

SF2 Systems for Semantic Radar Target Identification

Explainable real-time radar classification through contextual system understanding



only ~400
Radar Sweeps
achieves reliable results
from limited data



76
Radar Target Classes
flying object types
discriminated



t≈0
Near-Zero Latency
via 1% sparse fingerprints



98%+
Classification Accuracy
across almost all classes

THE CHALLENGE – Radar Data Is High-Dimensional, Noisy & Difficult to Interpret

Modern radar systems generate massive streams of complex signal data that are difficult to classify reliably in real time. Conventional statistical and machine-learning approaches often struggle with:

- **Noisy Radar Reflections** → Environmental interference and signal distortion reduce reliable target identification.
- **Overlapping Feature Spaces** → different radar targets often produce highly similar signal characteristics that conventional classifiers struggle to separate.
- **High Computational Requirements** – traditional radar AI approaches often require substantial processing power and cloud-based infrastructure for real-time analysis.

Even when advanced feature engineering is applied, radar target classes frequently remain poorly separable using traditional algebraic classification methods.

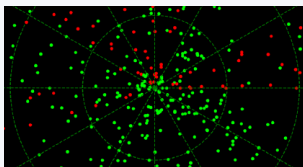
The core question is:
Can we classify radar signals
based on their contextual
'meaning' – instantly,
transparently, and on low-
power equipment?



THE SF2 SOLUTION – Transforming Radar Signals Into Digital Fingerprints

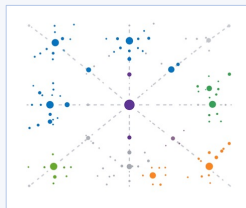
Instead of evaluating thousands of sensor dimensions independently, SF2 fuses raw radar-derived features into compact representations – semantic fingerprints - that preserve contextual relationships between signal characteristics.

Radar Signature Extraction

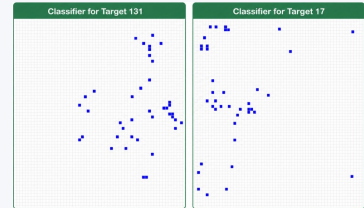


Radar sweep visualization: **Red** = flying objects |
Green = environmental reflections

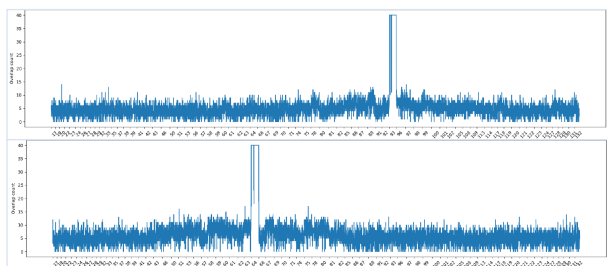
SF2 Sensor Fusion



Radar Classifier Fingerprints



THE RESULT – Highly Distinctive Semantic Radar Classification



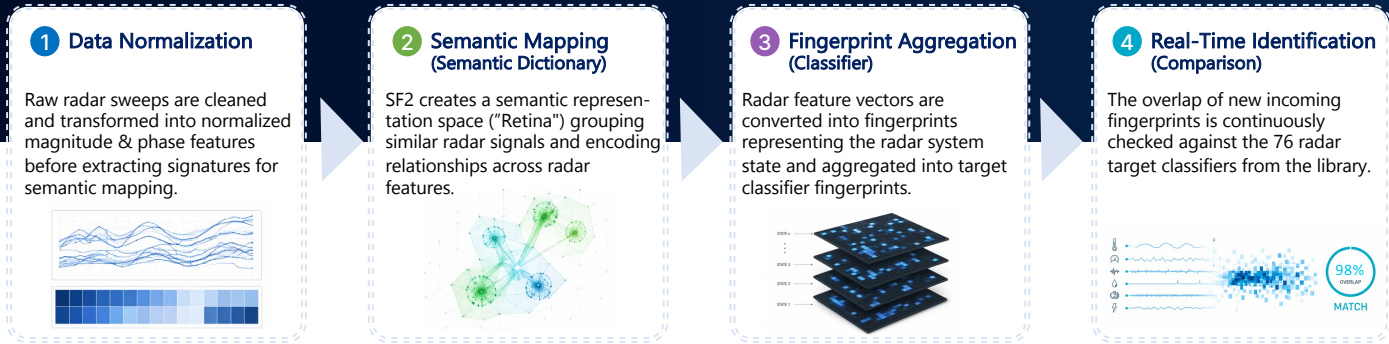
Overlap analysis as a time series diagrams for classifiers 93 and 64

Each plot shows the semantic overlap between the classifier fingerprint and all available radar signature records, with peaks at the corresponding correct class.

Proof of Performance

- ✓ **Near-perfect classification** – F1 > 0.98 for nearly all target classes.
- ✓ **Semantic fingerprints create highly separable radar target representations** – even in noisy and overlapping signal environments.
- ✓ **Efficient operation using compact sparse fingerprints** – only 1% active bits per classifier enable real-time processing at the edge.

HOW SF2 WORKS



SF2 transforms radar sweep signatures into semantic fingerprints in which similar targets produce consistent semantic similarity, while different target classes remain clearly separable.

Why Semantic Feature Representation Outperforms Statistical AI

SF2 (Deterministic)	Model-centric AI (Probabilistic)
✓ Accurate state-based monitoring & prediction ✓ Enables deployment-specific radar models ✓ Eliminates massive, manually-labelled training data need ✓ Explainable and reproducible ✓ Real-time, low compute ✓ 100% data sovereignty ✓ 100% edge-capable / offline – real-time on any device	✗ Uncertain approximations ✗ Often relies on generalized models ✗ Requires large labeled datasets ✗ Black-box behavior ✗ High compute & high-latency processing ✗ Mostly cloud-dependent (data & security risk) ✗ Not edge-ready

MEASURABLE BUSINESS IMPACT



Faster Situational Awareness
Real-time radar interpretation for faster operational response



Lower Infrastructure Costs
Reduced compute & storage requirements



Edge-Ready
Suitable for embedded systems & in-radar deployment



Reduced False Positives
Decreased unnecessary alerts & manual verification effort

Enables Threat & Anomaly Detection in:

- Airspace Monitoring
- Maritime Surveillance
- Drone Detection
- Autonomous Navigation
- Defense Systems

CONCLUSION

SF2 demonstrates that semantic target representation offers a powerful alternative to traditional statistical models. Semantic fingerprints provide distinct, explainable, and highly efficient radar classification tailored for real-time operational environments. This case study provides a scalable foundation for next-generation radar intelligence systems that require explainability, low-latency processing, and operational reliability simultaneously.

Learn more at www.SF2systems.com

FUTURE POTENTIAL – Any machine with sensors can become operationally interpretable

Industrial Manufacturing

Chemical & Process Industry

Pharmaceutical Industry

Industrial Equipment

Automotive Systems

Energy Infrastructure

Water & Utilities

Smart Buildings

Digital Infrastructure

Mobility & Transportation

