



Assessing the viability of an occupancy count prediction model

SESAR Innovation Days 2017

Nicolas Suarez, Iciar Garcia-Ovies, Danlin Zheng, *CRIDA*
Jean Boucquey, *EUROCONTROL*

Belgrade, 28th November 2017



Founding Members



Contents



Introduction

- Uncertainty in ATM
- COPTRA Project
- COPTRA Validation

Exercise 01

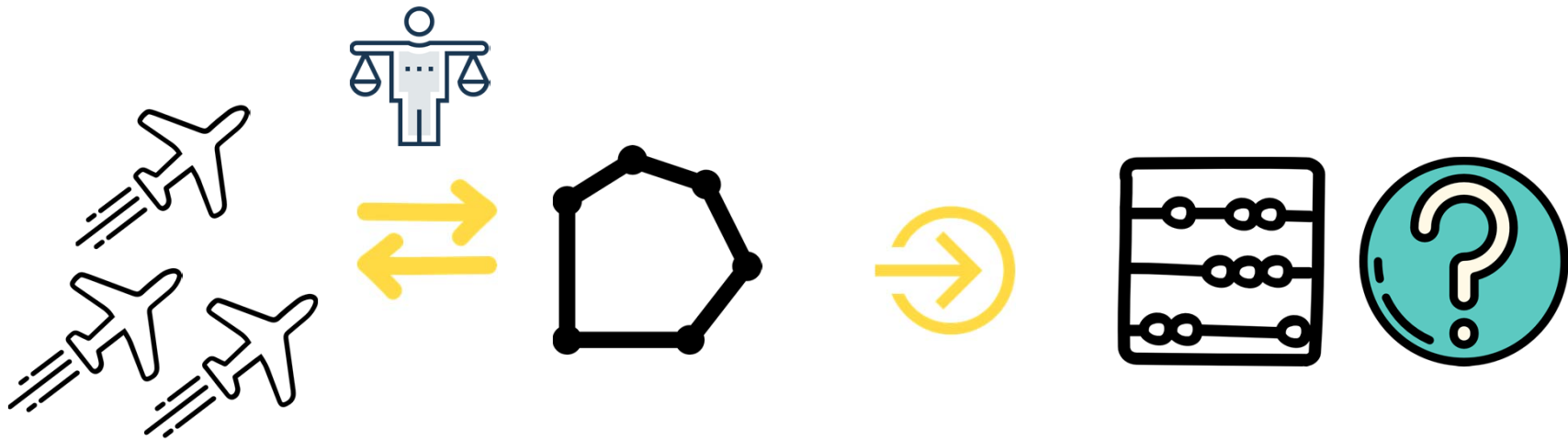
- Description
- Methodology
