

# Spatiotemporal validator report

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## 1 Introduction

In this report, we have advanced more on the spatiotemporal validator based on the feedback provided to us on the previous report. Initially we were generating samples randomly by generating time intervals in a consistent manner with a probability  $p$  and an inconsistent manner with probability  $(1-p)$ .

In this checkpoint, we have integrated our validator on top of an LLM to check for any inconsistencies in the output given by the LLM.

## 2 Data Sources

- `min_travel_times.csv`. This defines the minimum time required to travel from one place to another. This dataset only contains a few places in India.
- A predefined set of popular Indian travel destinations with their geographical coordinates

## 3 LLM Integration

- Uses OpenAI's GPT-4o-mini model for itinerary generation.  
We were **not** able to generate inconsistent itineraries from gpt-4o-mini. So we had to give it a prompt which would deliberately generate inconsistent outputs.
- Structured prompt engineering for consistent JSON output so that our validator can process it. Normal prompt to LLM which could not generate an inconsistency:

```
prompt1 = f"""Generate a travel itinerary for {person}
visiting {num_destinations} destinations in India.
Available destinations: {', '.join(places)}

Return ONLY a JSON object with the following structure:
```

```

{{
  "itinerary": [
    {{
      "place": "city_name",
      "arrival_time": "YYYY-MM-DD HH:MM",
      "departure_time": "YYYY-MM-DD HH:MM"
    }},
    ...
  ]
}}

Important:
1. Use 24-hour format but never use 24:00 (use 00:00 instead)
2. Use realistic dates within the next 30 days
3. Return ONLY the JSON object, no additional text or explanation
"""

```

Listing 1: Python f-string for travel itinerary prompt

- We have used the following prompt for generating inconsistent outputs:

```

prompt2 = f"""Consider planes that are superfast and
can travel 10 times faster than the current planes.
Generate a travel itinerary for {person} visiting
{num_destinations} destinations in India.
Available destinations: {'', '.join(places)}

Return ONLY a JSON object with the following
structure:
{{
  "itinerary": [
    {{
      "place": "city_name",
      "arrival_time": "YYYY-MM-DD HH:MM",
      "departure_time": "YYYY-MM-DD HH:MM"
    }},
    ...
  ]
}}

Important:
1. Use 24-hour format but never use 24:00 (use
   00:00 instead)
2. Use realistic dates within the next 30 days
3. Return ONLY the JSON object, no additional text
   or explanation
"""

```

Listing 2: Python f-string for inconsistent itineraries prompt

- For regenerating the output of the LLM, we tailored our prompt to tell it exactly what to fix (but it is still not able to fix it).

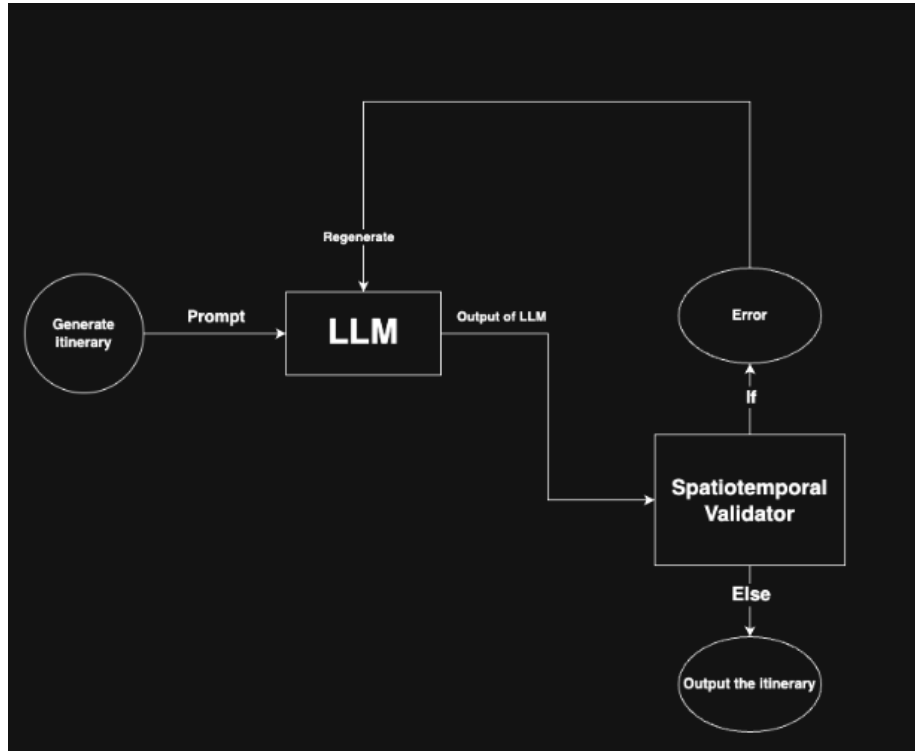
```
inconsistency_prompt = f"""Previous itinerary had the
following inconsistencies:
{chr(10).join(inconsistency_info)}
Please remove these inconsistencies by taking into
account the minimum travel time between the cities
and return a valid and reasonable itinerary.
"""
```

