An Open Source framework for Tracking and State Estimation (‘Stone Soup’)

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Tracker evaluation / comparison

Time-consuming!

Min Yang, Yuwei Wu, Mingtao Pei, Bo Ma, and Yunde Jia. Online Discriminative Tracking with Active Example Selection. IEEE Transactions on Circuits and Systems for Video Technology (TCSVT), 2015
‘Stone Soup’ project

Aims:
• The software structure necessary to put together any (logical) combination of algorithm or algorithm-component from a repository of algorithms.
• facilitate application of an algorithm to multiple different sets of data,
• contain state of the art metrics for quantification of performance.
Collaborative approach

Consortium
- Requirements Panel
  - Dstl
  - DRDC
  - NRL
  - DST Group
- Design and Implementation Team
  - Dstl
  - DRDC
  - ARL
  - DST Group

Open
- Moderating Panel
  - Dstl
  - DRDC
  - NRL
  - DST Group
  - + other contributing parties
- Design and Implementation Team
  - Open source community

Beta release
March 2019
Licence

Consortium
- The MIT License

Open
- The MIT License
- The BSD 3-Clause license
- The BSD 2-clause license
- The International Astronomical Union's Standards of Fundamental Astronomy License

No protective marking (unclassified)
Use cases
Use cases

Framework Developer

New_requirement

User/Developer

Modify Stone Soup Framework

Update Software documentation

Upload to Stone Soup Repository

Authorise New Release

Moderator

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Algorithms

Filtering algorithms: Discrete-Time State and Measurement Models
• Standard Kalman Filter for the Linear State and Measurement Model
• Extended Kalman Filter
• Derivative-free Kalman Filters

Particle Filter Class of algorithms
• Random Particle Filters
• Deterministic Particle Filters

Multiple Model filtering algorithms for Kalman filter class of algorithms

Data Model
The fundamental requirement:
• to enable the comparison of different algorithmic approaches against the same data or simulated scenario
• Therefore, algorithms must be “swappable” at the state and measurement model level
Data

- Airborne radar detection data. This could be in 2D or 3D, from a rotating radar or from a planar array.
- Coincident AIS data
- EO/IR data (which typically is reasonably accurate in bearing but has poor accuracy or no information about range)

Metrics

Initial priority:
- Assessments in the presence of entity “truth” state information.
  - Initiation of a track following the first appearance of an entity
  - Accuracy of a track estimate compared to the state of an entity
  - Continuity of a track during the time evolution of the state of an entity
  - Existence of false tracks
  - Credibility of a track estimate and its estimation uncertainty
Interface hierarchy: Filters
Interface hierarchy: Data Association

Without Integrated Track Management
- Continuity Over Time
  - Global Nearest Neighbor
  - Naïve Nearest Neighbor
  - JPDA
  - JPDA*
  - GNN-JPDA
  - CJPDA
  - CJPDA*
- No Continuity Over Time
  - Set JPDA

With Integrated Track Management
- Single Scan
  - Data Association Algorithms
- Multiple Scan
  - PMHT
  - MHT
  - Track-Oriented MHT
  - Hypothesis-Oriented MHT
  - Track Before Detect
  - ML-PDAF
  - ML-PMHT
  - Hough Transform
  - Dynamic Programming

Random Finite Set Based Methods
- Continuity Over Time
  - Labeled Multi-Bernoulli Filter
  - PHD
  - CPHD
- No Continuity Over Time

With permission from David Crouse, NRL
How can I join in?

- We **welcome** additional commitments of developer resources during the Consortium Phase.
- Open to all types of contributing agency; e.g. Government, Industry or Academia.
- The minimum meaningful commitment is 0.5 x developer-year per year.

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Stone Soup - Summary

- Collaborative initiative to create an open source framework for comparison of tracking and state estimation algorithms, data, metrics, simulators and sensor models
- Facilitates easy comparison of algorithm performance
- Allows algorithms to be developed with real data and benchmarked against “standard” data sets
- Enables characterisation of performance against different types of tracking problem
- Standardisation across research community
- “accelerated development” programme for personnel in industry