CS6380 April 21 2020

FAA-NASA vs. LSD Strategic Deconfliction

Flight Data

Given a set of flight requests: (lanes,start_time_interval), produce:

- Flight paths (entry_time,exit_time,speed,lane,flight_ID)

Determine:

- Flight delay: actual_start_time – start_time_interval(1)
- Flight time: flight.end_time – flight.start_time
- Flight distance: sum(length(polyline))

Considerations

- Number of flights
  - 10, 100, 1000
- Start interval
  - Fixed for all flights (e.g., [0,1000])
  - Variable across flights: random start in some interval, random end
    - t1 in [start,end]; t2 = t1 + rand*max_interval_length
- Routes:
  - Same route for all
  - Same launch/land vertexes, but different altitudes (for FNSD)
- Speed:
  - Constant for all
  - Variable per flight (but constant for whole flight)
- FN Deconfliction Parameters
  - Spatial step along segments: del_x
  - Temporal step along segment: del_t
  - Delay: amount to delay flight

Measures

LSD

- Average delay
- Max delay
- Average flight time
- n_c average
- n_c max
- Average wall clock deconfliction time

Measures

FNSD

- Average delay
- Max delay
- Average flight time
- Grid element overlap average
- Pinch point average
- Spatial count average
- Temporal count average
- Average wall clock deconfliction time

Example Measures

```
        num_flights: 1000
      start_distrib: 1
             routes: 1
            airway: [1×1 struct]
         UAS_speed: 1
             del_x: 0.1000
             del_t: 0.1000
             delay: 0.1000
      LSD_avg_delay: 1.6410
      LSD_max_delay: 51.7776
LSD_avg_flight_time: 69.6995
         LSD_nc_avg: 528.1220
         LSD_nc_max: 2135
         LSD_d_time: 0.0148
     FNSD_avg_delay: 306.5580
     FNSD_max_delay: 357.2119
FNSD_avg_flight_time: 56.9504
 FNSD_grid_count_avg: 322.5007
FNSD_pinch_count_avg: 121.9285
FNSD_space_count_avg: 4.1126e+03
 FNSD_time_count_avg: 1.1628e+06
        FNSD_d_time: 1.8983
```

LSD Measures

Compute the sum:

$$\sum_{k=1}^{n} f_k I_k$$

where:

f_k is number of flights in lane k

I_k is number of time intervals at lane k

FNSD Measures

Instrument code to get:

- Grid count: number of common grid elements between all flights
- Pinch count: number of segment pairs that are within headway distance between all flights
- Space count: number of steps along segments when testing closeness
- Time count: number of del_t steps when checking closeness

Note that the deconfliction wall clock time may require instrumenting some way to estimate full data. E.g., fit a line to first k flights and use interpolated data for the rest.

Verification

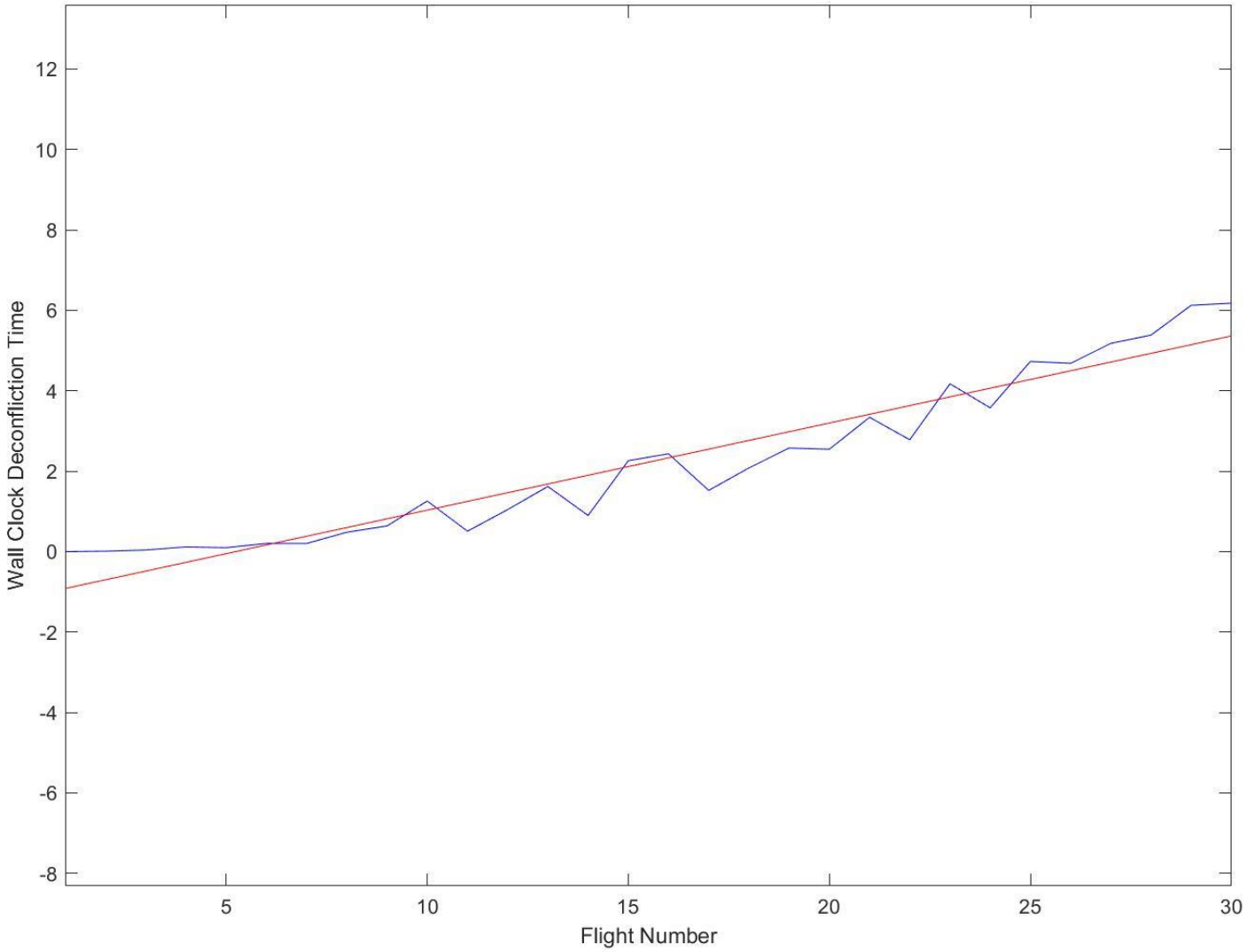
- Test on example with known results
  - 10 flights on same pathway require fixed offset in start times

LSD	FNSD
0.0000	0.0000
1.0000	1.5000
2.0000	3.0000
3.0000	4.5000
4.0000	6.0000
5.0000	7.5000
6.0000	9.0000
7.0000	10.5000
8.0000	12.0000
9.0000	13.5000

- Note that there is some offset here that may not be necessary

- You should implement an FNSD deconfliction method with minimal start delay

Example of Interpolation from 30 values




```
>> max(vals)

ans =

  215.4415

>> mean(vals)

ans =

  107.2627
```