Integrating Neurosymbolic AI in Advanced Air Mobility: A Comprehensive Survey

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Contents

- AI has shifted from symbolic logic to opaque neural nets, both insufficient alone
- Neurosymbolic AI integrates learning and reasoning to overcome this divide
- AAM promises air transit integration via eVTOLs and automation
- Current AAM challenges: regulatory gaps, safety concerns, and fragmented data
- AAM success demands AI that is both adaptive and explainable

- Neurosymbolic AI offers interpretable, constraint-aware decision-making
- Learns from real-time data; reasons with domain rules (e.g., airspace, safety)
- Enables dynamic path planning, traffic coordination, and compliance
- This survey bridges Neurosymbolic AI and aviation domains

- Hybrid AI merging neural learning with symbolic reasoning
- Symbolic AI: explainable, structured, but rule-heavy
- Neural AI: data-driven but opaque and less interpretable
- Neurosymbolic AI: efficient, explainable, and requires less data

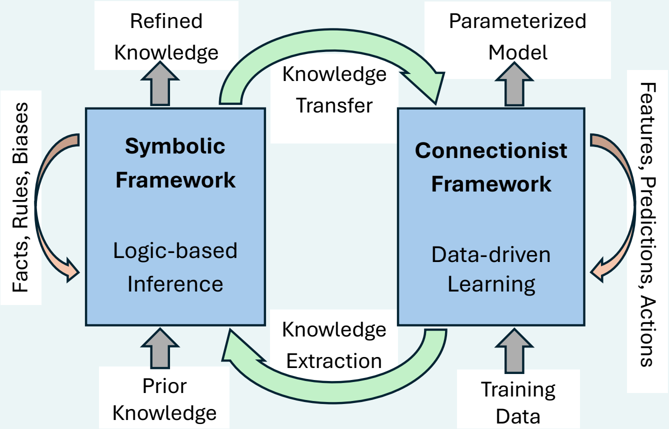

Figure: General interactions between symbolic and connectionist frameworks in Neurosymbolic AI

- Paradigm shift in transportation via eVTOL, UAM, and RAM.
- Driven by electric propulsion, automation, and autonomy.
- Challenges: battery tech, UTM systems, public acceptance.

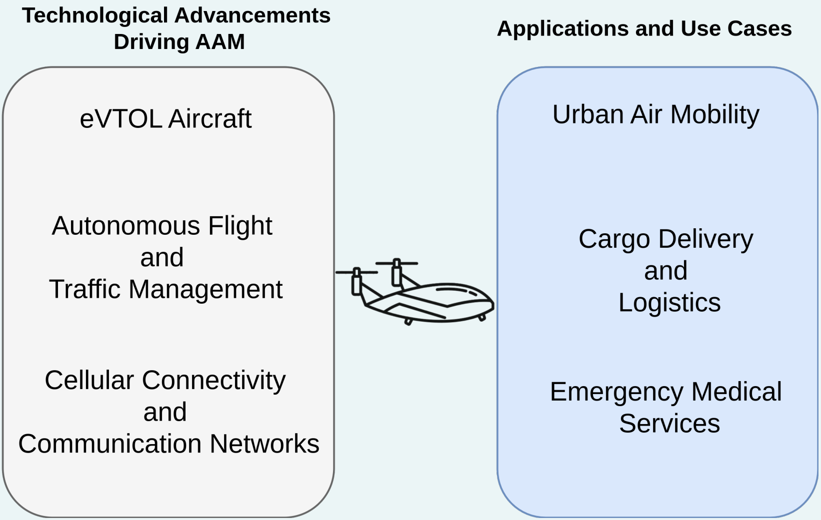

Figure: AAM Overview

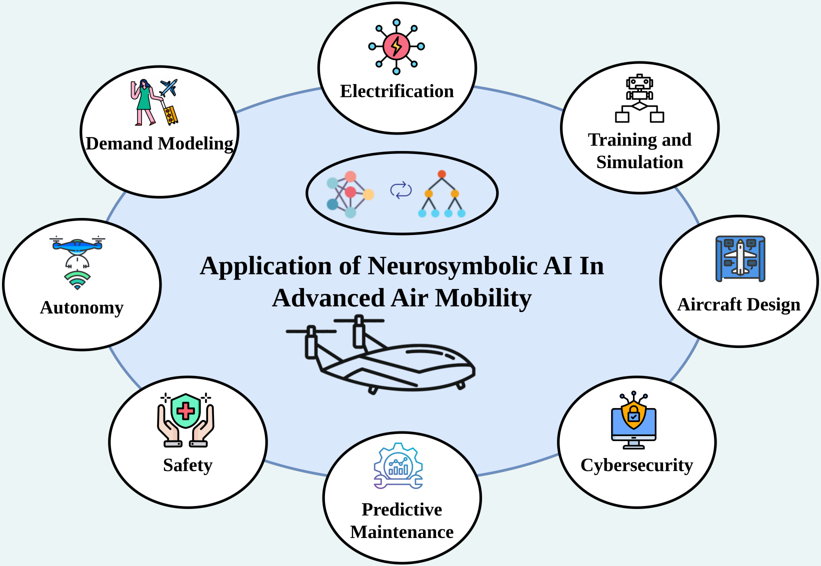

Figure: Applications of Neurosymbolic AI in AAM

- Phased, risk-based AI integration in aviation.
- Start with low-criticality systems $\rightarrow$ gather operational data $\rightarrow$ scale to safety-critical.
- Iterative approach links early insights to later deployments.
- Defines:
  - Learned AI: static, pre-trained.
  - Learning AI: adaptive, unpredictable.
- Certification challenges: unpredictability, bias, limited explainability.

- Foundation for AI in aviation: ML & DL in design, operations, maintenance, ATM, drones, and safety.
- Focus on trustworthiness:
  - Explainability.
  - Human-AI collaboration.
  - Phased certification.
- Safety-driven, reliability-first integration approach.

- Broader scope: hybrid AI (incl. Neurosymbolic), digital twins, predictive maintenance.
- Stronger emphasis: cybersecurity & AI safety assurance.
- Human centric, augmentation-focused vision.
- Risk-based AI categorization aligned with EU AI Act.
- Mandates transparency, explainability, and human oversight.

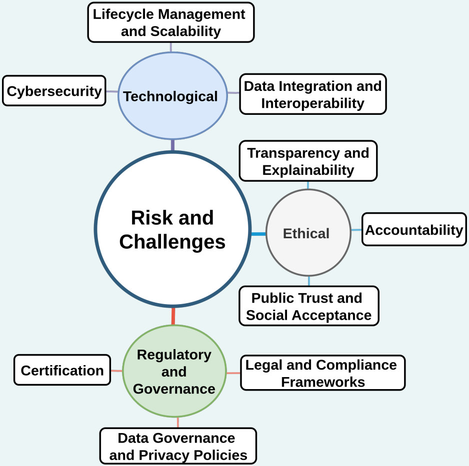

Figure: Risks and Challenges

- Neurosymbolic AI offers interpretability + adaptivity.
- Enables transparent and certifiable AAM systems.
- Future: Standardization, ethical compliance, interdisciplinary research.

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Thank You