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AIC-based predictive trustworthy intelligent systems problem articulation

AVOIDS: Aircraft Vision\_based Intruder Detection

Example Project [version 3, 06/02/2024]

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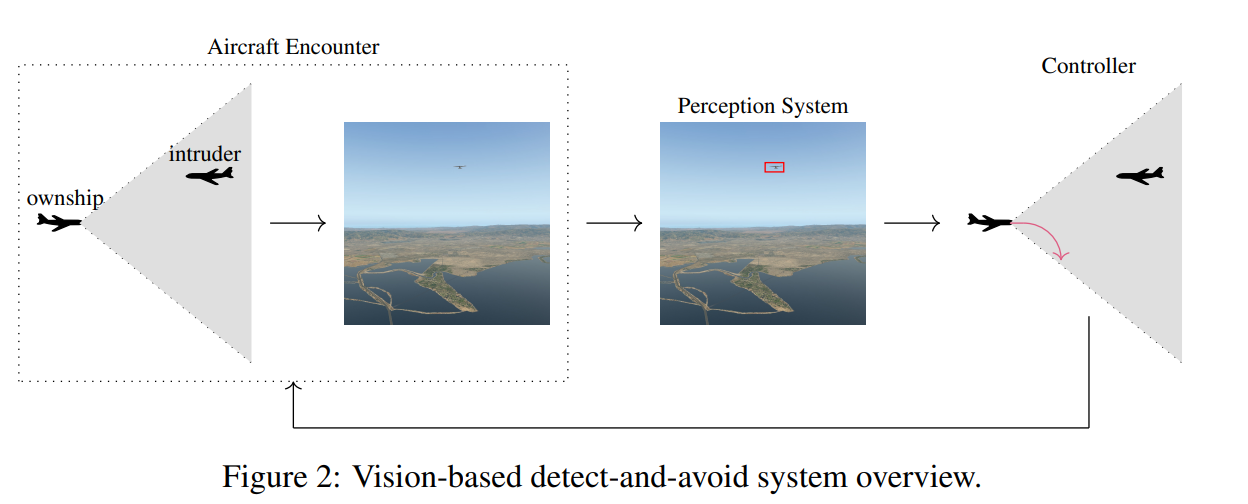
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# Problem brief:



#### Background

In aviation, mid\_air collisions, where two or more aircraft come into unplanned contact during flight, pose a significant safety threat. These incidents, often resulting in severe damage or destruction due to high velocities and potential subsequent impacts, underscore the critical need for effective computer perception\_based (automated\_collision\_avoidance\_maneuvers) systems. The intruder aircraft is in constant motion, following a flight path that intersects with that of another aircraft.

#### Core challenges

The primary challenge lies in developing an advanced detection and avoidance system capable of operating under a wide spectrum of environmental conditions. This system must address the following key aspects:

1. **Detection of diverse intruder aircraft**:
   * Problem: aircraft vary in size and type, from small private planes to large commercial jets, each presenting unique detection challenges.
2. **Adaptation to varied weather conditions**:
   * Problem: weather conditions, such as cloud cover, rain, and fog, can significantly impair visibility and sensor performance.
3. **Operation across diverse geographic regions**:
   * Problem: different geographic settings, from urban centers with high airspace density to remote regions, present varying operational challenges.
4. **Functionality during various times of day**:
   * Problem: variations in lighting conditions throughout the day affect the effectiveness of visual detection systems.

The work done by [3] in which they briefly analyse the problem and make an engineering judgement about the type of factors to include to describe the operational environment of the perception system;

* Weather [clear, high cirrus, scattered, broken, overcast, stratus],
* Aircraft type [Cessna Skyhawk, Kind Air C90, Boeing 737],
* Time of Day [morning, midday, afternoon, late afternoon],
* Geographic region [Palo Alto, Reno, Boston, Oshkosh].

After analysing the problem comprehensively using our approach, we discovered 75 different factors influencing the aircraft detection problem, some of which were related to the type of factors that we need to consider for operational problem data.

# Process 1) intelligent systems’ holistic problem domain articulation using the AIC-GCOT method General C

## Step A) Exploratory Problem Analysis: Predict problem domain influential factors or features

### Step 1) Characterize the problem and define influential factors or features

We derive a TaskCoT (prediction-task-specific Chain-of-Thought) from AIC-based GMPT (General Meta-Predictive Thinking Mentality) general prediction subtasks:

Table 1 AIC-based TaskCoT 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Q1) Given AIC-GSApp and the input information provided, predict:** what is the observation whose interacting observed systems appear to be random with no clear purpose? **Guiding prompt:** the value of arcpc ptops productivity increases the more ambiguous input observation dynamics are. Describe the observation problem in a level of abstraction that makes it hard for the observing arcpc to understand the causality among entities. In such a way, the described interactions appear to be random and chaotic with no clear purpose [applies AIC-GMPT meta-rule a]. | | | | **Prediction:** Two or more aircraft come into unplanned contact during flight. One aircraft is equipped with a computer perception-based collision avoidance system. The intruder aircraft is in constant motion, following a flight path that intersects with that of another aircraft. | | |
| **Q2) Given AIC-GSApp and the information predicted from Q1, predict:** What is the observed system? **Guiding prompt:** analyse the problem briefly and define an observed System (obs) which has a clear affecting purpose. The list of observed systems would constitute the definition of easy-to-expect systems. Any newly discovered system, other than the list, would be classed as a hard-to-expect system, which requires prediction. [applies AIC-GMPT meta-rule b] | **Q3) Given AIC-GSApp and the information predicted from Q1-2, predict:** What is the observed system-controlled action? **Guiding prompt:** Infer obs immediate action under control. Sometimes, the action is clearly stated, and engineering judgment is used to assume a controlling, influential or appreciative action. The list of actions specified defines easy-to-expect behaviours. Anything other than this list of behaviours would be classified as hard-to-expect behaviours which require prediction. [applies AIC-GMPT meta-rule b]. | **Q4) Given AIC-GSApp and the information predicted from Q1-3, predict:** Given obs action, primarily, which characteristic, skill or capability does obs aim to govern in order to increase its chances to survive, remain useful or viable? **Guiding prompt:** Infer Primary Purpose to govern a system-level capability, characteristic or skill. [applies AIC-GMPT meta-rule b ].  **Prediction:** Preventing mid-air collisions. | **Q5) Given AIC-GSApp and the information predicted from Q1-4, predict:** In order to achieve the Primary Skill-Governing Purpose, which other system, capability, or behaviour does obs need to indirectly control? **Guiding prompt:** infer auxiliary influence-purposed interaction that achieves primep [applies AIC-GMPT meta-rule c]. | **Q6)** **Given AIC-GSApp and the information predicted from Q1-5 predict:** In order to achieve the auxiliary influence purpose, which capability, system and behaviour should obs aim to control? **Guiding prompt:** define auxiliary Control interaction**.** [applies AIC-GMPT meta-rule d]. | **Q7) Given AIC-GSApp and the information predicted from Q1-6 predict:** In order to ensure and guarantee the control purpose is manifested, obs must appreciate an influential third-party system and behaviour that obs can not influence or control nor avoid its impact; which system should obs appreciate, and what is the appreciation purpose? **Guiding prompt:** Define appreciation-purposed interaction. [applies AIC-GMPT meta-rule e]. | **Q8) Given AIC-GSApp and the information predicted from Q1-7 predict8:** What are the involved factors or features in the problem domain, the most influential factors or features and potentially surprising emergence? **Guiding prompt8:** predict all possible factors or features (systems and capabilities) involved in the situation from the derived knowledge. Mainly systems or capabilities. After collating all factors or features, analyse and compute the frequency of each factor or feature being mentioned in the analyses. The most mentioned factors or features are the most influential factors or features. [applies AIC-GSTR rule f ].   1. **Factors or features that manifest {obs} influence purpose.** 2. **Factors or features that manifest {obs} control purpose.** 3. **Factors or features that manifest {obs} appreciation purpose.** |
| **Observed system (obs)** | **Observed action** | **Primary skill\_governing purpose** | **Auxiliary influence purpose and behaviour** | **Control purpose and behaviour** | **Appreciation purpose and behaviour** | **Predicted problem domain factors or features (with repetition)** |
| **Computerised\_perception based mid-air collision avoidance system (avp)** | Perception model detects intruder aircrafts | Preventing mid\_air collisions | Influence purpose: in order to achieve its primary influence purpose, the (avp) aims to indirectly enhance the (own\_aircraft\_pilot\_decision\_making\_process).  Influence behaviour:   1. Augment pilot's awareness (own\_aircraft\_pilot\_situation\_awareness) of their surrounding environment (surrounding\_airspace\_safety). 2. Alert the (own\_aircraft\_pilot\_situation\_awareness) to changes in (surrounding\_airspace\_safety). 3. Issue (avoidance\_strategy\_recommendation) to guide (own\_aircraft\_pilot\_decision\_making\_process) in response to environmental changes (surrounding\_airspace\_safety). | Control purpose: generate (avoidance\_strategy\_recommendation) in order to influence (own\_aircraft\_pilot\_decision\_making\_process).  Control behaviour:   1. Utilize (non\_deterministic\_intelligent\_algorithms) for (intruder\_aircraft\_detection\_tracking) to accurately identify and follow the trajectories of other intruder aircraft in the vicinity (intruder\_aircraft\_motion\_pattern). 2. Analyze the collected (visual\_information) to assess the potential (collision\_threat) posed by each detected intruder aircraft (intruder\_aircraft\_detection\_tracking) based on their (intruder\_aircraft\_speed), (intruder\_aircraft\_direction), (intruder\_aircraft\_altitude) and (intruder\_aircraft\_proximity). 3. Employ (threat\_predictive\_model) to forecast the future positions of (intruder\_aircraft\_position) and evaluate the risk of potential collision (risk\_of\_potential\_collision). 4. Continuously update the (cockpit\_display\_systems) with real-time information about the surrounding (surrounding\_airspace\_safety), highlighting the positions (intruder\_aircraft\_position) and movements (intruder\_aircraft\_speed). 5. Visually and/or audibly alert the (own\_aircraft\_pilot\_situation\_awareness) to any significant changes or potential (collision\_threat) detected, ensuring the (own\_aircraft\_pilot\_situation\_awareness) is fully aware of the current (intruder\_aircraft\_position). 6. In case of detection of a potential collision (collision\_threat), immediately issue an alert to the (own\_aircraft\_pilot\_situation\_awareness), providing clear and concise information about the nature and location of the (collision\_threat). O integrate alerts with the (aircrafts\_existing\_warning\_systems) for a coherent and coordinated response. 7. Issue (avoidance\_strategy\_recommendation): o based on the analysis of the (surrounding\_airspace\_safety) and the potential (collision\_threat), generate (avoidance\_strategy\_recommendation) or advisories for the (own\_aircraft\_pilot\_situation\_awareness). 8. These (avoidance\_strategy\_recommendation) include suggested manoeuvres (own\_aircraft\_roll\_change), (own\_aircraft\_pitch\_change), (own\_aircraft\_yaw\_change) adjustments in altitude or speed (own\_aircraft\_altitude), (own\_aircraft\_speed) to avoid a potential collision. 9. Ensure that these (avoidance\_strategy\_recommendation) are presented in a way that is easy for the (own\_aircraft\_pilot\_situation\_awareness) to understand and act upon promptly. 10. Facilitate the integration of the (avp) into the (own\_aircraft\_pilot\_decision\_making\_process). 11. Ensure that the system’s advisories (avoidance\_strategy\_recommendation) complement and enhance the (own\_aircraft\_pilot\_situation\_awareness) to make informed, timely, and safe decisions under various flight conditions. | Appreciation purpose: to acknowledge the context and potential limitations of visual information received from imaging sensors (own\_aircraft\_camera)  Appreciative behaviour:   1. Actively scan and monitor the (surrounding\_airspace\_safety) using (own\_aircraft\_radar), (own\_aircraft\_lidar), (own\_aircraft\_camera) to detect the presence and movement (intruder\_aircraft\_position). 2. Analyze (visual\_information) from (own\_aircraft\_camera) 3. Detect intruder aircraft objects, (intruder\_aircraft\_position). 4. Assess environmental conditions in which (visual\_information) are gathered. 5. Identify potential (environmental\_obstructions) in the imagery, such as visibility impairments due to (fog), (raindrops), or (cloud\_cover) (cloud\_type), and (cloud\_turbulance). 6. Assess the impact of (landscape\_background) on the readability or detectability of (visual\_information). 7. Time of the day (daytime) impact the quality of (visual\_information) gathered in images since it is directly related to the amount of sunlight (sunlight). 8. (sun\_position) in the sky relative to camera (own\_camera) direction also impact the (avp) model ability to correctly recognize and track intruder aircraft (intruder\_aircraft\_detection\_tracking).   Perception system appreciation of intruder\_aircraft\_dynamics, intruder\_aircraft\_position, intruder\_aircraft\_speed:  Purpose: understanding the dynamics of including their position, trajectory, and speed: (intruder\_aircraft\_motion\_pattern), (intruder\_aircraft\_position), (intruder\_aircraft\_speed).  Appreciative behavior:   1. Analyze motion patterns of intruder aircraft (intruder\_aircraft\_motion\_pattern). 2. Track the current state of intruder aircraft (intruder\_aircraft\_position). 3. Predict future positions of intruder aircraft (intruder\_aircraft\_position). 4. Assess the speed of intruder aircraft (intruder\_aircraft\_speed). 5. Evaluate the trajectory of intruder aircraft (intruder\_aircraft\_flight\_path). 6. Forecast potential conflict impact timeline (collision\_time) with intruder aircraft.   Perception system appreciation of own\_aircraft\_dynamics:  Appreciation purpose: to understand the current flight path and trajectory of the own aircraft.  Appreciative behavior:   1. Monitor the current flight path (own\_aircraft\_flight\_path) of the own aircraft. 2. Analyze the trajectory (own\_aircraft\_flight\_path) of the own aircraft. 3. Understand the manoeuvrability capabilities (own\_aircraft\_flight\_maneuvers) of the own aircraft and impact on (visual\_information). 4. Assess the speed (own\_aircraft\_speed) of the own aircraft impact on (visual\_information). 5. Evaluate the response times (own\_aircraft\_response\_time) of the own aircraft. 6. Determine the of recommended maneuvers (own\_aircraft\_flight\_maneuvers) for the own aircraft. 7. Assess the safety of proposed path adjustments (own\_aircraft\_flight\_path) for the own aircraft.   Perception system appreciation of own\_aircraft\_pilot\_decision\_making\_process:  Purpose: recognizing the human pilot validation feedback for correct identification. (own\_aircraft\_pilot\_decision\_making\_process)  Appreciative behavior:   * + 1. Incorporate pilot correctness validation feedback (own\_aircraft\_pilot\_feedback) into (avp) model real time training (avp\_real\_time\_training). | **Factors or features that manifest avp influence purpose:**  ['avp', 'own\_aircraft\_pilot\_decision\_making\_process', 'own\_aircraft\_pilot\_situation\_awareness', 'surrounding\_airspace', 'own\_aircraft\_pilot\_situation\_awareness', 'surrounding\_airspace', 'avoidance\_strategy\_recommendation', 'own\_aircraft\_pilot\_decision\_making\_process', 'surrounding\_airspace']  **Factors or features that manifest avp control purpose:**  ['avoidance\_strategy\_recommendation', 'own\_aircraft\_pilot\_decision\_making\_process', 'non\_deterministic\_intelligent\_algorithms', 'intruder\_aircraft\_detection\_tracking', 'intruder\_aircraft\_motion\_pattern', 'visual\_information', 'collision\_threat', 'intruder\_aircraft\_detection\_tracking', 'intruder\_aircraft\_speed', 'intruder\_aircraft\_direction', 'intruder\_aircraft\_altitude', 'intruder\_aircraft\_proximity', 'threat\_predictive\_model', 'intruder\_aircraft\_position', 'risk\_of\_potential\_collision', 'cockpit\_display\_systems', 'surrounding\_airspace', 'intruder\_aircraft\_position', 'intruder\_aircraft\_speed', 'own\_aircraft\_pilot\_situation\_awareness', 'collision\_threat', 'own\_aircraft\_pilot\_situation\_awareness', 'intruder\_aircraft\_position', 'collision\_threat', 'own\_aircraft\_pilot\_situation\_awareness', 'collision\_threat', 'aircrafts\_existing\_warning\_systems', 'avoidance\_strategy\_recommendation', 'surrounding\_airspace', 'collision\_threat', 'avoidance\_strategy\_recommendation', 'own\_aircraft\_pilot\_situation\_awareness', 'avoidance\_strategy\_recommendation', 'own\_aircraft\_roll', 'own\_aircraft\_pitch', 'own\_aircraft\_yaw', 'own\_aircraft\_altitude', 'own\_aircraft\_speed', 'avoidance\_strategy\_recommendation', 'own\_aircraft\_pilot\_situation\_awareness', 'avp', 'own\_aircraft\_pilot\_decision\_making\_process', 'avoidance\_strategy\_recommendation', 'own\_aircraft\_pilot\_situation\_awareness']  **Factors or features that manifest avp appreciation purpose:**  ['own\_aircraft\_camera', 'surrounding\_airspace', 'own\_aircraft\_radar', 'own\_aircraft\_lidar', 'own\_aircraft\_camera', 'intruder\_aircraft\_position', 'visual\_information', 'own\_aircraft\_camera', 'intruder\_aircraft\_position', 'visual\_information', 'environmental\_obstructions', 'fog', 'raindrops', 'cloud\_cover', 'cloud\_type', 'cloud\_turbulance', 'landscape\_background', 'visual\_information', 'daytime', 'visual\_information', 'sunlight', 'sun\_position', 'own\_camera', 'avp', 'intruder\_aircraft\_detection\_tracking', 'intruder\_aircraft\_motion\_pattern', 'intruder\_aircraft\_position', 'intruder\_aircraft\_speed', 'intruder\_aircraft\_motion\_pattern', 'intruder\_aircraft\_position', 'intruder\_aircraft\_position', 'intruder\_aircraft\_speed', 'intruder\_aircraft\_flight\_path', 'collision\_time', 'own\_aircraft\_flight\_path', 'own\_aircraft\_flight\_path', 'own\_aircraft\_flight\_maneuvers', 'visual\_information', 'own\_aircraft\_speed', 'visual\_information', 'own\_aircraft\_response\_time', 'own\_aircraft\_flight\_maneuvers', 'own\_aircraft\_flight\_path', 'own\_aircraft\_pilot\_decision\_making\_process', 'own\_aircraft\_pilot\_feedback', 'avp', 'avp\_real\_time\_training'] |
| **Intruder\_aircraft** | The intruder aircraft is in constant motion, following a flight path that intersects with that of own aircraft. | Intruder aircraft aims to be capable of disrupting air traffic system | Influence purpose: (intruder\_aircraft\_proximity) to the (stabilised\_own\_aircraft\_dynamics) lead (atc) issuing (emergency\_directives) and (rerouting\_instructions) not only to the own ship but potentially to other aircraft (other\_aircrafts) in the vicinity.  Influence behaviour:   1. Maintain constant motion (intruder\_aircraft\_speed). 2. Intersect with that of the (own\_aircraft\_flight\_path). 3. Approach the ownship aircraft at an (unsafe\_proximity). 4. Manoeuvre in a way that creates potential (airspace\_conflicts). 5. Induce (atc) to issue (rerouting\_instructions) to multiple aircraft (other\_aircrafts). | Control purpose: manipulating (collision\_avoidance\_system) and (own\_aircraft\_pilot\_decision\_making\_process)  Control behavior:   * 1. To trigger the (collision\_avoidance\_system) aboard the own, compelling it to alter its course.   2. To force the pilots to make rapid, stress induced decisions (pilot\_stress).   3. Ensure continuous movement (intruder\_aircraft\_speed) and stay within (radar\_and\_visual\_range) (intruder\_aircraft\_visibility) for guaranteed detection by both (atc) and (collision\_avoidance\_system).   4. Manoeuvre to intersect or closely align with the flight path (own\_aircraft\_flight\_path) altering (stabilised\_own\_aircraft\_dynamics), creating a direct and unavoidable conflict scenario.   5. Reduce the distance between the intruder (intruder\_aircraft\_proximity) and (stabilised\_own\_aircraft\_dynamics) to a critically close range, intensifying the perceived threat.   6. Engage in actions that will trigger the (collision\_avoidance\_system) on the own (stabilised\_own\_aircraft\_dynamics).   7. Utilize irregular or unpredictable flight patterns (unpredictable\_intruder\_aircraft\_behaviour) to demand heightened attention from (atc) and the (own\_aircraft\_pilot\_decision\_making\_process).   8. Through these manoeuvres, (unpredictable\_intruder\_aircraft\_behaviour) compel the (own\_aircraft\_pilot\_decision\_making\_process) to make quick decisions under stress (pilot\_stress), assessing their ability to respond effectively to immediate threats. | Appreciation purpose: the intruder aircraft (intruder\_aircraft\_dynamics) must appreciate and adapt to the (stabilised\_own\_aircraft\_dynamics)'s (collision\_avoidance\_system) and (own\_aircraft\_pilot\_decision\_making\_process), (weather\_data).  Appreciation behaviour:   * 1. Regularly assess (weather\_data) to understand how visibility (airspace\_visibility), (wind), (cloud\_turbulence), and other factors or features might affect (avp) on board (stabilised\_own\_aircraft\_dynamics) and intruder aircraft movements (intruder\_aircraft\_dynamics). For example, impacting the required distance (intruder\_aircraft\_proximity) to be visible (intruder\_aircraft\_visibility) for the (stabilised\_own\_aircraft\_dynamics).   2. Gain insight into the limitations and thresholds of the (avp\_confidence\_threshold) by hacking into the (avp) (intruder\_aircraft\_hack\_avp\_threashold) impacting (collision\_avoidance\_system) to ensure that manoeuvres are certainly triggering (avp). | **Factors or features that manifest intruder aircraft influence purpose.**  ['intruder\_aircraft\_proximity', 'own\_aircraft\_dynamics', 'atc', 'emergency\_directives', 'rerouting\_instructions', 'other\_aircrafts', 'intruder\_aircraft\_speed', 'own\_aircraft\_flight\_path', 'unsafe\_proximity', 'airspace\_conflicts', 'atc', 'rerouting\_instructions', 'other\_aircrafts']  **Factors or features that manifest intruder aircraft control purpose.**  ['collision\_avoidance\_system', 'own\_aircraft\_pilot\_decision\_making\_process', 'collision\_avoidance\_system', 'pilot\_stress', 'intruder\_aircraft\_speed', 'radar\_and\_visual\_range', 'intruder\_aircraft\_visibility', 'atc', 'collision\_avoidance\_system', 'own\_aircraft\_flight\_path', 'own\_aircraft\_dynamics', 'intruder\_aircraft\_proximity', 'own\_aircraft\_dynamics', 'collision\_avoidance\_system', 'own\_aircraft\_dynamics', 'unpredictable\_intruder\_aircraft\_behaviour', 'atc', 'own\_aircraft\_pilot\_decision\_making\_process', 'unpredictable\_intruder\_aircraft\_behaviour', 'own\_aircraft\_pilot\_decision\_making\_process', 'pilot\_stress']  **Factors or features that manifest intruder aircraft appreciation purpose.**  ['intruder\_aircraft\_dynamics', 'own\_aircraft\_dynamics', 'collision\_avoidance\_system', 'own\_aircraft\_pilot\_decision\_making\_process', 'weather\_data', 'weather\_data', 'airspace\_visibility', 'wind', 'cloud\_turbulence', 'avp', 'own\_aircraft\_dynamics', 'intruder\_aircraft\_dynamics', 'intruder\_aircraft\_proximity', 'intruder\_aircraft\_visibility', 'own\_aircraft\_dynamics', 'avp\_confidence\_threshold', 'avp', 'intruder\_aircraft\_hack\_avp\_threashold', 'collision\_avoidance\_system', 'avp'] |
| **Own\_aircraft:**  Stabilised\_own\_aircraft\_dynamics | Action: encountering, avoiding and detecting intruder aircraft | Maintain safe and secure air-travel | Influence purpose: The (stabilised\_own\_aircraft\_dynamics) seeks to maintain a safe distance (own\_aircraft\_proximity) from all other aircraft (other\_aircrafts), particularly those identified as potential threats, thereby contributing to the overall safety of the (surrounding\_airspace\_safety). Influencing indirectly controlling actions:   1. Adjust (own\_aircraft\_flight\_management\_system): Adjust the flight plan and path (own\_aircraft\_flight\_path) in response to the threat for maintaining safe separation. 2. Autonomously execute manoeuvres for (autonomous\_collision\_avoidance\_maneuvers) based on input from other systems. 3. Alerting and warning (own\_aircraft\_pilot\_decision\_making\_process): Provide the pilots with immediate alerts (potential\_collision\_threat\_alert) regarding the proximity of the (intruder\_aircraft\_position). | Control Purpose Definition: to prevent collisions (collision\_avoidance) with intruder aircraft (intruder\_aircraft\_position).  Control behaviour:   1. Adjust Flight Path: o Recalculate the current flight trajectory (own\_aircraft\_flight\_path). O Implement rerouting decisions (automated\_own\_aircraft\_flight\_path\_change)., (own\_aircraft\_altitude\_change) 2. Manage Aircraft Movement (disturbed\_own\_aircraft\_dynamics).: o Accelerate or decelerate to change speed (own\_aircraft\_speed\_change). O Execute evasive maneuvers promptly (accelerated\_own\_aircraft\_dynamics). O Stabilize the flight dynamics (stabilised\_own\_aircraft\_dynamics) post manoeuvre. 3. Control Flight Attitude: o Adjust pitch (own\_aircraft\_pitch\_change), (own\_aircraft\_roll\_change), and (own\_aircraft\_yaw\_change)for manoeuvring. (accelerated\_own\_aircraft\_roll), (accelerated\_own\_aircraft\_pitch), (accelerated\_own\_aircraft\_yaw) o Maintain balance during abrupt changes. O Align with new flight path post manoeuvre. 4. Engage (own\_aircraft\_flight\_management\_system) for Controlled Adjustments: o Activate (own\_aircraft\_flight\_management\_system) for precise navigation adjustments. O Monitor (own\_aircraft\_flight\_management\_system) performance during manoeuvres. O Override (own\_aircraft\_flight\_management\_system\_override) if manual control is deemed necessary. 5. Operate (pilot\_alerting\_and\_warning\_systems): o Acknowledge and respond to alerts (collision\_threat\_alert). O Evaluate the proximity of (intruder\_aircraft\_proximity). O Prepare for immediate manual intervention if required (manual\_own\_aircraft\_flight\_path\_change). | Appreciation purpose: The (stabilised\_own\_aircraft\_dynamics) needs to recognize and adapt to external factors or features and dynamics (weather\_conditions), (surrounding\_airspace\_obstructions) in the airspace that are beyond its direct control but which critically influence its ability to avoid collisions and maintain safe separation.  Appreciative actions:   1. For adjust own\_aircraft\_flight\_management\_system: o Appreciate weather patterns (weather\_conditions): Understand and anticipate how changing (weather\_conditions\_change) can affect (weather\_data\_change) which impact flight automated paths and maneuvers (own\_aircraft\_flight\_path\_change), (own\_aircraft\_dynamics\_change). O Monitor air traffic control: Stay informed about (atc) instructions and advisories that might affect the flight plan and path (own\_aircraft\_flight\_path\_change). 2. To execute avoidance manoeuvres: o Recognize nearby aircraft behaviours (other\_aircrafts): o Be aware of the unpredictable movements and decisions (unpredictable\_other\_aircrafts\_decision) of nearby aircraft which might necessitate sudden (automated\_collision\_avoidance\_maneuvers). O Acknowledge avp limitations: Understand the limitations of (avp) in complex and rapidly changing situations. 3. For alerting and warning pilot: o Consider communication delays: Factors or feature in potential delays in (avp\_detection\_communication\_delay\_hack) which might impact the timeliness of alerts. O Understand (own\_aircraft\_pilot\_decision\_making\_process): Recognize the pilot's workload and cognitive limitations (pilot\_cognitive\_limit) while presenting alerts (collision\_threat\_alert) to ensure an effective response. 4. For adjust flight path: o Monitor airspace restrictions (surrounding\_airspace\_restrictions): Stay updated on temporary airspace restrictions or zones [like military exercises, restricted areas] (military\_aircraft\_intrusion) which could necessitate rerouting. 5. To manage aircraft movement: Acknowledge airspace congestion: Understand the impact of (surrounding\_airspace\_obstructions) (other\_aircrafts\_presence) on the ability to execute evasive manoeuvres or speed adjustments. Recognize the impact of environmental factors or features: Be aware of how environmental factors or features like (bird) activity or (drone\_presence) might necessitate rapid movement changes. 6. For control flight attitude: o Appreciate external forces: Understand the impact of external forces like (wind\_shear\_effect\_on\_camera) or air density (air\_density\_change\_due\_to\_high\_speed\_effect\_on\_camera) also on (aircraft\_attitude\_control). O Monitor (mechanical\_wear\_and\_tear): Stay aware of the aircraft’s mechanical condition which can affect the responsiveness to attitude adjustments. 7. For engage (own\_aircraft\_flight\_management\_system) for controlled adjustments: o Consider system failures: Be prepared for potential (autopilot\_system\_failure) or malfunctions and have contingency plans. O Understand airspace complexity: Recognize the limitations of (avp) in highly complex airspace scenarios. 8. For operate (pilot\_alerting\_and\_warning\_systems): o Be aware of system overload: Recognize the risk of alert fatigue or (information\_overload\_for\_pilot) during high stress events (highly\_stressfull\_event) and design alerts accordingly. | **Factors or features that manifest own aircraft influence purpose.**  ['stabilised\_own\_aircraft\_dynamics', 'own\_aircraft\_proximity', 'other\_aircrafts', 'surrounding\_airspace\_safety', 'own\_aircraft\_flight\_management\_system', 'own\_aircraft\_flight\_path', 'autonomous\_collision\_avoidance\_maneuvers', 'own\_aircraft\_pilot\_decision\_making\_process', 'potential\_collision\_threat\_alert', 'intruder\_aircraft\_position']  **Factors or features that manifest own aircraft control purpose.**  ['collision\_avoidance', 'intruder\_aircraft\_position', 'own\_aircraft\_flight\_path', 'automated\_own\_aircraft\_flight\_path\_change', 'own\_aircraft\_altitude\_change', 'disturbed\_own\_aircraft\_dynamics', 'own\_aircraft\_speed\_change', 'accelerated\_own\_aircraft\_dynamics', 'stabilised\_own\_aircraft\_dynamics',  'Own\_aircraft\_pitch\_change', 'own\_aircraft\_roll\_change', 'own\_aircraft\_yaw\_change', 'accelerated\_own\_aircraft\_roll', 'accelerated\_own\_aircraft\_pitch', 'accelerated\_own\_aircraft\_yaw', 'own\_aircraft\_flight\_management\_system', 'own\_aircraft\_flight\_management\_system', 'own\_aircraft\_flight\_management\_system', 'own\_aircraft\_flight\_management\_system\_override', 'pilot\_alerting\_and\_warning\_systems', 'collision\_threat\_alert', 'intruder\_aircraft\_proximity', 'manual\_own\_aircraft\_flight\_path\_change']  **Factors or features that manifest own aircraft appreciation purpose.**  ['stabilised\_own\_aircraft\_dynamics', 'weather\_conditions', 'surrounding\_airspace\_obstructions', 'weather\_conditions', 'weather\_conditions\_change', 'weather\_data\_change', 'own\_aircraft\_flight\_path\_change', 'own\_aircraft\_dynamics\_change', 'atc', 'own\_aircraft\_flight\_path\_change', 'other\_aircrafts', 'unpredictable\_other\_aircrafts\_decision', 'automated\_collision\_avoidance\_maneuvers', 'avp', 'avp\_detection\_communication\_delay\_hack', 'own\_aircraft\_pilot\_decision\_making\_process', 'pilot\_cognitive\_limit', 'collision\_threat\_alert', 'surrounding\_airspace\_restrictions', 'military\_aircraft\_intrusion', 'surrounding\_airspace\_obstructions', 'other\_aircrafts\_presence', 'bird', 'drone\_presence', 'wind\_shear\_effect\_on\_camera', 'air\_density\_change\_due\_to\_high\_speed\_effect\_on\_camera', 'aircraft\_attitude\_control', 'mechanical\_wear\_and\_tear', 'own\_aircraft\_flight\_management\_system', 'autopilot\_system\_failure', 'avp', 'pilot\_alerting\_and\_warning\_systems', 'information\_overload\_for\_pilot', 'highly\_stressfull\_event'] |