- Results

Exercise 02

- Description
- Methodology
- Results

Introduction

UNCERTAINTY IN ATM



The actual DCB process is subject to uncertainty



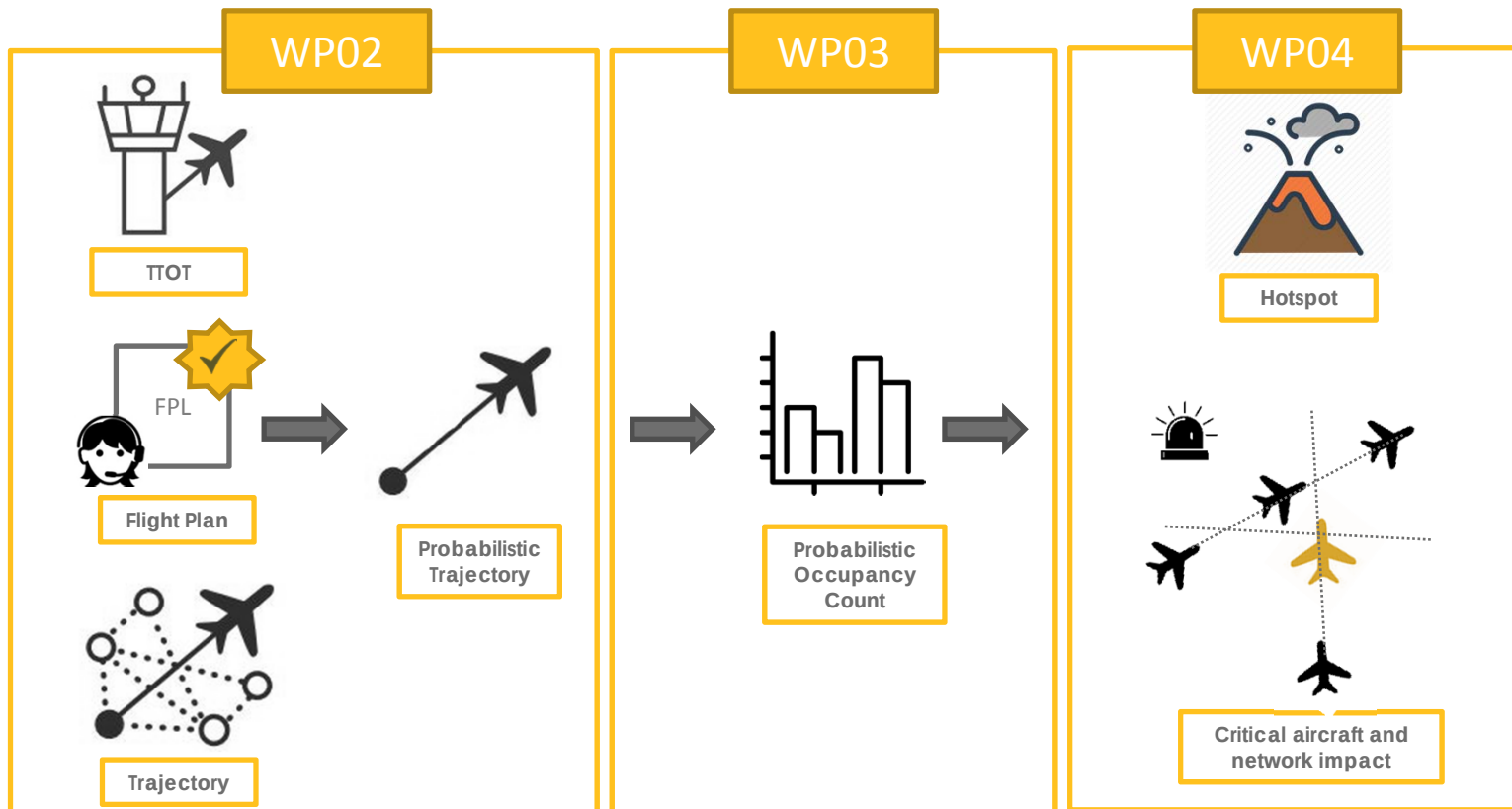
COPTRA project aims at improving the demand predictions through the quantification of uncertainty in order to better understand the likely evolution of the demand and therefore improve decision making.

