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EDITORIAL

Reviews and Responses for Identifying Orthodromy and Loxodromy Segments in ADS-B Aircraft Trajectory Data

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Reviewers: Ramon Dalmau, and Yutong Chen

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1. Original paper

The DOI for the original paper is https://doi.org/10.59490/joas.2026.8466

2. Review - round 1

2.1 Reviewer 1

This paper presents a methodological contribution to understanding aircraft trajectory patterns by automatically identifying orthodromic and loxodromic segments in ADS-B data. The approach cleverly leverages the mathematical properties of Mercator and gnomonic projections to detect constant track-angle segments without requiring prior knowledge of waypoints or flight plans. The study is technically sound and addresses a relevant problem in air traffic analysis, particularly for understanding deconfliction maneuvers and pilot/controller behavior. The method demonstrates promising results, with nearly half of identified loxodromies matching known deconfliction events. The paper is well-structured and the algorithms are clearly presented, making it suitable for publication with medium and minor revisions.

Medium Issues:

ADS-B acronym

- The paper introduces technical terms without proper definition. ADS-B should be expanded as Automatic Dependent Surveillance-Broadcast on first use. While this acronym may be familiar to aviation researchers, the interdisciplinary audience interested in trajectory analysis, or crowdsourced data may require this clarification.

Choice of hyper-parameters

- The paper introduces several threshold parameters in Table 1 on page 3. These values appear in Algorithms 1 and 2 but lack justification for their selection. This represents a significant methodological gap. Were these values selected through empirical experimentation on a training dataset? Are they based on theoretical considerations about aircraft dynamics or measurement noise? How sensitive are the results to variations in these parameters? The authors should provide either a brief explanation of the rationale behind each threshold or, preferably, include a sensitivity analysis showing how algorithm performance varies with these parameters. This could be presented as supplementary material if space is limited, but some discussion is essential.

- Similarly, on page 4, the paper states that r = 0.5 and thresh_loxo_ortho = 30 m were chosen for all results, but provides no justification for these specific values.

Algorithm limitations

- The paper correctly identifies cases where orthodromy and loxodromy are theoretically indistinguishable, such as when aircraft fly along meridians or the equator. While this limitation is acknowledged, the authors should address its practical implications more directly. What proportion of trajectories in typical airspaces fall into this ambiguous category? Does this limitation significantly affect the method's utility in real-world applications? If meridian-following segments are rare in most operational contexts, particularly in the mid-latitude European airspace studied here, this should be stated clearly to reassure readers. If they are common in certain regions or flight types, the authors should discuss potential workarounds or acknowledge this as a practical constraint on the method's applicability.

Minor Issues:

Bias due to the dataset used

- The authors appropriately note in Section 5 that their reference dataset contains only trajectories with deconfliction maneuvers, which may bias results. However, this limitation deserves more prominent discussion earlier in the paper, particularly when presenting the 50% match rate between loxodromies and deconfliction events in Section 4.3. Readers should understand upfront that this dataset characteristic likely inflates the observed association. The paper would benefit from explicitly stating that validation on a more balanced dataset including normal flight operations without deconfliction maneuvers would provide better assessment of the method's performance.

Typo

- Line 54 contains a spacing error where "tothe" should be "to the."

Pseudo-code Python-like notation

- The pseudo-code in Algorithms 1 and 2 is generally clear, but the paper could briefly mention that the algorithms use Python-like pseudo-code for readers unfamiliar with notation such as "angles[i:j]" for array slicing.

Why IoU and IoL, and emphasize differences between the two

- While the IoU and IoL metrics are well-explained in Section 3.3, the paper could more explicitly discuss why different metrics are needed for different comparisons when presenting results in Section 4. The choice between IoU and IoL depends on whether exact matching or inclusion is being evaluated, and this distinction could be emphasized more clearly.

2.2 Reviewer 2

The paper addresses a topic with meaningful potential, and the general idea is interesting. However, the current version would benefit from a clearer presentation of the motivation, a more explicit positioning of the method relative to existing work, a sharper articulation of the theoretical contribution, and a more thoroughly justified experimental setup. Strengthening these aspects would help better convey the scientific value and practical relevance of the study. At this stage, a revision is recommended.

Why identifying of Loxodromy/Orthodromy could be useful

The practical significance of the study could be explained in a more detailed manner. Although the results suggest a relationship between loxodromic segments and deconfliction manoeuvres, the broader value of such identification for air traffic analysis or trajectory interpretation is not yet fully discussed, which makes the overall motivation appear somewhat understated.

Why this new method is needed

The discussion of related work could be elaborated to more clearly position the contribution. While prior studies are cited, it remains somewhat unclear why existing approaches are not able to address the specific problem studied here. Clarifying the limitations of current methods would help define the methodological gap more explicitly.

Theoretical contribution? Conceptual rationale?

The theoretical contribution of the paper remains somewhat implicit. The method is presented primarily as an algorithmic workflow, and the underlying conceptual rationale may not yet be fully articulated. Making these elements clearer could help highlight the paper's conceptual contribution.

Choice of dataset, parameters and baseline method

The experimental justification could be strengthened. The choice of dataset, the empirical nature of parameter settings, and the asymmetry between the baseline and the proposed method introduce uncertainties that are not fully addressed in the current discussion. A more detailed interpretation of the reported results would also help improve the clarity and persuasiveness of the evaluation.

3. Response - round 1

3.1 Response to reviewer 1

We thank the reviewer for their constructive comments, which helped us clarify the methodology, and contribution of the paper.