Listing 3: Python f-string for regenerating inconsistent itinerary prompt

```
Min. required time to travel between {place_A} and
{place_B} is {min_required/3600:.1f} hours but the
itinerary allots only {travel_time/3600:.1f} hours
which is not possible.
```

Listing 4: The inconsistency information is formatted as above

Despite the LLM generated itineraries, we have also generated random itineraries using the same places which have then been used to check our validator.

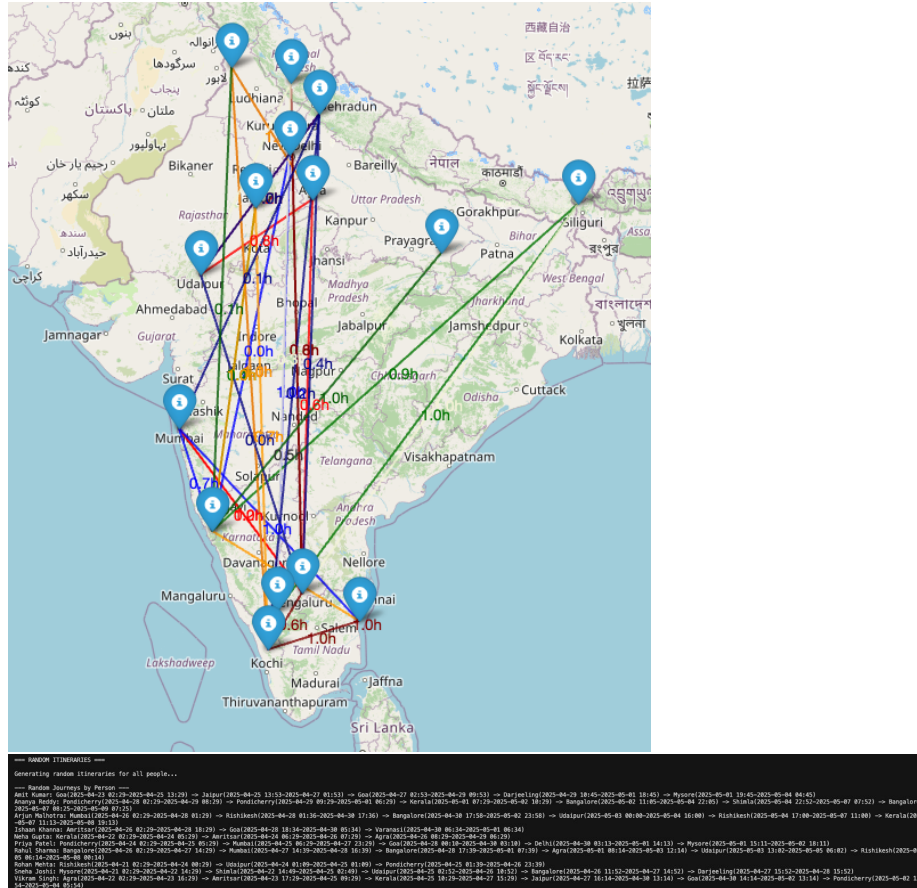


## 4 Validation System

- Temporal consistency checks, which take into account, the minimum time required to travel between the two places.
- Graph-based cycle detection.