COPTRA Project

DESCRIPTION

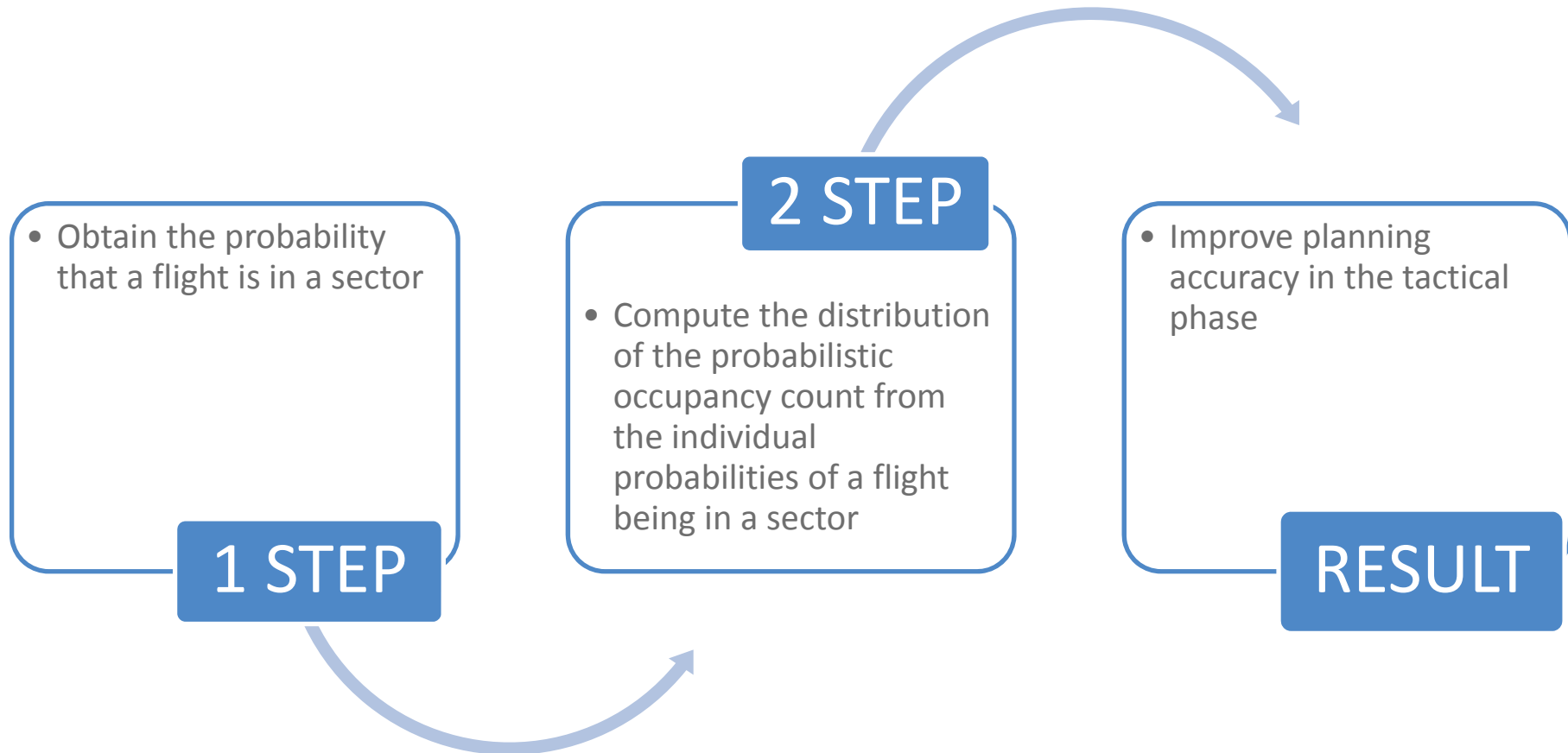


- COPTRA is a SESAR Exploratory Research Project.
- Activities are organised in 3 main WP:
 - WP02 Building Probabilistic Trajectories
 - WP03 Combining Probabilistic Trajectories
 - WP04 Application of Probabilistic traffic prediction to ATC planning