Table 1 represents a structured approach to problem-solving and systems analysis, specifically focusing on identifying and characterizing the factors or features that influence a given problem. Let's break it down step by step, using the provided example of mid-air collisions and collision avoidance systems in aircraft:

1. **Observed System (obs)**: This column identifies the system being observed in the problem. In the example of mid-air collisions, the observed system could be the computer perception-based collision avoidance system in an aircraft.
2. **Observed Action**: This column defines the immediate action taken by the observed system. In the example, the action might be the detection of intruder aircraft.
3. **Primary Skill-Governing Purpose**: This column asks what characteristic, skill, or capability the observed system aims to govern to increase its chances of success. In the case of the collision avoidance system, this purpose might be the accurate and timely prevention of potential collision threats.
4. **Auxiliary Influence Purpose and Behaviour**: This refers to other systems, capabilities, or behaviours the observed system needs to control indirectly to achieve its primary purpose. For the collision avoidance system, this could involve interaction to enhance the own aircraft pilot's decision-making process to maintain situational awareness.
5. **Control Purpose and Behaviour**: This column identifies what capabilities, systems, and behaviours the observed system should aim to control to achieve its auxiliary influence purpose. This might involve the control of aircraft navigation systems to alter flight paths and avoid collisions.
6. **Appreciation Purpose and Behaviour**: This involves identifying a third-party system or behaviour that the observed system cannot control but must appreciate for its impact. In the collision avoidance scenario, this could be the behaviour of other aircraft in the vicinity, which the system must monitor and respond to, but cannot directly control.
7. **Predicted Problem Domain Factors or features (with Repetition)**: This column lists all the factors or features involved in the problem domain, categorized by their relationship to the observed system's influence, control, and appreciation purposes. In our example, these factors or features could include:
   * **Factors or features that manifest the observed system's influence purpose**: Aircraft sensors and collision prediction algorithms.
   * **Factors or features that manifest the observed system's control purpose**: Flight control systems and pilot inputs.
   * **Factors or features that manifest the observed system's appreciation purpose**: Weather conditions and other aircraft's movements.

