OSINT Pattern Recognition: *Slip (Street Level Image Processing)*

Extract Bollard Features:

1. Get raw data to show object boundaries
    - Possibly enhance to better recognize color or differences in arrangements or color scheme - (adaptive histogram equalization)
    - Use Gaussian blur to reduce noise
2. Detect bollards using object detection (Faster R-CNN)
    - Apply edge detection (Canny or Sobel)
    - Use image processing techniques that help you find and separate upright objects (Morphological Operations that can be used to isolate vertical structures)
        - Further filtering for precise image recognition
    - Also for additional contrast for image detection: Contour detection
3. Work on extracting pattern features
    - Measure bollard height-to-width ratios
    - Record bollard top shapes (flat, rounded, decorative) ***Distinctive across regions****
    - Document material appearance (concrete, metal, plastic)
    - Detect color patterns or reflective elements
    - Calculate alignment patterns (straight line, curved, staggered)
4. Return Vector layout of bollard arrangement for later analysis

To Analyze Central Asian Telephone Pole:

1. Detect telephone poles
    - Use vertical line detection for poles
    - Apply template matching with common Central Asian pole pattern
2. Extract distinctive regional features (examples given)
    - Kazakhstan: Measure height-to-width ratio (typically taller)
    - Uzbekistan: Count number and arrangement of crossbeams (often X-pattern)
    - Tajikistan: Detect specific insulator configurations (ceramic clusters)
    - Kyrgyzstan: Identify mountain-specific reinforcement patterns
    - Turkmenistan: Detect distinctive pole tops and desert-specific modifications
3. Analyze surrounding power line configurations
    - Calculate angles between lines
    - Count number of wires
    - Measure height of lowest wire from ground
4. Return feature vector of pole characteristics

Further Machine Learning algorithms to Classify Country From Infrastructure:

1. bollardFeatures = Extraction from Bollard features given *(image)*
2. poleFeatures = Analysis from Central Asian Telephone Poles given *(image)*
3. Load pre-trained country-specific models
    - bollardModel = loadBollardClassificationModel()
    - poleModel = loadPoleClassificationModel()
4. Generate prediction scores
    - bollardScores = bollardModel.predict(bollardFeatures)
    - poleScores = poleModel.predict(poleFeatures)
5. Apply weighted ensemble method
    - If image is urban street with bollards: weight bollardScores higher
    - If image is roadside/rural with poles: weight poleScores higher
    - Otherwise use balanced weighting
6. Calculate confidence intervals
    - AImplement bootstrap resampling on feature vectors
        - (Estimates the sample distribution through repeated sampling of a specific population; for a range of predictions)
7. Calculate confidence bounds and return top 3 country predictions with confidence scores

// Key bollard patterns by country (Source: https://plonkit.net)

```
bollardPatterns = {
    Netherlands: {"spacing": "wide", "shape": "cylindrical", "color": "red/white alternating"},
    UK: {"spacing": "medium", "shape": "round-topped", "material": "cast iron"},
    Japan: {"spacing": "tight", "shape": "square/rectangular", "color": "yellow/black"},
    France: {"spacing": "medium", "shape": "conical", "material": "concrete"},
    // Put other countries here during implementation...
}

// Central Asian telephone pole characteristics
centralAsianPoles = {
    "Kazakhstan": {
        "height": "tall",
        "crossbeam": "perpendicular double",
```

```
        "insulators": "white ceramic clusters"
    },
    "Uzbekistan": {
        "height": "medium",
        "crossbeam": "X-pattern",
        "insulators": "spaced evenly in rows"
    },
    "Tajikistan": {
        "height": "variable",
        "crossbeam": "single T-top",
        "insulators": "mixed ceramic/glass"
    },
    "Kyrgyzstan": {
        "height": "reinforced base",
        "crossbeam": "angled braces",
        "insulators": "compact arrangement"
    },
    "Turkmenistan": {
        "height": "shorter",
        "crossbeam": "triangular pattern",
        "insulators": "desert-specific spacing"
    }
}
```