## 5 Results and Validation

### 5.1 Random journeys



As these are random itineraries, there are inconsistencies. They are listed below:

```

--- Validator Report for Random Itineraries ---
Inconsistent edges found:

Mumbai -> Bangalore | Person: Rahul Sharma
Departure: 2025-04-28 16:39
Arrival: 2025-04-28 17:39
Travel time: 1.0 hours (Minimum required: 1.5 hours)

Full journey with inconsistency:
Bangalore: Arrive 2025-04-26 02:29 - Depart 2025-04-27 14:29
Mumbai: Arrive 2025-04-27 14:39 - Depart 2025-04-28 16:39
Bangalore: Arrive 2025-04-28 17:39 - Depart 2025-05-01 07:39
Agra: Arrive 2025-05-01 08:14 - Depart 2025-05-03 12:14
Udaipur: Arrive 2025-05-03 13:02 - Depart 2025-05-05 06:02
Rishikesh: Arrive 2025-05-05 06:14 - Depart 2025-05-08 00:14

Mumbai -> Goa | Person: Priya Patel
Departure: 2025-04-27 23:29
Arrival: 2025-04-28 00:10
Travel time: 0.7 hours (Minimum required: 1.0 hours)

Full journey with inconsistency:
Pondicherry: Arrive 2025-04-24 02:29 - Depart 2025-04-25 05:29
Mumbai: Arrive 2025-04-25 06:29 - Depart 2025-04-27 23:29
Goa: Arrive 2025-04-28 00:10 - Depart 2025-04-30 03:10
Delhi: Arrive 2025-04-30 03:13 - Depart 2025-05-01 14:13
Mysore: Arrive 2025-05-01 15:11 - Depart 2025-05-02 18:11

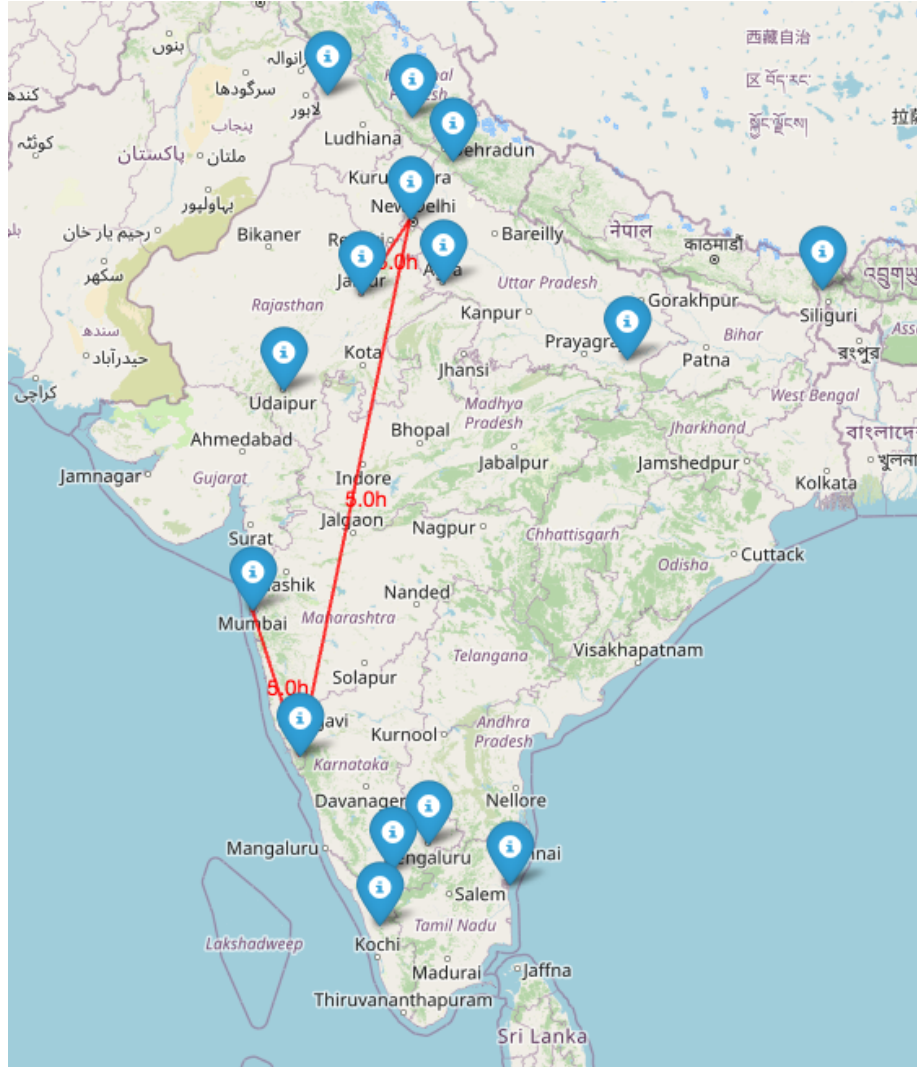
Mumbai -> Rishikesh | Person: Arjun Malhotra
Departure: 2025-04-28 01:29
Arrival: 2025-04-28 01:36
Travel time: 0.1 hours (Minimum required: 3.5 hours)

Full journey with inconsistency:
Mumbai: Arrive 2025-04-26 02:29 - Depart 2025-04-28 01:29
Rishikesh: Arrive 2025-04-28 01:36 - Depart 2025-04-30 17:36
Bangalore: Arrive 2025-04-30 17:58 - Depart 2025-05-02 23:58
Udaipur: Arrive 2025-05-03 00:00 - Depart 2025-05-04 16:00
Rishikesh: Arrive 2025-05-04 17:00 - Depart 2025-05-07 11:00

