12:07:19</td>
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<td>SLU</td>
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<td>03/09/2022 10:26</td>
<td>POLICE</td>
<td>1001 CADMUS CT</td>
<td>NOA</td>
<td>03/09/2022 11:21:23</td>
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</tbody>
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2022001146
03/09/2022 10:24 | HIT RUN ACCIDENT | 1201 GATEWAY BLVD | 308 | RPT | 03/09/2022 11:53:40 |
03/09/2022 11:41 | BOLO             | 900 SPOTSY ECO LEFT 600 | 03/09/2022 11:42:33 |
03/09/2022 11:03 | FOLLOW UP        | LPO - IRBY         | LOG               | 03/09/2022 11:26:17 |
03/09/2022 12:03 | FRAUD            | ITC               | 03/09/2022 12:03:30 |
03/09/2022 12:18 | 911 HANGUP       | 1301-100 SAM PERRY | MISD             | 03/09/2022 12:20:36 |
03/09/2022 12:19 | MENTAL HEALTH    | TOWNSEND.SHEILA | LOG               | 03/09/2022 12:20:23 |
03/09/2022 12:56 | MENTAL HEALTH    | 1704 LAFAYETTE BLVD | ADVS  | 03/09/2022 12:16:04 |
03/09/2022 12:34 | CHECK WELFARE    | 447 EMANOPATION HWY | DUP  | 03/09/2022 12:40:08 |
03/09/2022 12:40 | LARCENY          | LOG               | 03/09/2022 12:49:15 |
03/09/2022 12:40 | FOLLOW UP        | LPO - GREEN        | LOG               | 03/09/2022 13:03:47 |
03/09/2022 12:42 | FOLLOW UP        | LPO - JACKSON      | LOG               | 03/09/2022 13:02:05 |
03/09/2022 14:16 | FOUND PROPERTY   | 1300 AUGUSTINE AVE | 307 | ADVS | 03/09/2022 14:44:25 |
03/09/2022 13:26 | MVA PROPERTY     | 900 BLUE GRAY PKWY | ITC             | 03/09/2022 13:27:30 |

2022001149
03/09/2022 12:36 | DRINKING IN PUBLIC | 110 GOCOLOE DR  | 336 | RPT  | 03/09/2022 14:20:57 |
03/09/2022 17:18 | ASSAULT           | 1001 SAM PERRY BLVD | 341 | RPT  | 03/09/2022 18:06:11 |
03/09/2022 13:45 | VANDALISM         | 1901-A HOWARD AVE | 313 | RPT  | 03/09/2022 14:51:40 |
03/09/2022 13:25 | VEHICLE STOP      | 512 LAFAYETTE BLVD | 517 | WWR  | 03/09/2022 13:35:00 |
03/09/2022 15:07 | EMERGENCY         | 600 JACKSON ST | DUP  | 03/09/2022 15:08:32 |

Nature
- ASSAULT
- B & E IN PROGRESS
- DOMESTIC
- DRUG ACTIVITY
- LARCENY
- NARCOTICS
- PROSTITUTION
- ROBBERY
- SEX OFFENSE
- STABBING
- STALKING
- VANDALISM
Methodology:
Areal Analysis

- Step 2: Create a tessellation in each zone
  - This is to aggregate the crime into equal-sized areas
  - Data was hexagonally binned using the City boundary obtained by the City GIS

- Step 3: Join Crimes to the Tessellation
  - *Summarize Incident Count* to have the crime types and count per record of tessellation

- Step 4: Convert the Tessellation polygons to points for ingestion to route development
Methodology:
Database infrastructure for Analysis

- Step 5: Prepare to create a network dataset
  - Create a Feature dataset and add the road network
  - Create a network dataset
  - Create a Route Network Analysis Layer

- Step 6: Import points to the Route Analysis Layer
  - To identify which points, Select from the tessellation points a crime count that is higher than average. Add Locations tool will import the selection as Stops to the Route Analysis Layer

- Step 7: Solve the Route
  - On the order of point ingestion, a route can be developed

Conclusion: Route creation with “stops” at each hotspot generated within the tessellation, unique to each zones data.
PARTNER MODEL

Preliminary Analytic RouTing for Neighborhood Emergency Response
Demonstration
Results

Ideal Solution: An Accessible line of analysis that be created and retrieved on whim of the officer, with minimal latency between input and route creation

Projected result:
An ArcGIS Pro workspace that can export a custom, crime-based route to be disseminated to the patrol officers

ACHIEVED

Desired result for future work:
A web-based application, with predefined parameters.
• ***Mobile use will be considered while developing the application.

PENDING
Future Work: Web and Mobile Application - ArcGIS Navigator

- Step 1: Develop/condition the data in the ArcGIS Pro environment
- Step 2: Run PARTNER
  - This used ModelBuilder to make a single process
- Step 3: Share as Route Layer
  - Can be used as a mobile app or Web App
  - Can be ingested into ArcGIS Navigator
    - Directions must be enabled when the Solve tool is completed
- Step 4: Open ArcGIS Navigator
  - Retrieve the unique route assigned within the group
Future Work:
Web and Mobile Alternative

- Step 1: Develop/condition the data in the ArcGIS Pro environment
- Step 2: Run PARTNER
- Step 3: Share PARTNER as Geoprocessing Service
  - A geoprocessing history is required to share a toolbox/script/model
- Step 4: Access ArcGIS Online and begin creating a web application
  - A web map with the network and route analysis layers may be required for the tool to work. Future iterations will explore the leeway with this approach
- Step 4: Add PARTNER as a widget to a web application
  - AGOL is able to take a Geoprocessing Service and convert it to a widget without the additional Java Script
  - Routes can be generated on demand by WebApp users
Lessons Learned
Geocoding Issues

- **ArcInsight**: ArcInsight is a tool on the ArcGIS Online portal with a license. One of the options within the tool is to geocode tables to display on a map.
  - This option created two tables that could not be joined outside of the ArcInsight environment.
  - Future iterations of PARTNER may require this to be the option for establishing the map.

- **Geocodio**: This tool is a free online geocoding service after a user signs up.
  - Batch geocoding was limited to 500 records per iteration.
  - More table manipulation is required for use with large datasets.

- **Feature Manipulation Engine**: Feature Manipulation Engine (FME) is a standard tool analysts use for processing and geoprocessing data.
  - When the crime data was ingested, various error codes were presented. This may be a feasible option, but a solution was not reached for this study.

- **Other Options**:
  - Geoapify
  - GitHub
  - Cvs2Geo
Dataset Development

- Feature Dataset & Network Dataset
  - Both of these elements within a specified map are essential for PARTNER to operate.
  - Without these steps, PARTNER will not read any of the input data

- Route Analysis Layer
  - The Route Analysis Layer builds off the feature dataset and Network dataset. Unless the previous two layers are created, the route analysis layer will not know where to “look” and will cause more locational identification issues.
    - Error codes are not indicative or informative this is the issue.
Questions?