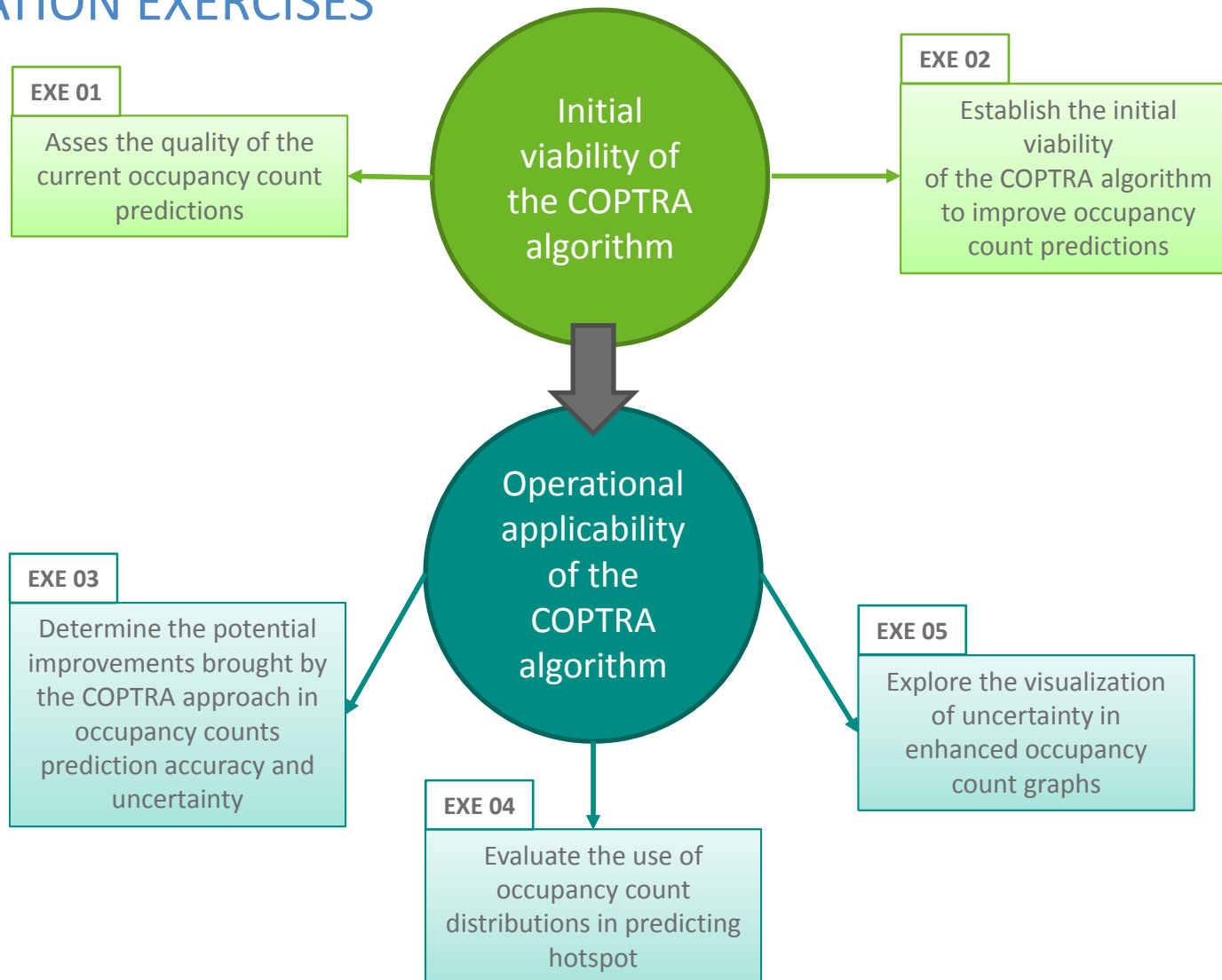
COPTRA Project

ALGORITHM



COPTRA Project

VALIDATION EXERCISES



EXERCISE 01

DESCRIPTION

COMPARE



Occupancy counts obtained
through FPLs in 3 time horizons
(-3h, -1h and 0h)



Occupancy counts obtained
through the improved flight plan
(imFPL)

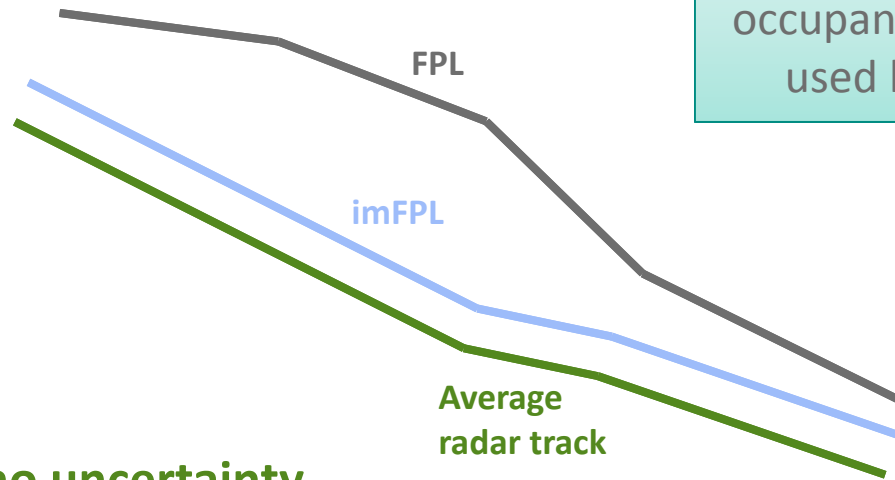
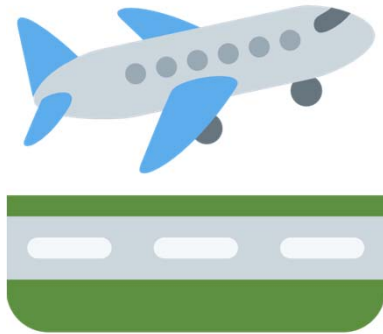


Assess the accuracy
and quality of current
occupancy prediction
to establish the
baseline for further
validation



EXERCISE 01

imFPL



The use of the imFPL will enhance the accuracy of the occupancy count predictions used by ANSPs and NM

imFPL = FPL with no uncertainty
Most probable trajectory between a given city pair



COMBINES

Methodology:

- FPL (3 time horizons -3h, -1h, 0h)
- Radar Track

EXERCISE 01

SCENARIO SELECTION

1

- Ranking of days with more controller issued vectors



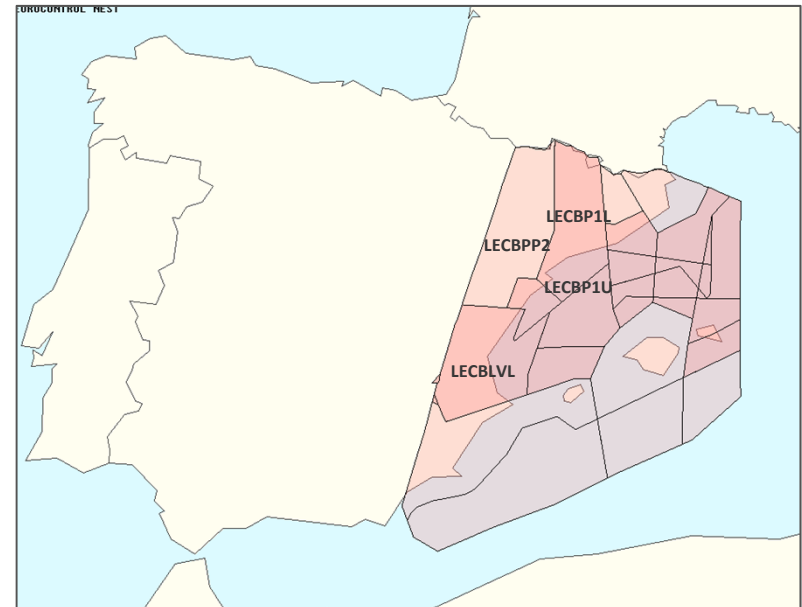
2

- Ranking of sectors with more controller issued vector

3

- Ranking of origin/destination with more controller issued vectors

4 SECTOR IN BARCELONA ACC
12th May 2016



EXERCISE 01

METHODOLOGY

Calculation of the occupancy count using FPLs at the three time horizons

Calculation of the occupancy count using imFPL

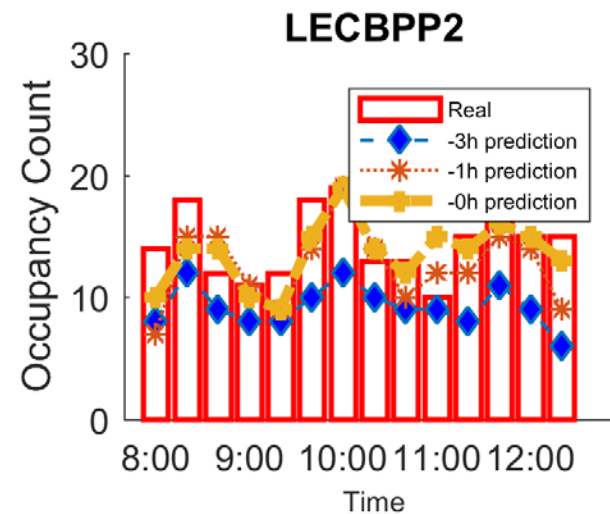
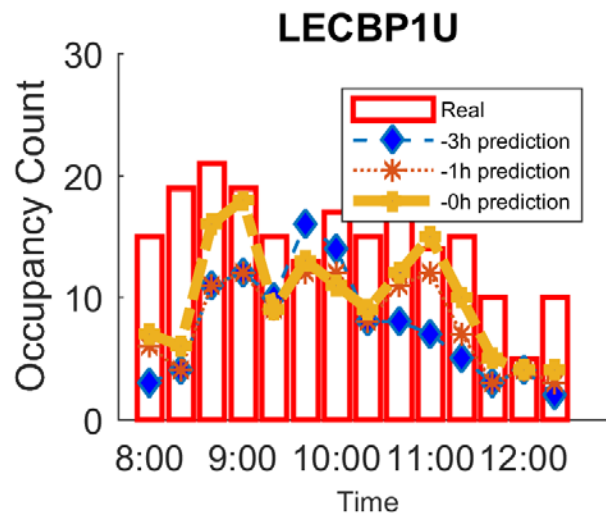
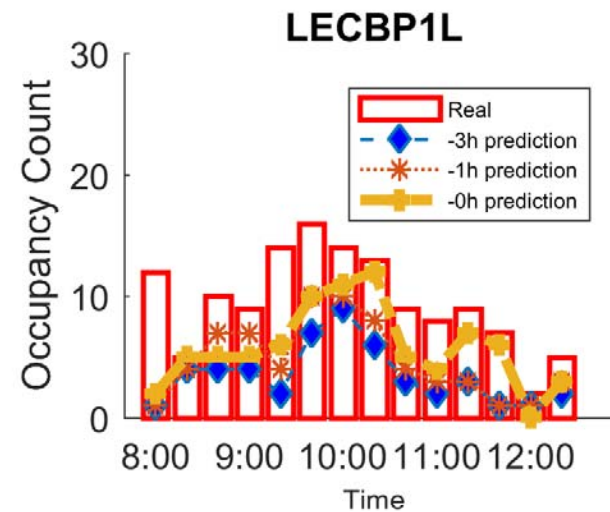
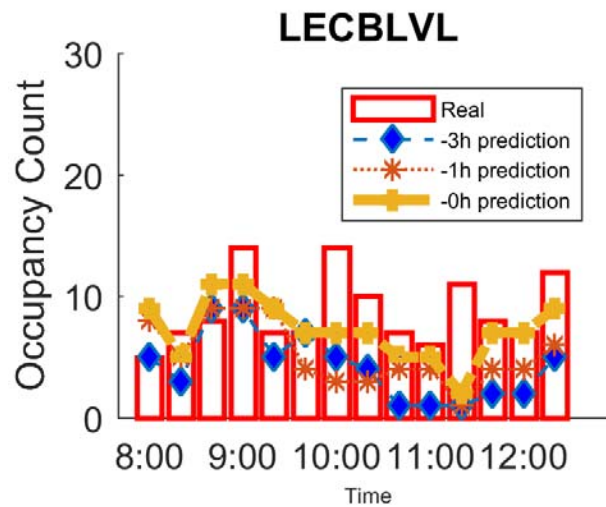
Calculate difference between occupancy count variables using Glass' delta indicator