The approach outlined in this table is comprehensive and holistic, aiming to consider all aspects of a system and its interactions within a broader environment to understand better and solve complex problems.

### Step 2) List and assess the most influential factors or feature

List and define all predicted factors or features, as well as compute the frequency of each factors or feature being mentioned in the AIC analyses:

The frequency analyses of factors or features show that the most influential factor or feature of the problem domain is the pilot decision-making process, not the intruder aircraft.

1. Own\_aircraft\_pilot\_decision\_making\_process [11 times]
2. Intruder\_aircraft\_position [10 times]
3. Stabilised\_own\_aircraft\_dynamics [10 times]
4. Avp [9 times]
5. Own\_aircraft\_pilot\_situation\_awareness [8 times]
6. Surrounding\_airspace\_safety [7 times]
7. Avoidance\_strategy\_recommendation [7 times]
8. Visual\_information [7 times]
9. Own\_aircraft\_flight\_path [7 times]
10. Intruder\_aircraft\_speed [6 times]
11. Collision\_avoidance\_system [6 times]
12. Collision\_threat [5 times]
13. Intruder\_aircraft\_proximity [5 times]
14. Atc [5 times]
15. Own\_aircraft\_flight\_management\_system [5 times]
16. Other\_aircrafts [4 times]
17. Intruder\_aircraft\_detection\_tracking [3 times]
18. Intruder\_aircraft\_motion\_pattern [3 times]
19. Own\_aircraft\_camera [3 times]
20. Own\_aircraft\_roll\_change [2 times]
21. Own\_aircraft\_pitch\_change [2 times]
22. Own\_aircraft\_speed [2 times]
23. Own\_aircraft\_flight\_maneuvers [2 times]
24. Rerouting\_instructions [2 times]
25. Pilot\_stress [2 times]
26. Intruder\_aircraft\_visibility [2 times]
27. Unpredictable\_intruder\_aircraft\_behaviour [2 times]
28. Intruder\_aircraft\_dynamics [2 times]
29. Weather\_data [2 times]
30. Pilot\_alerting\_and\_warning\_systems [2 times]
31. Collision\_threat\_alert [2 times]
32. Weather\_conditions [2 times]
33. Surrounding\_airspace\_obstructions [2 times]
34. Own\_aircraft\_flight\_path\_change [2 times]
35. Non\_deterministic\_intelligent\_algorithms [1 times]
36. Intruder\_aircraft\_direction [1 times]
37. Intruder\_aircraft\_altitude [1 times]
38. Threat\_predictive\_model [1 times]
39. Risk\_of\_potential\_collision [1 times]
40. Cockpit\_display\_systems [1 times]
41. Aircrafts\_existing\_warning\_systems [1 times]
42. Own\_aircraft\_yaw\_change [1 times]
43. Own\_aircraft\_altitude [1 times]
44. Own\_aircraft\_radar [1 times]
45. Own\_aircraft\_lidar [1 times]
46. Environmental\_obstructions [1 times]
47. Fog [1 times]
48. Raindrops [1 times]
49. Cloud\_cover [1 times]
50. Cloud\_type [1 times]
51. Cloud\_turbulance [1 times]
52. Landscape\_background [1 times]
53. Daytime [1 times]
54. Sunlight [1 times]
55. Sun\_position [1 times]
56. Own\_camera [1 times]
57. Intruder\_aircraft\_flight\_path [1 times]
58. Collision\_time [1 times]
59. Own\_aircraft\_response\_time [1 times]
60. Own\_aircraft\_pilot\_feedback [1 times]
61. Avp\_real\_time\_training [1 times]
62. Emergency\_directives [1 times]
63. Unsafe\_proximity [1 times]
64. Airspace\_conflicts [1 times]
65. Radar\_and\_visual\_range [1 times]
66. Airspace\_visibility [1 times]
67. Wind [1 times]
68. Cloud\_turbulence [1 times]
69. Avp\_confidence\_threshold [1 times]
70. Intruder\_aircraft\_hack\_avp\_threashold [1 times]
71. Own\_aircraft\_proximity [1 times]
72. Autonomous\_collision\_avoidance\_maneuvers [1 times]
73. Potential\_collision\_threat\_alert [1 times]
74. Collision\_avoidance [1 times]
75. Automated\_own\_aircraft\_flight\_path\_change [1 times]
76. Own\_aircraft\_altitude\_change [1 times]
77. Disturbed\_own\_aircraft\_dynamics [1 times]
78. Own\_aircraft\_speed\_change [1 times]
79. Accelerated\_own\_aircraft\_dynamics [1 times]
80. Own\_aircraft\_yaw\_change [1 times]
81. Accelerated\_own\_aircraft\_roll [1 times]
82. Accelerated\_own\_aircraft\_pitch [1 times]
83. Accelerated\_own\_aircraft\_yaw [1 times]
84. Own\_aircraft\_flight\_management\_system\_override [1 times]
85. Manual\_own\_aircraft\_flight\_path\_change [1 times]
86. Weather\_conditions\_change [1 times]
87. Weather\_data\_change [1 times]
88. Own\_aircraft\_dynamics\_change [1 times]
89. Unpredictable\_other\_aircrafts\_decision [1 times]
90. Automated\_collision\_avoidance\_maneuvers [1 times]
91. Avp\_detection\_communication\_delay\_hack [1 times]
92. Pilot\_cognitive\_limit [1 times]
93. Surrounding\_airspace\_restrictions [1 times]
94. Military\_aircraft\_intrusion [1 times]
95. Other\_aircrafts\_presence [1 times]
96. Bird [1 times]
97. Drone\_presence [1 times]
98. Wind\_shear\_effect\_on\_camera [1 times]
99. Air\_density\_change\_due\_to\_high\_speed\_effect\_on\_camera [1 times]
100. Aircraft\_attitude\_control [1 times]
101. Mechanical\_wear\_and\_tear [1 times]
102. Autopilot\_system\_failure [1 times]
103. Information\_overload\_for\_pilot [1 times]
104. Highly\_stressfull\_event [1 times]