Response

ADS-B acronym

The title has been changed accordingly, and the introduction now starts with a definition of ADS-B.

Choice of hyper-parameters

The parameters (*max_error_thresh*, *thresh_border*, and *thresh_slope*, *thresh_iou*) are now chosen using a grid search so that the orthodromies found by our algorithm match the ones found by the baseline. The Sub-Section 4.1.1 "Parameters tuning" has been added.

Concerning the criteria ($thresh\_loxo\_ortho = 30\ m$ and $r = 0.5$) used to label pure loxodromy/orthodromy. As stated in Section 2.2, the first parameter `thresh_loxo_ortho` is a distinguishability criteria threshold whereas `r` is to quantify how much closer the positions sequence needs to be close to one theoretical path while being far from the other path to be considered as "pure". The value of these parameters has been set empirically as there is no ground truth data set containing labeled pure loxodromy and pure orthodromy. Looking at trajectories, the value $thresh\_loxo\_ortho = 30\ m$ has been set empircally so that the two paths are separated enough to be able to discriminate between them using the positions sequence affected by noise measurement. Concerning the r, when drawing the two theoretical paths connecting the starting and ending points using a Mercator projection, the paths form a "lens" where one side is straight (the loxodromy) and the other is curved line (the orthodromy). The r is here to control where the positions sequence actually are regarding this "lens". Roughly speaking, if $r = 1$, then the positions needs to be in one half of the "lens" ($dist(traj, ortho) < r \times dist(loxo, ortho)$), and it also needs to be close to one border of this "lens" ($dist(traj, ortho) < r \times dist(loxo, traj)$). The parameter

$r = 0.5$ has been set so that the ADS-B positions are inside about 1/3 of this "lens", and far enough from the delimitation between the two halves.

Algorithm limitations

A discussion with greater details on the algorithm limits has been added in Sub-Section "Results on the discrimination between loxodromy and orthodromy". The proportion of theoretically indistinguishable orthodromy and loxodromy may vary according: 1) the latitude of the airspace, 2) the noisiness of the data, and 3) the track angle of the considered flight. In our experiments, the considered sector is located at a latitude of approximately 44°. This latitude is intermediate within the European airspace, being neither the closest to the equator nor the most northerly. The data used are real ADS-B data which are somewhat noisy data, we did not quantify this noise nor tried to lower or increase it as it is not a simple thing to do. Lastly, concerning the track angle, the Figure 6 (or 7 in revised version) that plots the Average MaxIoU per track angle allows us to quantify how much orthodromies overlaps with at least one loxodromy. This overlap is almost complete with a MaxIoU around 0.9 for track angles in the North-South part ±10°. This overlap falls drastically to a MaxIoU below 0.3 when considering track angles in the East-West part ±60°. The overlap is even lower when considering long segment with a duration superior to 300 s. All this suggests that in this East-West track angle interval, the identified orthodromy and loxodromy segments do not overlap, they are mostly distinct parts of the trajectories and hence orthodromies and loxodromies are distinguishable inside this track angle interval, in the considered sector's latitude.

Bias due to the dataset used

Yes it could be misleading. The abstract, Sub-Section 4.3 and conclusion have also been modified to include ratio of deconfliction maneuvers in our dataset and in the identified loxodromies/orthodromies.

Typo

The spacing error in line 54 ("tothe") has been corrected to "to the."

Pseudo-code Python-like notation

The $[i:j]$ slicing is in the text in Section 2.1, if we did not miss some. In the revised version it is replaced by a mathematical formula: $\max_{i \leq k \leq j} angles[k] - \min_{i \leq l \leq j} angles[l]$.

Why IoU and IoL, and emphasize differences between the two

A phrase was added at the end of the first paragprah of Section 3. and also inside Section 4, hopefuly clarifying the different usage of both metrics.

3.2 Response to reviewer 2

We thank the reviewer for their insightful comments, which helped us clarify the motivation, and contribution of the paper.

Response

Why identifying of Loxodromy/Orthodromy could be useful

The proposed identification provides an algorithm to bring a semantic interpretation of raw ADS-B trajectories by distinguishing between segments likely driven by navigation toward a target (orthodromy) and segments reflecting constant-heading behaviour (loxodromy). This distinction is relevant for several air traffic analysis tasks, including the post-hoc interpretation of pilot and controller intent, the characterization of tactical versus strategic trajectory changes, and the extraction of meaningful behavioural patterns from large-scale historical data.

Importantly, the method does not rely on flight plan or waypoint information, which makes it applicable in contexts where such information is unavailable, incomplete, or intentionally ignored. As such, the approach can complement existing trajectory analysis tools by providing an additional, geometry-based layer of interpretation, rather than being limited to the detection of deconfliction events alone.

Why this new method is needed

Existing methods, such as `aligned_on_navpoint` in the traffic library, rely on flight plan data or at least a set of existing beacons/navaids. Those are not broadly/openly available. The method presented in this paper does not have these caveats. These motivations are better underlined in the introduction of the revised version.

Theoretical contribution? Conceptual rationale?

It is an algorithmic workflow. However, this could enable the use of large-scale data over the whole ADS-B coverage without having to deal with any details about beacons/navaids/flight plan data. With this, no discussions are required about getting beacons/navaids consistent the date of the trajectory processsed. Likewise no discussions required about the version of flight plan, or the adherence of the actual flight to the flight plan.

Choice of dataset, parameters and baseline method

A Sub-Section 4.1.1 “Parameters tuning” has been added. A more detailed interpretation has been provided especially concerning the link between deconfliction maneuvers and pure loxodromies.