Rhino Poaching Use Case – Template

## Scenario

The setting takes place in a major national park in South Africa. A set of human tracks (3 persons on foot) approximately two hours old have been discovered by game rangers in the field. Since there are dangerous animals are fairly abundant, and humans other than game rangers are not allowed to traverse the park. Hence there is a strong suspicion that the discovered tracks belong to poachers. The tracks are heading in an easterly direction and the time of day is early evening in summer. There is a watercourse two kilometers east which drains towards the North-East.

## Problem to solve / Question

The section ranger would like to deploy a unit that can ambush the suspected poachers at the most probable location. The team will need a variable time to get in position, depending on the ambush location. A map can be calculated which indicates how much time would be needed to get to a particular position.

The questions are thus:

*1. What is the probability map over area and time depicting the most probable locations of poachers, given sensor and GIS sources of information?*

*2. Where is the best ambush location taking into account the last known poacher positions and other context information such terrain, weather, season etc.*

# ADP Breakdown

This section identifies the main components of the fusion system that influence the decision making process. The section systematically breaks down the overall problem by using the concept of Atomic Decision Procedure (ADP). In this way we make the evaluation context explicit: any evaluation subject is characterized by the following fusion workflow, which starts with the sources of information and ends with a decision process, which is the ultimate objective of the fusion system. As such, the elements of the ADP should be evaluated with the decision process in mind.

## Sources of information

|  |  |  |
| --- | --- | --- |
| Source | Data | FOV (scenario) |
| Radar | Range, Doppler, Azimuth detections and tracks | A few poachers, many animals, clutter, coverage up to 10km |
| Radar | Target classification(Target type) , association to track/detection | A few poachers, many animals, clutter, coverage up to 10km |
| Fence crossing | Location, direction, time estimate |  |
| Tracks | Location, direction, time estimate | Poachers |
| Poaching events | Locations, dates | Where patrols have covered |
| Map/GIS | Terrain | Entire park |
| Map/GIS | Satellite/Google Earth | Entire park |
| Map/GIS | Roads | Entire park |
| Map/GIS | Drainage lines/rivers | Entire park |
| Map/GIS | Camps | Entire park |
| Map/GIS | Radar coverage/ | Radar line-of-sight |

## Input Processes (Uncertainty Representation Processes)

This section describes the Input Processes that transform data to representations supported by the fusion processes. The outputs are encoded through suitable representations reflecting the uncertainty. The output is a function of the input data as well as various interpretation elements influencing the quality of the output, such as the source model, self confidence, objectivity, etc. We should explicitly describe the assumptions used in the implementation of the Input Processes.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | Input | Output (uncertainty representation) | Processing method  (a function considering the source types, objectivity, self confidence, etc.) | Assumptions/  risks |
| Radar | Range, Doppler, Azimuth detections and tracks | Probabilistic  Mean values: Range, range rate, azimuth, azimuth rate, Covariance matrix of aformentioned quantities |  |  |
| Radar | Target classification(Target type) , association to track/detection | Probabilistic  Target class (human/animal) and probabilities |  |  |
| Fence crossing | Location, direction, time estimate | Location (point estimate), time estimate (probabilistic), direction estimate (probabilistic) | Convert ranger report to probability distribution over time and direction |  |
| Tracks | Location, direction, time estimate | Natural language report with time and location (vagueness) | Convert ranger report to probability distribution over time and direction |  |
| Poaching events | Locations, dates | Point estimates of poaching locations, vague date/time estimates | Convert vague dates/times to point estimates |  |
| Map/GIS | Terrain | DEM map with specified resolution | N/A |  |
| Map/GIS | Satellite/Google Earth | Image with specified resolution | N/A |  |
| Map/GIS | Roads | GIS map with specified/unspecified accuracy | N/A |  |
| Map/GIS | Drainage lines/rivers | GIS map with specified/unspecified accuracy | N/A |  |
| Map/GIS | Camps | GIS map with specified/unspecified accuracy | N/A |  |

## Information Combination (Fusion): Extracting new information

This section describes the used fusion methods. It might explicitly address (i) the modeling and (ii) the processing aspects (Algorithms).

### Basic modelisation

Observation variables: X = { Radar range, azimuth, covariance matrix,

Radar target class and probability,

Fence crossings and time (can be observed or unobserved),

Poacher tracks and time (can be observed or unobserved),

Poaching events and dates (can be observed or unobserved),

time t}

Context variables: Z = { all maps}

Decision variable: Probability map H, Ranger instructions R

Fusion: P(H|X,Z,t), R = f(H,t) – distinction between deterministic t and random variables X and Z

Modelling Framework: Bayesian network and Kalman filter

Main uncertainty representation: Bayesian probabilistic

### Algorithms

Describe the used algorithms (e.g. Junction Tree, Approximate Inference). Discuss the impact of algorithms on the quality, performance, etc. in the context of the input types and the modeling elements.

Junction tree, Kalman filter

### Assumptions and Simplifications

This section discusses the impact of the assumptions, simplifications and their impact on the decision making process.

## Decision Process

This section describes the usage of the fusion process outputs. Evaluate the impact of the preceding elements on the quality of the decision making process (e.g. the likelihood of making the right decisions). How is the decision making process sensitive to the source noise, the modeling parameters in the fusion processes?

Sensitivity analyses:

* Effect of time accuracy
* Representation of time uncertainty
* Variable importances/weights
* Representation of location uncertainties
* Importance of spatial resolution – best balance between the “fineness” of the resolution and the accuracy/certainty provided by the fusion algorithm
* Cost of being early vs being late
* Cost of location offset

Atomic Case Study - Template

## Use case

Rhino counter poaching use case #1

## Type of ACS

Singular assessment

X Comparative assessment

## Solution #1

Basic modelling and cell resolution

## Question of interest

At what resolution should an inherently continuous variable be discretised? Discretisation required such that a Bayesian network can be used, which can incorporate expert knowledge.

## Evaluation subjects

Discrete probability heat map cell size

## Evaluation criteria (from the URREF ontology)

Representation criteria

Data criteria

## Example(s) of how the ontology would be used on this ACS

It makes no sense to make use of a resolution that greatly exceeds the spatial accuracy of the fused result. In such cases noise will be modelled as opposed to larger scaled patterns. As such the criteria classes of interest would be ***Representation critetion → Expressiveness*** and **Data criterion → Quality → (accuracy, precision)**