2 OBJECTIVES

1. Determine the quality of the current occupancy count estimations and determine the occupancy count error
2. Establish the baseline for further validation experiments

EXERCISE 01

RESULTS



EXERCISE 01

RESULTS

EXE 01		SD	MSE	Glass' Δ	CI	t-test
LECBVL	3h	2,7506	31,0000	1,5690	[0.5672;2.5708]	4,2689
	1h	2,5774	28,2857	1,2258	[0.3050;2.1465]	3,4353
	0h	2,4862	14,0000	0,5393	[-0.2674;1.3461]	1,5351
LECBP1L	3h	2,4099	45,4286	1,5018	[0.5169;2.4869]	4,8116
	1h	3,1483	31,3571	1,1979	[0.2831;2.1126]	3,5203
	0h	3,3553	21,1429	0,9297	[0.0671;1.7923]	2,6638
LECBP1U	3h	4,4308	68,1429	1,6671	[0.6398;2.6943]	4,2906
	1h	3,6132	54,9286	1,5480	[0.5515;2.5445]	4,3904
	0h	4,4973	34,2857	1,1227	[0.2235;2.0218]	2,8669
LECBPP2	3h	1,6723	31,9286	1,8668	[0.7851;2.9483]	5,9928
	1h	3,1796	11,1429	0,6649	[-0.1570;1.4867]	1,64186038
	0h	2,6520	6,2857	0,3069	[-0.4798;1.0936]	0,8327