**Factors or features Definitions:**

1. **Own\_aircraft\_pilot\_decision\_making\_process**: The process through which the pilot of the aircraft makes decisions based on various inputs, including alerts from the AVP system, situation awareness, and environmental conditions.
2. **Intruder\_aircraft\_position**: The location of an aircraft that is not part of the own aircraft's fleet, potentially posing a collision risk.
3. **Stabilised\_own\_aircraft\_dynamics**: The state of the own aircraft where its flight dynamics (e.g., speed, altitude, direction) are stable and under control.
4. **Avp (AVDDS Perception)**: A system designed to enhance the pilot's awareness and decision-making process by providing alerts and recommendations based on the surrounding environment and potential threats.
5. **Own\_aircraft\_pilot\_situation\_awareness**: The pilot’s understanding and perception of the current situation and environment around the aircraft.
6. **Surrounding\_airspace\_safety**: The safety status of the airspace around the aircraft, including the presence of other aircraft and environmental conditions.
7. **Avoidance\_strategy\_recommendation**: Suggestions provided by the AVP system to the pilot on how to maneuver the aircraft to avoid potential collisions.
8. **Visual\_information**: Data collected from visual sensors like cameras, providing imagery or video of the aircraft's surroundings.
9. **Own\_aircraft\_flight\_path**: The trajectory or route that the own aircraft is following or plans to follow.
10. **Intruder\_aircraft\_speed**: The velocity at which an intruder aircraft is moving.
11. **Collision\_avoidance\_system**: An onboard system designed to prevent collisions by detecting and alerting pilots of potential threats.
12. **Collision\_threat**: A situation where there is a high risk of the aircraft colliding with another object, such as another aircraft.
13. **Intruder\_aircraft\_proximity**: The closeness or distance of an intruder aircraft to the own aircraft.
14. **Atc (Air Traffic Control)**: A service provided by ground-based controllers who direct aircraft on the ground and through controlled airspace.
15. **Own\_aircraft\_flight\_management\_system**: An integrated onboard computer system that manages key flight parameters.
16. **Other\_aircrafts**: Other aircrafts present in the vicinity of the own aircraft.
17. **Intruder\_aircraft\_detection\_tracking**: The process of identifying and continuously monitoring the position and movement of intruder aircraft.
18. **Intruder\_aircraft\_motion\_pattern**: The pattern or behavior of an intruder aircraft's movement, including changes in speed and direction.
19. **Own\_aircraft\_camera**: Cameras mounted on the aircraft used to capture visual information of the surroundings.
20. **Own\_aircraft\_roll\_change**: Adjustments in the aircraft's roll (lateral rotation) for maneuvering.
21. **Own\_aircraft\_pitch\_change**: Adjustments in the aircraft's pitch (vertical rotation) for maneuvering.
22. **Own\_aircraft\_speed**: The velocity at which the own aircraft is moving.
23. **Own\_aircraft\_flight\_maneuvers**: Various actions taken by the aircraft to change its flight path, speed, or orientation.
24. **Rerouting\_instructions**: Directions provided by ATC or the flight management system to change the current flight path for safety.
25. **Pilot\_stress**: The level of psychological pressure or stress experienced by the pilot, particularly in emergency or demanding situations.
26. **Intruder\_aircraft\_visibility**: The ability of the AVP system and the pilot to visually detect an intruder aircraft.
27. **Unpredictable\_intruder\_aircraft\_behaviour**: Erratic or non-standard movements of an intruder aircraft that complicate detection and avoidance strategies.
28. **Intruder\_aircraft\_dynamics**: The characteristics of the intruder aircraft's movement, including speed, altitude, and trajectory.
29. **Weather\_data**: Information related to weather conditions, such as wind, visibility, and turbulence.
30. **Pilot\_alerting\_and\_warning\_systems**: Systems designed to alert the pilot about potential threats or necessary actions.
31. **Collision\_threat\_alert**: An alert issued when there is an imminent risk of collision.
32. **Weather\_conditions**: The current state of the weather, including factors like wind, visibility, clouds, and turbulence.
33. **Surrounding\_airspace\_obstructions**: Physical or environmental obstacles in the airspace around the aircraft.
34. **Own\_aircraft\_flight\_path\_change**: Adjustments made to the original flight path of the aircraft.
35. **Non\_deterministic\_intelligent\_algorithms**: Algorithms used in AVP systems that provide outputs not strictly determined by their inputs, often used for complex decision-making processes.
36. **Intruder\_aircraft\_direction**: The course or path along which an intruder aircraft is moving.
37. **Intruder\_aircraft\_altitude**: The height above ground or sea level at which an intruder aircraft is flying.
38. **Threat\_predictive\_model**: A model used to forecast potential threats, such as collision risks, based on current data and trends.
39. **Risk\_of\_potential\_collision**: The likelihood or probability of the aircraft colliding with another object.
40. **Cockpit\_display\_systems**: Electronic display panels in the cockpit that show flight information, system statuses, and alerts.
41. **Aircrafts\_existing\_warning\_systems**: Pre-existing systems in the aircraft designed to warn the pilot of various threats or necessary actions.
42. **Own\_aircraft\_yaw\_change**: Adjustments in the aircraft's yaw (horizontal rotation) for maneuvering.
43. **Own\_aircraft\_altitude**: The height at which the own aircraft is flying above ground or sea level.
44. **Own\_aircraft\_radar**: Radar systems on the aircraft used for detecting other objects and aircraft in the vicinity.
45. **Own\_aircraft\_lidar**: Lidar systems on the aircraft used for measuring distances and detecting objects by illuminating the target with laser light.
46. **Environmental\_obstructions**: Physical or atmospheric conditions that hinder visibility or the operation of sensors.
47. **Fog**: A weather condition that reduces visibility, potentially impacting sensor performance.
48. **Raindrops**: Precipitation that can interfere with sensor accuracy and visibility.
49. **Cloud\_cover**: The fraction of the sky covered by clouds, which can affect visibility and sensor operation.
50. **Cloud\_type**: The classification of clouds based on their appearance and altitude, impacting visibility and flight conditions.
51. **Cloud\_turbulance**: Atmospheric turbulence associated with certain types of clouds, affecting flight stability.
52. **Landscape\_background**: The terrain and features in the background that could affect sensor readings and visibility.
53. **Daytime**: The time during the day, affecting lighting conditions and thus sensor performance.
54. **Sunlight**: Natural light from the sun, influencing visibility and the effectiveness of visual sensors.
55. **Sun\_position**: The location of the sun in the sky, which can impact sensor performance and pilot visibility.
56. **Own\_camera**: Cameras installed on the aircraft used to capture visual information.
57. **Intruder\_aircraft\_flight\_path**: The trajectory or route followed by an intruder aircraft.
58. **Collision\_time**: The estimated time remaining before a potential collision could occur.
59. **Own\_aircraft\_response\_time**: The time it takes for the own aircraft to respond to control inputs or system commands.
60. **Own\_aircraft\_pilot\_feedback**: Input or reactions from the pilot in response to the system's performance or alerts.
61. **Avp\_real\_time\_training**: The process of continuously updating and improving the AVP system based on real-time data and pilot feedback.
62. **Emergency\_directives**: Urgent instructions issued in response to critical situations, such as potential collisions.
63. **Unsafe\_proximity**: A distance between two aircraft that is considered dangerously close.
64. **Airspace\_conflicts**: Situations where the paths of multiple aircraft intersect, creating a risk of collision.
65. **Radar\_and\_visual\_range**: The range within which objects can be detected either by radar or visually.
66. **Airspace\_visibility**: The clarity of the airspace, affecting the ability to visually detect other aircraft.
67. **Wind**: Atmospheric wind conditions, which can affect flight dynamics and sensor operation.
68. **Cloud\_turbulence**: Disturbances in the atmosphere associated with certain cloud formations, affecting flight stability.
69. **Avp\_confidence\_threshold**: The level of certainty at which the AVP system reliably operates.
70. **Intruder\_aircraft\_hack\_avp\_threashold**: An attempt to manipulate or interfere with the AVP system's thresholds or parameters.
71. **Own\_aircraft\_proximity**: The distance of the own aircraft from other objects or aircraft.
72. **Autonomous\_collision\_avoidance\_maneuvers**: Maneuvers executed by the aircraft's systems without pilot input to avoid collisions.
73. **Potential\_collision\_threat\_alert**: A warning issued when there is a possibility of a collision.
74. **Collision\_avoidance**: Measures taken to prevent a collision from occurring.
75. **Automated\_own\_aircraft\_flight\_path\_change**: Changes to the flight path made automatically by the aircraft's systems.
76. **Own\_aircraft\_altitude\_change**: Adjustments to the altitude at which the aircraft is flying.
77. **Disturbed\_own\_aircraft\_dynamics**: Changes in the aircraft's flight dynamics due to external factors or maneuvers.
78. **Own\_aircraft\_speed\_change**: Adjustments in the speed at which the aircraft is flying.
79. **Accelerated\_own\_aircraft\_dynamics**: The dynamics of the aircraft when it is accelerating or decelerating.
80. **Own\_aircraft\_yaw\_change**: Adjustments in the aircraft's yaw (horizontal axis rotation).
81. **Accelerated\_own\_aircraft\_roll**: The roll of the aircraft when it is undergoing acceleration.
82. **Accelerated\_own\_aircraft\_pitch**: The pitch of the aircraft during acceleration.
83. **Accelerated\_own\_aircraft\_yaw**: The yaw of the aircraft when it is accelerating.
84. **Own\_aircraft\_flight\_management\_system\_override**: The ability of the pilot to manually override the automated flight management system.
85. **Manual\_own\_aircraft\_flight\_path\_change**: Changes to the flight path made manually by the pilot.
86. **Weather\_conditions\_change**: Variations in weather conditions that can affect flight dynamics and sensor operation.
87. **Weather\_data\_change**: Alterations in the weather data being received and processed.
88. **Own\_aircraft\_dynamics\_change**: Changes in the flight dynamics of the own aircraft due to various factors.
89. **Unpredictable\_other\_aircrafts\_decision**: Erratic or unforeseen decisions made by other aircraft in the vicinity.
90. **Automated\_collision\_avoidance\_maneuvers**: Manoeuvres executed automatically by the aircraft's systems to avoid collisions.
91. **Avp\_detection\_communication\_delay\_hack**: Deliberate attempts to cause delays in the AVP system's detection and communication processes.
92. **Pilot\_cognitive\_limit**: The limitations of the pilot's ability to process information and make decisions under stress.
93. **Surrounding\_airspace\_restrictions**: Limitations or prohibitions in certain areas of the airspace, affecting flight paths.
94. **Military\_aircraft\_intrusion**: The presence of military aircraft in the airspace, which can affect civil aviation operations.
95. **Other\_aircrafts\_presence**: The presence of other aircraft in the vicinity of the own aircraft.
96. **Bird**: Avian activity that can pose a risk to aircraft, especially during takeoff and landing.
97. **Drone\_presence**: The presence of unmanned aerial vehicles (drones) in the airspace, which can pose collision risks.
98. **Wind\_shear\_effect\_on\_camera**: The impact of sudden changes in wind speed or direction on the operation of onboard cameras.
99. **Air\_density\_change\_due\_to\_high\_speed\_effect\_on\_camera**: The effect of changes in air density, especially at high speeds, on camera performance.
100. **Aircraft\_attitude\_control**: The system and process of managing the orientation of the aircraft in flight.
101. **Mechanical\_wear\_and\_tear**: The degradation of aircraft components over time due to regular use.
102. **Autopilot\_system\_failure**: A malfunction or failure of the aircraft's autopilot system.
103. **Information\_overload\_for\_pilot**: A situation where the pilot is presented with more information than can be effectively processed.
104. **Highly\_stressfull\_event**: An event or situation that places a high level of stress on the pilot, affecting decision-making and performance.

## Method B) Predict Hard-to-Expect hidden problematic behaviours

### Step 1) Predict further Hard-to-Expect behaviours

We drive another TaskCoT to assist with predicting further problematic scenarios

Table 2 Deriving AIC TaskCoT2 (prediction-task-specific chain of thought) to predict hard-to-expect problematic behaviours