```

and so on...

## 5.2 Journeys generated by LLM



```

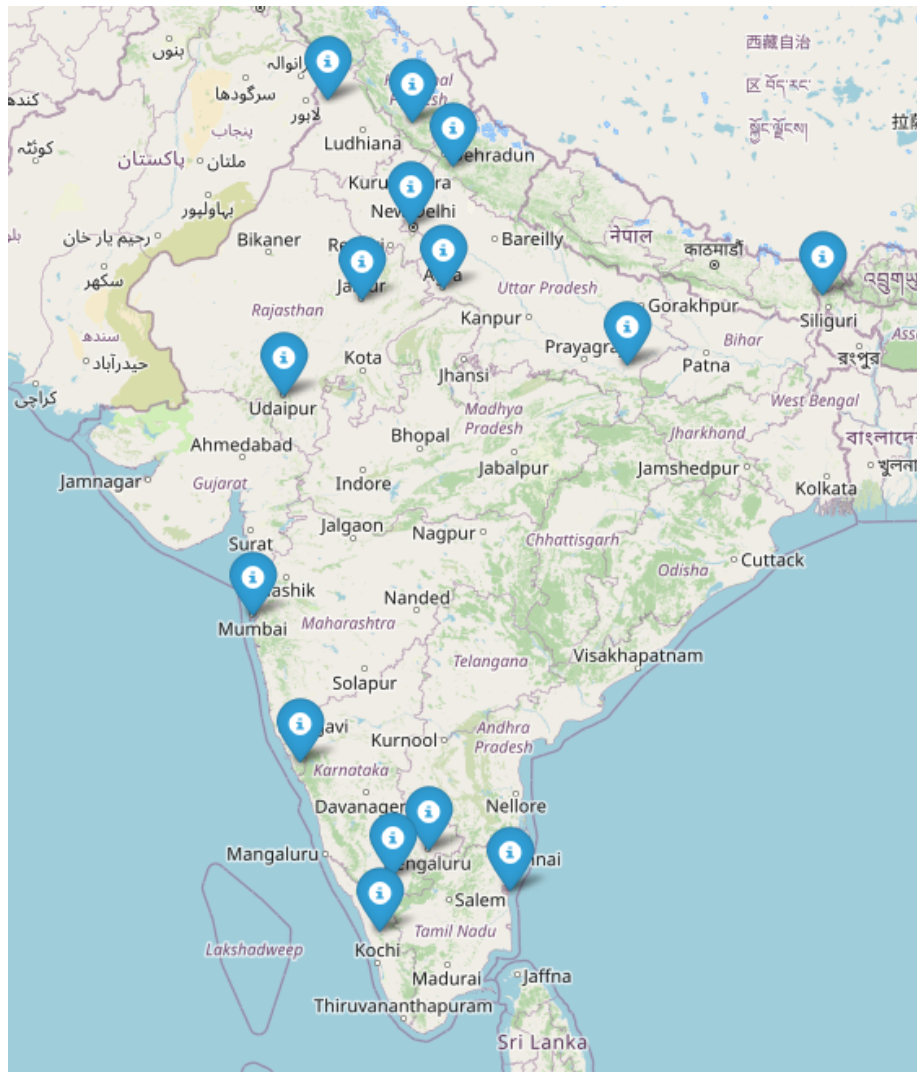
== NORMAL LLM ITINERARY ==
Generating normal LLM itinerary for Rahul Sharma...
Generating normal itinerary...
Normal Itinerary - Attempt 1 of 3
Generated Normal Itinerary:
Mumbai: Arrive 2022-03-05 15:00 - Depart 2022-03-07 10:00
Goa: Arrive 2022-03-07 15:00 - Depart 2022-03-09 11:00
Delhi: Arrive 2022-03-09 16:00 - Depart 2022-03-11 10:00
Jaipur: Arrive 2022-03-11 15:00 - Depart 2022-03-13 11:00
Validating journey...
Checking segment: Mumbai -> Goa
Departure from Mumbai: 2022-03-07 10:00
Arrival at Goa: 2022-03-07 15:00
Segment validated successfully
Checking segment: Goa -> Delhi
Departure from Goa: 2022-03-09 11:00
Arrival at Delhi: 2022-03-09 16:00
Segment validated successfully
Checking segment: Delhi -> Jaipur
Departure from Delhi: 2022-03-11 10:00
Arrival at Jaipur: 2022-03-11 15:00
Segment validated successfully
Valid normal itinerary found!
== Normal LLM Journey ==
Rahul Sharma: Mumbai(2022-03-05 15:00-2022-03-07 10:00) -> Goa(2022-03-07 15:00-2022-03-09 11:00) -> Delhi(2022-03-09 16:00-2022-03-11 10:00) -> Jaipur(2022-03-11 15:00-2022-03-13 11:00)
== Validator Report for Normal LLM Itinerary ==
No inconsistent edges found.
No cycle detected in the normal itinerary graph.
Creating map visualization for normal LLM itinerary...
Map visualization has been saved as 'LLM_itineraries_travel_map1.html'
Open this file in a web browser to view the interactive map.

```

Here there were no inconsistencies found.