EXERCISE 02

DESCRIPTION

COMPARE



Real occupancy counts



Predicted occupancy counts with
COPTRA algorithm



Assess the initial
viability of the COPTRA
algorithm



EXERCISE 02

METHODOLOGY

Calculation of the real occupancy count using radar tracks

Calculation of the predicted occupancy count using COPTRA algorithm

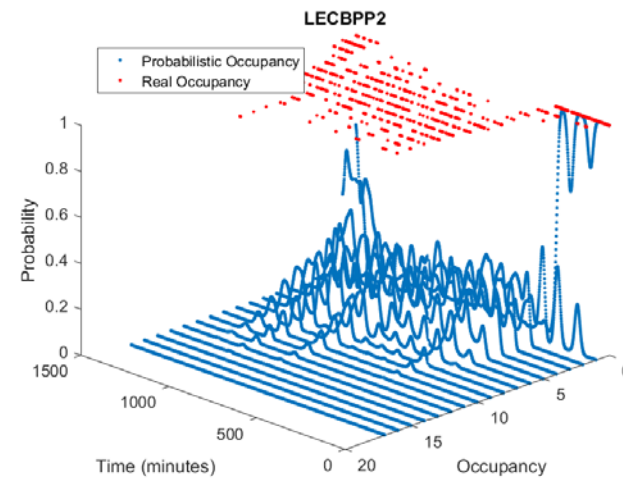
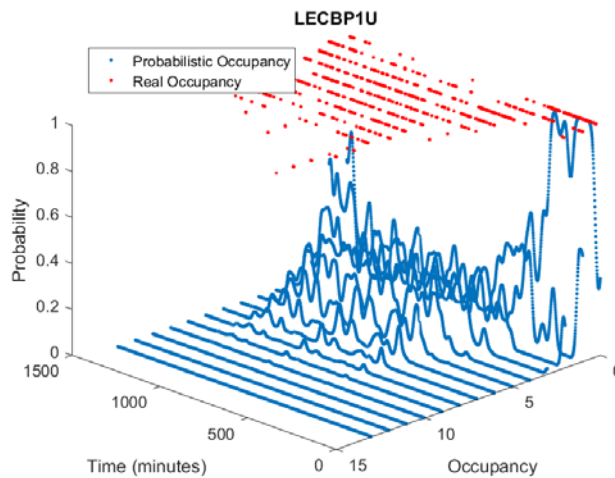
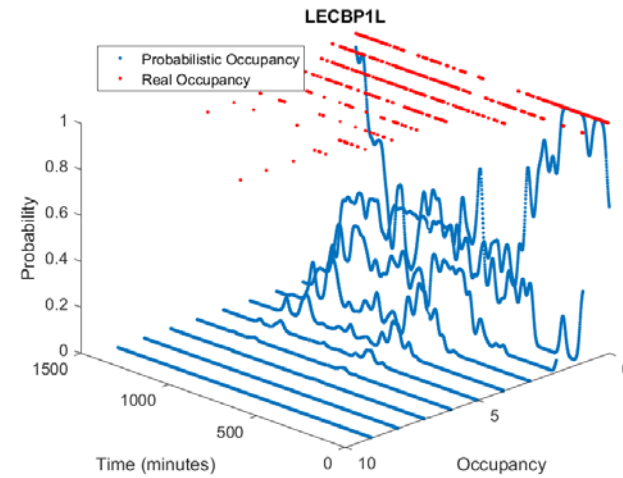
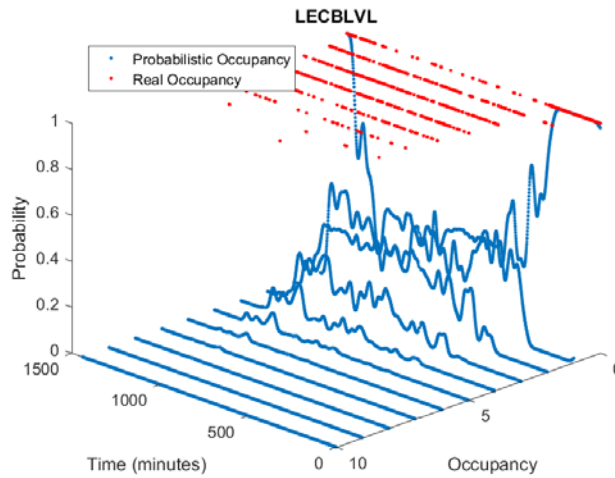
Calculate difference between occupancy count variables using Glass' delta indicator

2 OBJECTIVES

1. Improve the prediction of hotspots through the provision of probabilistic occupancy counts
2. Understand the use of probabilistic occupancy counts on contiguous sectors