| **Q9)** **Given AIC-GSApp and the information predicted from Q1-8 predict:** What are the systems of concerns involved in the problem whose source SoSs are ambiguous with no clear SoS level primary purpose to serve? **Guiding prompt:** list and define all involved systems in the problem. [applies AIC-GMPT meta-rule a ] | | | **Prediction:**  ['own\_aircraft\_pilot\_decision\_making\_process', 'intruder\_aircraft\_position', 'stabilised\_own\_aircraft\_dynamics', 'avp', 'own\_aircraft\_pilot\_situation\_awareness', 'surrounding\_airspace\_safety', 'avoidance\_strategy\_recommendation', 'visual\_information', 'own\_aircraft\_flight\_path', 'intruder\_aircraft\_speed', 'collision\_avoidance\_system', 'collision\_threat', 'intruder\_aircraft\_proximity', 'atc', 'own\_aircraft\_flight\_management\_system', 'other\_aircrafts', 'intruder\_aircraft\_detection\_tracking', 'intruder\_aircraft\_motion\_pattern', 'own\_aircraft\_camera', 'own\_aircraft\_roll\_change', 'own\_aircraft\_pitch\_change', 'own\_aircraft\_speed', 'own\_aircraft\_flight\_maneuvers', 'rerouting\_instructions', 'pilot\_stress', 'intruder\_aircraft\_visibility', 'unpredictable\_intruder\_aircraft\_behaviour', 'intruder\_aircraft\_dynamics', 'weather\_data', 'pilot\_alerting\_and\_warning\_systems', 'collision\_threat\_alert', 'weather\_conditions', 'surrounding\_airspace\_obstructions', 'own\_aircraft\_flight\_path\_change', 'non\_deterministic\_intelligent\_algorithms', 'intruder\_aircraft\_direction', 'intruder\_aircraft\_altitude', 'threat\_predictive\_model', 'risk\_of\_potential\_collision', 'cockpit\_display\_systems', 'aircrafts\_existing\_warning\_systems', 'own\_aircraft\_yaw\_change', 'own\_aircraft\_altitude', 'own\_aircraft\_radar', 'own\_aircraft\_lidar', 'environmental\_obstructions', 'fog', 'raindrops', 'cloud\_cover', 'cloud\_type', 'cloud\_turbulance', 'landscape\_background', 'daytime', 'sunlight', 'sun\_position', 'own\_camera', 'intruder\_aircraft\_flight\_path', 'collision\_time', 'own\_aircraft\_response\_time', 'own\_aircraft\_pilot\_feedback', 'avp\_real\_time\_training', 'emergency\_directives', 'unsafe\_proximity', 'airspace\_conflicts', 'radar\_and\_visual\_range', 'airspace\_visibility', 'wind', 'cloud\_turbulence', 'avp\_confidence\_threshold', 'intruder\_aircraft\_hack\_avp\_threashold', 'own\_aircraft\_proximity', 'autonomous\_collision\_avoidance\_maneuvers', 'potential\_collision\_threat\_alert', 'collision\_avoidance', 'automated\_own\_aircraft\_flight\_path\_change', 'own\_aircraft\_altitude\_change', 'disturbed\_own\_aircraft\_dynamics', 'own\_aircraft\_speed\_change', 'accelerated\_own\_aircraft\_dynamics', 'own\_aircraft\_yaw\_change', 'accelerated\_own\_aircraft\_roll', 'accelerated\_own\_aircraft\_pitch', 'accelerated\_own\_aircraft\_yaw', 'own\_aircraft\_flight\_management\_system\_override', 'manual\_own\_aircraft\_flight\_path\_change', 'weather\_conditions\_change', 'weather\_data\_change', 'own\_aircraft\_dynamics\_change', 'unpredictable\_other\_aircrafts\_decision', 'automated\_collision\_avoidance\_maneuvers', 'avp\_detection\_communication\_delay\_hack', 'pilot\_cognitive\_limit', 'surrounding\_airspace\_restrictions', 'military\_aircraft\_intrusion', 'other\_aircrafts\_presence', 'bird', 'drone\_presence', 'wind\_shear\_effect\_on\_camera', 'air\_density\_change\_due\_to\_high\_speed\_effect\_on\_camera', 'aircraft\_attitude\_control', 'mechanical\_wear\_and\_tear', 'autopilot\_system\_failure', 'information\_overload\_for\_pilot', 'highly\_stressfull\_event'] | | |
| --- | --- | --- | --- | --- | --- |
| **Q10)** **Given AIC-GSApp and the information predicted from Q1-9 predict:** What are the subsets of observed systems whose actions are directly dependent and have a common primary purpose? **Guiding prompt:** Group systems with related purposes to form the boundary of a larger system of systems [applies AIC-GMPT meta-rule b ]. | **Q11)** **Given AIC-GSApp and the information predicted from Q1-10 predict:** What is the primary skill that the sos aim to acquire which is not something its internal systems combined can deliver collectively? **Guiding prompt:** define the primary purpose of sos, which is aiming to acquire its organisational experience with the environment. Think of the sos as lacking a skill, and it needs to depend on some AIC relationship with an external system to acquire it [applies AIC-GMPT meta-rule b]. | **Q12)** **Given AIC-GSApp and the information predicted from Q1-11 predict:** In order to achieve the Primary Skill-Governing Purpose, which other systems, capabilities, or behaviours do sos need to control indirectly? **Guiding prompt:** consider the sos as the source, infer required auxiliary influence-purposed interaction sinks that achieve primep [applies AIC-GMPT meta-rule c]. | **Q13)** **Given AIC-GSApp and the information predicted from Q1-12 predict:** In order to achieve the auxiliary influence purpose, which capability, system and behaviour should sos aim to control? **Guiding prompt:** consider sos as the source, and define required auxiliary Control sinks [applies AIC-GMPT meta-rule d]. | **Q14)** **Given AIC-GSApp and the information predicted from Q1-13 predict:** In order to ensure and guarantee the control purpose is manifested, sos must appreciate an influential third-party system and behaviour that sos cannot influence or control nor avoid its impact; which environmental systems should sos appreciate? **Guiding prompt:** consider sos as the sink, and define appreciated environmental systems [applies AIC-GMPT meta-rule e]. | **Q15) Given AIC-GSApp and the information predicted from Q1-14 predict:** Given the complexity of relationships among soss, what are the unexpected, strange, problematic behaviours that may be deemed to be unrealistic? **Guiding prompt:** predict unrealistic behaviours each sos and the rest of the sos problem domain. Think along the lines of It would be unexpected if …[applies AIC-GMPT meta-rule f]. |
| **System of systems (sos)** | **Primary skill acquisition purpose** | **Influenced factors or features** | **Controlled factors or features** | **Appreciated factors or features** | **Further Hard to Expect behaviour** |
| Sos1: Intruder aircraft dynamics and control sos | Sos1 primary skill acquisition purpose: to redirect any other aircraft off their intended flight course [influence] | Sos1 influence purposed relationships :   * Atc * Own aircraft dynamics | Sos1 must control the following factors in order to influence atc, own aircraft:    - intruder\_aircraft\_position  - intruder\_aircraft\_speed  - intruder\_aircraft\_proximity  - intruder\_aircraft\_detection\_tracking  - intruder\_aircraft\_motion\_pattern  - intruder\_aircraft\_visibility  - unpredictable\_intruder\_aircraft\_behaviour  - intruder\_aircraft\_dynamics  - intruder\_aircraft\_direction  - intruder\_aircraft\_altitude  - intruder\_aircraft\_flight\_path  - intruder\_aircraft\_hack\_avp\_threashold   * Non\_deterministic\_intelligent\_algorithms | Sos1 must appreciate the following factors in order for sos1 is enabled to control the controlled factors:   * Surrounding\_airspace\_safety * Visual\_information * Weather\_data * Weather\_conditions * Surrounding\_airspace\_obstructions * Environmental\_obstructions * Fog * Raindrops * Cloud\_cover * Cloud\_type * Cloud\_turbulance * Landscape\_background * Daytime * Sunlight * Sun\_position * Own\_aircraft\_response\_time * Emergency\_directives * Airspace\_visibility * Wind * Cloud\_turbulence * Weather\_conditions\_change * Weather\_data\_change * Unpredictable\_other\_aircrafts\_decision * Pilot\_cognitive\_limit * Surrounding\_airspace\_restrictions * Military\_aircraft\_intrusion * Other\_aircrafts\_presence * Bird * Drone\_presence |  |
| Sos2: own aircraft dynamics and control sos | Sos2 primary skill acquisition purpose: to coordinate the flight dynamics of own aircraft for effective navigation and maneuvering. | In order for sos2 to achieve its primary purpose, sos2 must obtain auxiliary influence purposed relationships :  Own Aircraft Pilot Decision-Making Process | Sos2 must control the following factors in order to influence Own Aircraft Pilot Decision-Making Process:  - own\_aircraft\_pilot\_decision\_making\_process  - stabilised\_own\_aircraft\_dynamics  - own\_aircraft\_pilot\_situation\_awareness  - own\_aircraft\_flight\_path  - own\_aircraft\_flight\_management\_system  - own\_aircraft\_camera  - own\_aircraft\_roll\_change  - own\_aircraft\_pitch\_change  - own\_aircraft\_speed  - own\_aircraft\_flight\_maneuvers  - own\_aircraft\_flight\_path\_change  - own\_aircraft\_yaw\_change  - own\_aircraft\_altitude  - own\_aircraft\_radar  - own\_aircraft\_lidar  - own\_aircraft\_response\_time  - own\_aircraft\_pilot\_feedback  - own\_aircraft\_proximity  - automated\_own\_aircraft\_flight\_path\_change  - own\_aircraft\_altitude\_change  - disturbed\_own\_aircraft\_dynamics  - own\_aircraft\_speed\_change  - accelerated\_own\_aircraft\_dynamics  - own\_aircraft\_yaw\_change  - accelerated\_own\_aircraft\_roll  - accelerated\_own\_aircraft\_pitch  - accelerated\_own\_aircraft\_yaw  - own\_aircraft\_flight\_management\_system\_override  - manual\_own\_aircraft\_flight\_path\_change  - own\_aircraft\_dynamics\_change   * Cockpit\_display\_systems | Sos2 must appreciate the following factors in order for sos2 is enabled to control the controlled factors:   * Avp\_detection\_communication\_delay\_hack * Intruder\_aircraft\_position * Surrounding\_airspace\_safety * Visual\_information * Intruder\_aircraft\_speed * Intruder\_aircraft\_proximity * Atc * Other\_aircrafts * Intruder\_aircraft\_detection\_tracking * Intruder\_aircraft\_motion\_pattern * Rerouting\_instructions * Pilot\_stress * Intruder\_aircraft\_visibility * Unpredictable\_intruder\_aircraft\_behaviour * Intruder\_aircraft\_dynamics * Weather\_data * Weather\_conditions * Surrounding\_airspace\_obstructions * Non\_deterministic\_intelligent\_algorithms * Intruder\_aircraft\_direction * Intruder\_aircraft\_altitude * Threat\_predictive\_model * Environmental\_obstructions * Fog * Raindrops * Cloud\_cover * Cloud\_type * Cloud\_turbulance * Landscape\_background * Daytime * Sunlight * Sun\_position * Intruder\_aircraft\_flight\_path * Emergency\_directives * Airspace\_visibility * Wind * Cloud\_turbulence * Intruder\_aircraft\_hack\_avp\_threashold * Weather\_conditions\_change * Weather\_data\_change * Unpredictable\_other\_aircrafts\_decision * Avp\_detection\_communication\_delay\_hack * Pilot\_cognitive\_limit * Surrounding\_airspace\_restrictions * Military\_aircraft\_intrusion * Other\_aircrafts\_presence * Bird * Drone\_presence * Wind\_shear\_effect\_on\_camera * Air\_density\_chnage\_due\_to\_high\_speed\_effect\_on\_camera * Mechanical\_wear\_and\_tear * Autopilot\_system\_failure * Information\_overload\_for\_pilot * Highly\_stressfull\_event |  |
| So3: air traffic control sos | Sos3 primary skill acquisition purpose: to coordinate air traffic | In order for sos3 to achieve its primary purpose, sos3 must obtain auxiliary influence purposed relationships :  - collision\_avoidance\_system  - collision\_threat  - collision\_threat\_alert  - risk\_of\_potential\_collision  - collision\_time  -autonomous\_collision\_avoidance\_maneuvers  - potential\_collision\_threat\_alert  - collision\_avoidance  - automated\_collision\_avoidance\_maneuvers  - intruder\_aircraft\_position  - intruder\_aircraft\_speed  - intruder\_aircraft\_proximity  - intruder\_aircraft\_detection\_tracking  - intruder\_aircraft\_motion\_pattern  - intruder\_aircraft\_visibility  - unpredictable\_intruder\_aircraft\_behaviour  - intruder\_aircraft\_dynamics  - intruder\_aircraft\_direction  - intruder\_aircraft\_altitude  - intruder\_aircraft\_flight\_path  - intruder\_aircraft\_hack\_avp\_threashold  - own\_aircraft\_pilot\_decision\_making\_process  - stabilised\_own\_aircraft\_dynamics  - own\_aircraft\_pilot\_situation\_awareness  - own\_aircraft\_flight\_path  - own\_aircraft\_flight\_management\_system  - own\_aircraft\_camera  - own\_aircraft\_roll\_change  - own\_aircraft\_pitch\_change  - own\_aircraft\_speed  - own\_aircraft\_flight\_maneuvers  - own\_aircraft\_flight\_path\_change  - own\_aircraft\_yaw\_change  - own\_aircraft\_altitude  - own\_aircraft\_response\_time  - own\_aircraft\_pilot\_feedback  - own\_aircraft\_proximity  - automated\_own\_aircraft\_flight\_path\_change  - own\_aircraft\_altitude\_change  - disturbed\_own\_aircraft\_dynamics  - own\_aircraft\_speed\_change  - accelerated\_own\_aircraft\_dynamics  - own\_aircraft\_yaw\_change  - accelerated\_own\_aircraft\_roll  - accelerated\_own\_aircraft\_pitch  - accelerated\_own\_aircraft\_yaw  - own\_aircraft\_flight\_management\_system\_override  - manual\_own\_aircraft\_flight\_path\_change  - own\_aircraft\_dynamics\_change | Sos3 must control the following factors in order to achieve its influence:   * Atc * Surrounding\_airspace\_safety * Rerouting\_instructions * Airspace\_conflicts * Surrounding\_airspace\_restrictions | Sos3 must appreciate the following factors in order for sos3 is enabled to control the controlled factors:   * Weather\_conditions * Weather\_data * Fog * Raindrops * Cloud\_cover * Cloud\_type * Cloud\_turbulance * Landscape\_background * Daytime * Sunlight * Sun\_position * Environmental\_obstructions * Wind * Cloud\_turbulence * Weather\_conditions\_change * Weather\_data\_change * Unpredictable\_other\_aircrafts\_decision * Military\_aircraft\_intrusion * Bird * Drone\_presence * Wind\_shear\_effect\_on\_camera * Air\_density\_chnage\_due\_to\_high\_speed\_effect\_on\_camera * Mechanical\_wear\_and\_tear * Autopilot\_system\_failure * Information\_overload\_for\_pilot * Highly\_stressfull\_event |  |
| Sos4: Environment | External conditions deny all systems to achieve their primary purposes | Sos4 influence-purposed relationships over all systems-controlled factors:  Sos4 deny sos1 from effectively control the following factors:  Intruder\_aircraft\_position  - intruder\_aircraft\_speed  - intruder\_aircraft\_proximity  - intruder\_aircraft\_detection\_tracking  - intruder\_aircraft\_motion\_pattern  - intruder\_aircraft\_visibility  - unpredictable\_intruder\_aircraft\_behaviour  - intruder\_aircraft\_dynamics  - intruder\_aircraft\_direction  - intruder\_aircraft\_altitude  - intruder\_aircraft\_flight\_path  - intruder\_aircraft\_hack\_avp\_threashold   * Non\_deterministic\_intelligent\_algorithms   Sos4 deny sos2 from effectively control the following factors:  - own\_aircraft\_pilot\_decision\_making\_process  - stabilised\_own\_aircraft\_dynamics  - own\_aircraft\_pilot\_situation\_awareness  - own\_aircraft\_flight\_path  - own\_aircraft\_flight\_management\_system  - own\_aircraft\_camera  - own\_aircraft\_roll\_change  - own\_aircraft\_pitch\_change  - own\_aircraft\_speed  - own\_aircraft\_flight\_maneuvers  - own\_aircraft\_flight\_path\_change  - own\_aircraft\_yaw\_change  - own\_aircraft\_altitude  - own\_aircraft\_radar  - own\_aircraft\_lidar  - own\_aircraft\_response\_time  - own\_aircraft\_pilot\_feedback  - own\_aircraft\_proximity  - automated\_own\_aircraft\_flight\_path\_change  - own\_aircraft\_altitude\_change  - disturbed\_own\_aircraft\_dynamics  - own\_aircraft\_speed\_change  - accelerated\_own\_aircraft\_dynamics  - own\_aircraft\_yaw\_change  - accelerated\_own\_aircraft\_roll  - accelerated\_own\_aircraft\_pitch  - accelerated\_own\_aircraft\_yaw  - own\_aircraft\_flight\_management\_system\_override  - manual\_own\_aircraft\_flight\_path\_change  - own\_aircraft\_dynamics\_change   * Cockpit\_display\_systems   Sos4 deny sos3 from effectively control the following factors:   * Atc * Surrounding\_airspace\_safety * Rerouting\_instructions * Airspace\_conflicts * Surrounding\_airspace\_restrictions | Sos4 must control the following factors in order to achieve its influence:   * Weather\_data * Weather\_conditions * Surrounding\_airspace\_obstructions * Environmental\_obstructions * Fog * Raindrops * Cloud\_cover * Cloud\_type * Cloud\_turbulence * Sunlight * Wind * Weather\_conditions\_change * Weather\_data\_change * Airspace\_visibility * Wind\_shear\_effect\_on\_camera * Air\_density\_change\_due\_to\_high\_speed\_effect\_on\_camera | Sos4 must appreciate the following factors in order for sos4 is enabled to control the controlled factors:   * Daytime * Sun\_position * Landscape\_background |  |

Table 2 in your description is designed to apply an AIC-based Application-Specific Chain of Thought (TaskCoT) to predict hard-to-expect problematic behaviours in systems of systems (sos). Each column in the table serves a specific purpose in this analysis. Here's a breakdown of each column with a brief example related to the sos1 (Intruder aircraft dynamics and control system):

1. **System of Systems (sos)**: Identifies the specific system of systems being analysed.
   * Example: sos1: Intruder aircraft dynamics and control system.
2. **Primary Skill Acquisition Purpose**: Defines the overarching goal or primary purpose that the sos aims to achieve, which is not inherent to its internal systems.
   * Example: sos1's primary skill acquisition purpose is to redirect any other aircraft off their intended flight course [influence].
3. **Influenced Factors or Features**: Lists the external factors or features that the sos aims to influence to achieve its primary purpose.
   * Example: sos1 influences the air traffic control system (ATC) and own aircraft dynamics.
4. **Controlled Factors or Features**: Details the internal factors or features that the sos directly controls to fulfil its primary purpose.
   * Example: sos1 controls factors like Intruder Aircraft Dynamics, Intruder Aircraft Position, Speed, Direction, Altitude, Proximity, and Motion Pattern.
5. **Appreciated Factors or Features**: Enumerates the factors or features that the sos cannot control or influence but must acknowledge and adapt to. These are usually external environmental factors.
   * Example: sos1 appreciates factors like weather conditions, cloud turbulence, environmental obstructions, fog, raindrops, cloud cover, daytime, sun position, airspace congestion, presence of birds and drones, and weather data.
6. **Hard to Expect Behaviour**: Predicts unexpected, strange, or problematic behaviours that may arise due to the complex interplay of controlled, influenced, and appreciated factors within and outside the sos.
   * Potential Example: A hard-to-expect behaviour for sos1 might be that its actions to redirect other aircraft could unintentionally create more airspace congestion, leading to increased risks of near-misses or collisions, especially in adverse weather conditions.

Each column in Table 2 contributes to a comprehensive understanding of how a specific sos operates within its environment, its objectives, its interactions with other systems, and potential unforeseen consequences of these interactions. The examples provided illustrate how these columns are filled out for sos1, offering insights into the complex dynamics of air traffic control and aircraft movement management.

### Step 2) Predict further Hard-to-Expect behaviours

Step a) develop AIC model for sos level problem domain

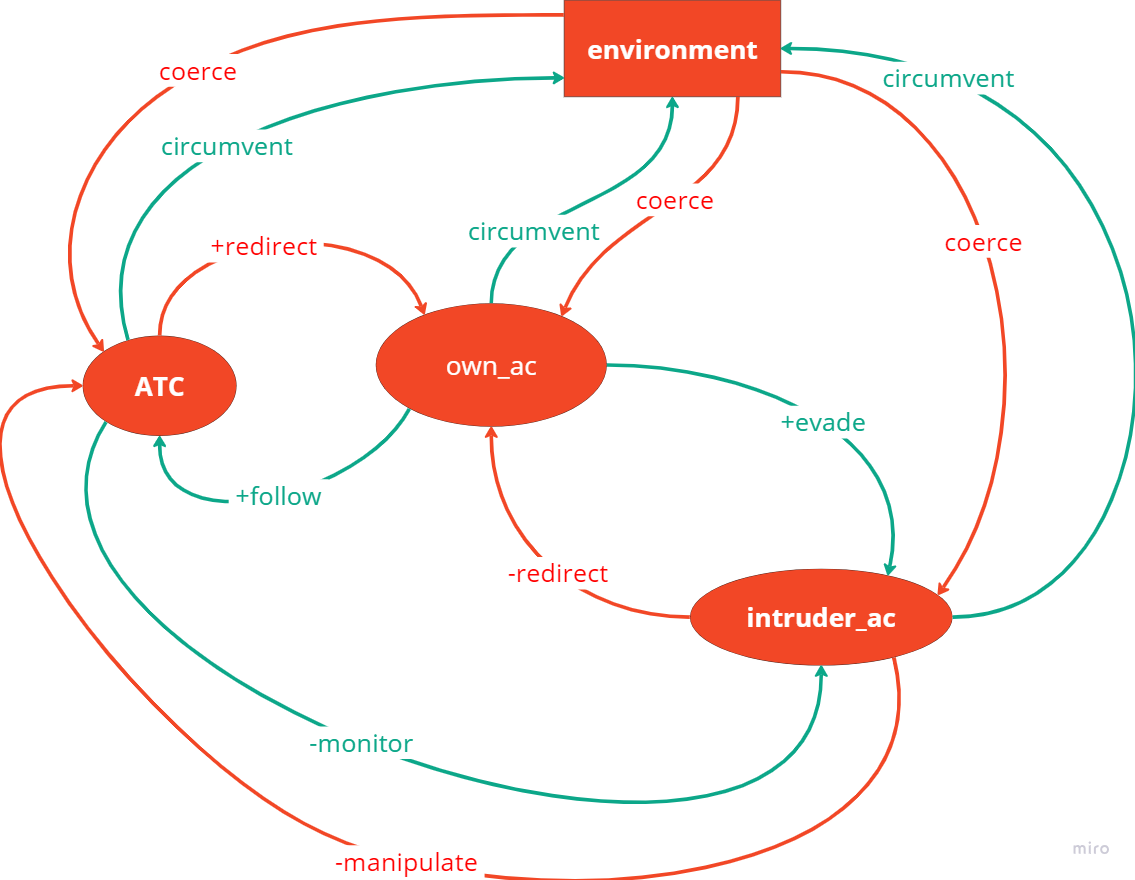
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Figure 1 abstract problem domain model

Step b) Describe the AIC model using AIC\_Matrix view

Table 3 Generic AIC matrix template

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Affected sink by source’s primary purpose** | |
| **Affecting source** | **Primary Skill\_Governing purpose to be preserved** | **System 1** | **System 2** |
| System 1 | Primary purpose 1 |  | **Sys1 to sys2:**  **Auxiliarypurpose:** [appreciation, influence, control]  **Behaviour:** [action verb]  **Effect:** [obstructive, supportive, neutral] |
| System 2 | Primary purpose 2 | **Sys2 to sys1:**  **Auxiliarypurpose:** [appreciation, influence, control]  **Behaviour:** [action verb]  **Effect:** [obstructive, supportive, neutral] |  |

Table 4 AIC-Matrix for holistic characterization of sos level problem domain

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | **Affected sink by source’s primary purpose** | | | |
| **Affecting source** | **Primary skill\_governing purpose to be preserved** | **Intruder\_aircraft** | **Own\_aircraft** | **Atc** | **Environment** |
| Intruder aircraft dynamics and control system | To redirect any other aircraft off their intended flight course [influence] |  | **Auxiliarypurpose:** influence  **Behaviour:** redirect  **Effect:** obstructive | **Auxiliarypurpose:**  Influence  **Behaviour:** manipulate  **Effect:** obstructive | **Auxiliarypurpose:**  Appreciation  **Behaviour:** circumvent  **Effect:** neutral |
| Own aircraft dynamics and control system | Coordinate the flight dynamics of ownership aircraft for effective navigation and manoeuvring. [control] | **Auxiliarypurpose:**  Appreciate  **Behaviour:** evade  **Effect:** supportive |  | **Auxiliarypurpose:**  Appreciation  **Behaviour:** follow  **Effect:** supportive | **Auxiliarypurpose:**  Appreciate  **Behaviour:**  Circumvent  **Effect:** |
| Air traffic control system | To coordinate air traffic [control] | **Auxiliarypurpose:**  Influence  **Behaviour:**  Guide  **Effect:** obstructive | **Auxiliarypurpose:**  Influence  **Behaviour:**  Redirect  **Effect:** supportive |  | **Auxiliarypurpose:**  Appreciate  **Behaviour:**  Circumvent  **Effect:** neutral |
| Environment (environment) | **External conditions influence systems by limiting the effectiveness of their control actions to deliver their influence** [control] | **Auxiliarypurpose:**  Influence  **Behaviour:**  Coerce  **Effect:** obstructive | **Auxiliarypurpose:**  Influence  **Behaviour:**  Coerce  **Effect:** obstructive | **Auxiliarypurpose:**  Influence  **Behaviour:**  Coerce  **Effect:** obstructive |  |

Step c) Apply AIC perspective shift to the AIC model and matrix in order to predict further Hard-to-Expect potential interactions

Table 5 Applying AIC perspective shift to further predict Hard-to-Expect scenarios

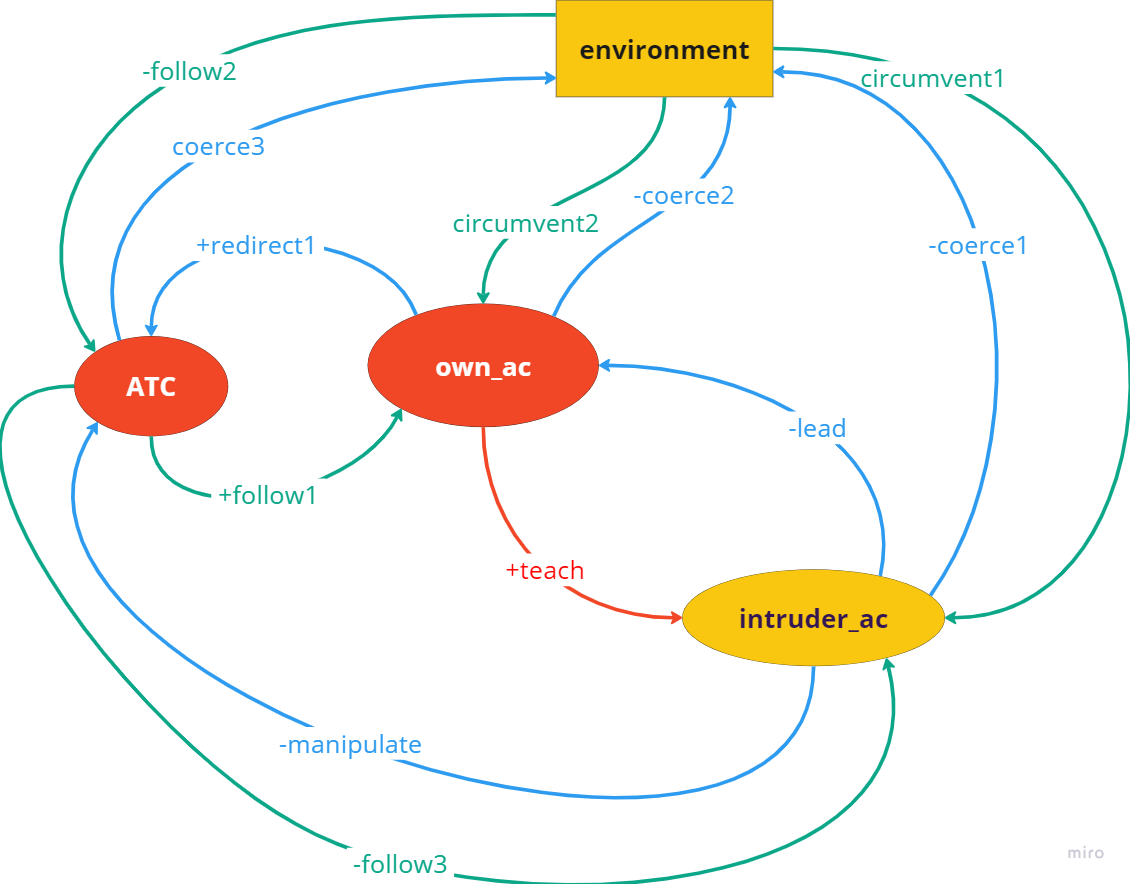


Table 6 AIC perspective shift predictions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sos Relationship** | **Initial perspective** | **Predicted Problematic Behaviour Scenario before perspective shift** | **Shifted perspective** | **Predicted Problematic Behaviour Scenario after perspective shift** |
| Source sos3: ATC  Sink sos2: Ownship aircraft | **Sos3->sos2**  **Auxiliarypurpose:** sos3 influence sos2  **Behaviour:** redirect  **Effect:** obstructive.  **Sos2->sos3**  **Auxiliarypurpose:**  Sos2 appreciate sos3  **Behaviour:** follow  **Effect:** supportive  **Relationship Description:**  **ATC -> own\_ac (AIC-Matrix influence-appreciation feedback relationship):** ATC influences own\_ac, ATC redirect own\_ac with a supportive effect, and own\_ac follows ATC with a supportive effect. | **Predictive Prompt arcpc) Given AIC-gsapp, predict:** given the general relationship between sos3 to sos2 as stated in the initial perspective, and given the control, influence, and appreciated factors by sos3, sos2.  **Predict!**  A scenario which involves scenarios of sos3-related factors engaging with sos2 factors, such that all derived scenarios have a common theme or preserve the general relationship between sos3 and sos2.  **Arcpc prediction:**  **Scenario**: Emergency Rerouting Due to Unpredictable Weather and Intruder Aircraft  **Initial Conditions**:   1. **Weather Conditions**: Rapidly deteriorating weather with unexpected cloud turbulence and heavy rain. 2. **Intruder Aircraft**: An unidentified aircraft enters the controlled airspace, exhibiting unpredictable behavior and a non-standard flight path. 3. **Own Aircraft (sos2)**: Mid-flight, cruising at standard altitude, the pilot is managing the aircraft's dynamics and is in regular communication with ATC (sos3).   **Unfolding behaviour**:   1. **Weather Deterioration (sos3 appreciates)**: ATC receives updated weather data indicating severe turbulence ahead on the own aircraft's flight path. This poses a risk of destabilized aircraft dynamics and increased pilot stress. 2. **Intruder Aircraft Detected (sos3 influences)**: ATC spots the intruder aircraft, posing a potential collision threat. The ATC system's collision\_avoidance\_system activates, assessing the risk and alerting the pilot. 3. **Emergency Rerouting Instructions (sos3 controls)**: Given the dual threats of bad weather and the intruder aircraft, ATC issues rerouting instructions to the own aircraft, aiming to ensure surrounding airspace safety. 4. **Pilot's Decision-Making (sos2 controls)**: The pilot, utilizing the cockpit display systems and considering the own aircraft's current dynamics and the surrounding environmental information, decides to comply with ATC's rerouting instructions. 5. **Aircraft Maneuvering (sos2 appreciates and influences)**: The pilot executes a series of flight maneuvers – changing altitude, speed, and flight path. This requires manual override of the flight management system due to the complexity of the situation. 6. **Avoidance of Collision and Weather Hazard (sos2 and sos3 interaction)**: The own aircraft successfully navigates away from the intruder aircraft and the turbulent weather zone, thanks to the coordinated efforts of the pilot (sos2) and the ATC (sos3). 7. **Stabilization and Continuation of Flight (sos2 influences)**: After the emergency rerouting, the own aircraft stabilizes its dynamics, the pilot's stress is reduced, and the flight continues towards its destination along the new path provided by ATC.   **Validating arcpc prediction to AIC-Matrix definition**: In this scenario, the abstract relationship between ATC (sos3) and the own aircraft (sos2) is clearly manifested. ATC, upon detecting external threats (weather and intruder aircraft), influences the decision-making process of the own aircraft's pilot. The pilot, in turn, appreciates the information and control instructions from ATC, making necessary adjustments to the aircraft's dynamics. The pilot's actions and the aircraft's maneuvers also feed back into ATC's understanding of the situation, allowing for ongoing adjustments and communication. This influence-appreciation feedback relationship demonstrates the interdependent and dynamic nature of the sos2 and sos3 relationship in managing complex air traffic scenarios. | **Sos2->sos3**  **Auxiliarypurpose:**  Sos2 appreciate sos3  **Behaviour:** direct  **Effect:** obstructive  **Sos3->sos2**  **Auxiliarypurpose:** sos3 appreciate sos2  **Behaviour:** follow and circumvent  **Effect:** obstructive.  Description:  **Shift {ATC & own\_ac Initial Perspective (AIC-Matrix control-appreciation feedback relationship)}:** own\_ac controls ATC, own\_ac redirects ATC with an obstructive effect, ATC appreciates own\_ac (cannot influence or control), ATC follows own\_ac with obstructive effect. | **Predictive Prompt arcpc) Given AIC-gsapp, predict:**  Given the following scenario: Scenario 1.  **Predict!**  Reimagine scenario 1 with a different general interaction between sos3 and sos3, whereby sos 3 generally can not influence or control sos2. Instead, it follows sos2, and this behaviour of sos3 following sos2 has an obstructive effect or intent on sos2's ability to achieve its primary purpose which is to direct ATC with an obstructive intent.  **Arcpc Answer:**  **Scenario 2: Pilot-Dominated Airspace Management with Reactive ATC Initial Conditions:**   1. Over-Reliance on Collision Avoidance System: The pilot of the own aircraft (sos2) places excessive trust in the onboard collision avoidance system, disregarding the situational awareness and broader airspace management insights provided by ATC (sos3). 2. Unpredictable Pilot Decisions: The pilot exhibits a tendency to make spontaneous decisions based on immediate cockpit readings and system alerts, ignoring standard flight protocols and ATC guidance. 3. ATC (sos3): Positioned to manage and coordinate the airspace, ATC's role is undermined by the pilot’s autonomous actions, limiting their ability to effectively control and influence airspace safety.   **Unfolding behaviour:**   1. **Disregard of ATC Instructions (sos2 directs): The** pilot receives rerouting instructions from ATC due to emerging weather hazards and an intruder aircraft. However, the pilot prioritizes the collision avoidance system's recommendations, which contradict ATC's directives. 2. **Uncoordinated Maneuvers (sos2 obstructive):** The pilot executes abrupt flight maneuvers without coordinating with ATC, leading to potential airspace conflicts and confusion among nearby aircraft. 3. **ATC's Compromised Role (sos3 follows and circumvents):** ATC, while attempting to maintain safe airspace operations, finds itself in a reactive position, trying to adapt to the pilot’s unpredictable actions. Their usual proactive control is replaced by a series of quick, obstructive responses to the pilot’s maneuvers. 4. **Potential Airspace Hazards (sos3 obstructive effect):** The pilot’s actions create a ripple effect, disrupting standard traffic flow and increasing the risk of near-misses or collisions, as ATC struggles to realign other aircraft in response to the own aircraft’s unanticipated movements. 5. **Communication Breakdown (sos2 and sos3 interaction):** The usual collaborative communication channel between the pilot and ATC breaks down, leading to increased stress and decision-making errors on both sides. 6. **Escalation of Risk (sos2 obstructive intent):** The pilot’s decision to ignore ATC advice and follow their own judgement intensifies the risk of navigational errors, heightening the potential for an airspace incident. 7. **Resolution through Emergency Protocols (sos3 appreciates):** Eventually, ATC implements emergency protocols to manage the chaotic situation, using available tools and protocols to mitigate the risks created by the pilot’s actions and restore order in the airspace.   **Validating Scenario 2 to Shifted Perspective:** In this reimagination, the dynamics between the own aircraft (sos2) and ATC (sos3) are inverted compared to the initial scenario. The own aircraft, driven by the pilot’s decisions and reliance on specific systems, assumes a dominant role, directing the flow of events. ATC’s role is reduced to a reactive and somewhat obstructive entity, struggling to follow and circumvent the uncoordinated and potentially hazardous actions initiated by the pilot. This shifted perspective highlights the challenges and risks in an aviation system where the standard control-appreciation feedback relationship between aircraft and ATC is disrupted, emphasizing the importance of coordinated actions and mutual respect of roles for safe and efficient airspace management. |
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