### 5.3 Journeys generated by LLM with prompt for inconsistencies

In this case, we deliberately gave the LLM a prompt which will generate inconsistent itinerary.





```

=== SUPERFAST LLM ITINERARY ===

Generating superfast LLM itinerary for Rahul Sharma...

Generating superfast itinerary...

Superfast Itinerary - Attempt 1 of 3

Generated Superfast Itinerary:
Mumbai: Arrive 2022-04-01 10:00 - Depart 2022-04-02 08:00
Delhi: Arrive 2022-04-02 10:00 - Depart 2022-04-03 08:00
Bangalore: Arrive 2022-04-03 10:00 - Depart 2022-04-04 08:00
Goa: Arrive 2022-04-04 10:00 - Depart 2022-04-05 08:00

Validating journey...

Checking segment: Mumbai -> Delhi
Departure from Mumbai: 2022-04-02 08:00
Arrival at Delhi: 2022-04-02 10:00
Segment validated successfully

Checking segment: Delhi -> Bangalore
Departure from Delhi: 2022-04-03 08:00
Arrival at Bangalore: 2022-04-03 10:00
INCONSISTENCY FOUND:
Travel time: 2.0 hours
Minimum required: 2.5 hours

Inconsistencies found in superfast itinerary:
- Min. required time to travel between Delhi and Bangalore is 2.5 hours but the itinerary allots only 2.0 hours which is not possible.

Generated new superfast itinerary with inconsistency feedback:
Error generating new superfast itinerary: 'place'

Attempt 1: superfast itinerary had inconsistencies. Retrying...

Superfast Itinerary - Attempt 2 of 3

Generated Superfast Itinerary:
Delhi: Arrive 2022-10-01 10:00 - Depart 2022-10-02 08:00
Bangalore: Arrive 2022-10-02 10:00 - Depart 2022-10-03 08:00
Kerala: Arrive 2022-10-03 10:00 - Depart 2022-10-04 08:00
Goa: Arrive 2022-10-04 10:00 - Depart 2022-10-05 08:00

Validating journey...

Checking segment: Delhi -> Bangalore
Departure from Delhi: 2022-10-02 08:00
Arrival at Bangalore: 2022-10-02 10:00
INCONSISTENCY FOUND:
Travel time: 2.0 hours
Minimum required: 2.5 hours

Inconsistencies found in superfast itinerary:
- Min. required time to travel between Delhi and Bangalore is 2.5 hours but the itinerary allots only 2.0 hours which is not possible.

Attempt 2: superfast itinerary had inconsistencies. Retrying...

Superfast Itinerary - Attempt 3 of 3

Generated Superfast Itinerary:
Mumbai: Arrive 2022-03-15 10:00 - Depart 2022-03-16 10:00
Delhi: Arrive 2022-03-16 11:00 - Depart 2022-03-17 11:00
Bangalore: Arrive 2022-03-17 12:00 - Depart 2022-03-18 12:00
Goa: Arrive 2022-03-18 13:00 - Depart 2022-03-19 13:00

Validating journey...

```

Here, there were inconsistencies found, which are listed below:

```

Checking segment: Mumbai -> Delhi
Departure from Mumbai: 2022-03-16 10:00
Arrival at Delhi: 2022-03-16 11:00
INCONSISTENCY FOUND:
Travel time: 1.0 hours
Minimum required: 2.0 hours

Inconsistencies found in superfast itinerary:
- Min. required time to travel between Mumbai and Delhi is 2.0 hours but the itinerary allots only 1.0 hours which is not possible.
- Min. required time to travel between Delhi and Bangalore is 2.5 hours but the itinerary allots only 1.0 hours which is not possible.
- Min. required time to travel between Bangalore and Goa is 2.0 hours but the itinerary allots only 1.0 hours which is not possible.

Generated new superfast itinerary with inconsistency feedback:
Error generating new superfast itinerary: 'place'

Attempt 3: superfast itinerary had inconsistencies. Retrying...
Failed to generate valid superfast itinerary for Rahul Sharma after 3 attempts

Creating map visualization for superfast LLM itinerary...

Map visualization has been saved as 'LLM_itineraries_travel_map2.html'
Open this file in a web browser to view the interactive map.

```

and so on...

Interactive maps have been attached in the mail as html files. To open it in your browser, just double click on the file or click "open with" and select your browser.

## 6 Conclusion

The spatiotemporal travel itinerary generation system successfully combines:

- Real-world travel data
- LLM-based generation
- Comprehensive validation
- Interactive visualization

Future improvements could include:

- Usage of a larger dataset regarding minimum travel times.
- Scaling across India and then across all countries.
- More sophisticated validation rules.
- Enhanced visualization features.
- Support for multiple transportation modes.