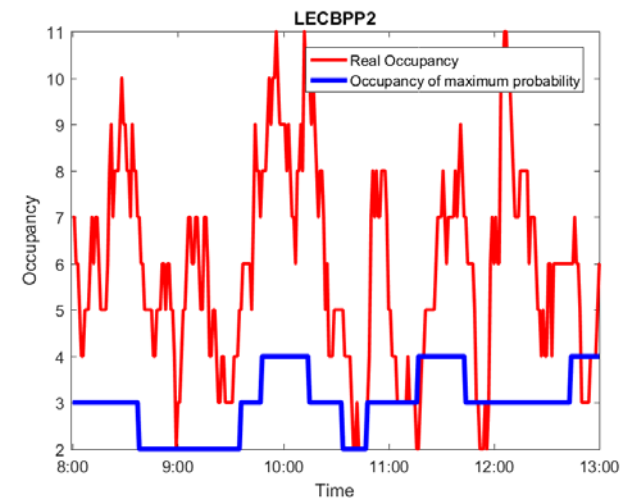
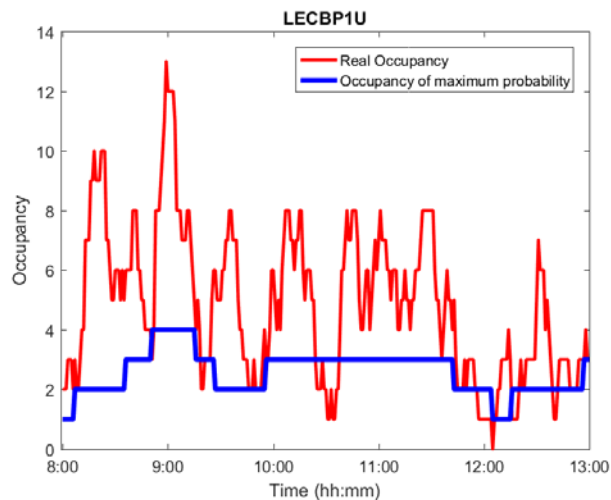
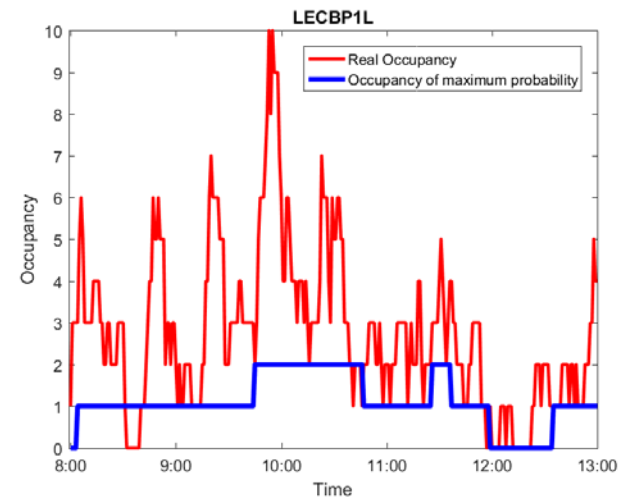
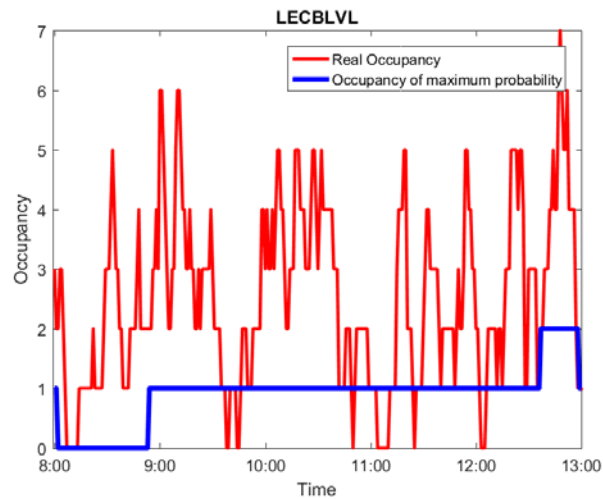
EXERCISE 02

RESULTS



EXERCISE 02

RESULTS



EXERCISE 02

RESULTS

EXE02	SD	MSE	Glass' Δ
LECBVL	1,3842	2,5104	0,6456
LECBP1L	1,8319	2,1097	0,5061
LECBP1U	2,3142	4,3931	0,5191
LECBPP2	2,4153	5,8417	0,4630

Values of glass delta show a medium size effect of the similarity between the two dataset.

EXE01 vs EXE02		SD	MSE	Glass' Δ
LECBVL	3h	2,7506	31,0000	1,5690
	1h	2,5774	28,2857	1,2258
	0h	2,4862	14,0000	0,5393
	EXE02	1,4315	4,4413	1,0952
LECBP1L	3h	2,4099	45,4286	1,5018
	1h	3,1483	31,3571	1,1979
	0h	3,3553	21,1429	0,9297
	EXE02	2,0090	5,6655	0,8744
LECBP1U	3h	4,4308	68,1429	1,6671
	1h	3,6132	54,9286	1,5480
	0h	4,4973	34,2857	1,1227
	EXE02	2,5778	10,9181	0,9398
LECBPP2	3h	1,6723	31,9286	1,8668
	1h	3,1796	11,1429	0,6649
	0h	2,6520	6,2857	0,3069
	EXE02	2,1673	13,0107	1,4133

The values of glass delta corresponding to EXE02 shown in the table are, in general, between the same indicator for 1h and 0h of the EXE01 (predicted occupancy).

In the best cases, the size effect is even better than 0h predicted occupancy (LECBP1U).

Limitations of the results

Only archived
data

Limited
network view

Mathematical
viability of the
algorithm

Conclusions

- Description of the operational context of the use of uncertainty in a trajectory based operations environment.
- Description of the validation approach of COPTRA.
- Establishment of a baseline to explore the viability of the COPTRA algorithm.
- Improvements in the occupancy count prediction through the use of the COPTRA algorithm.





Thank you very much for your attention!



This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 699274



Founding Members



The opinions expressed herein reflect the author's view only.

Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein.