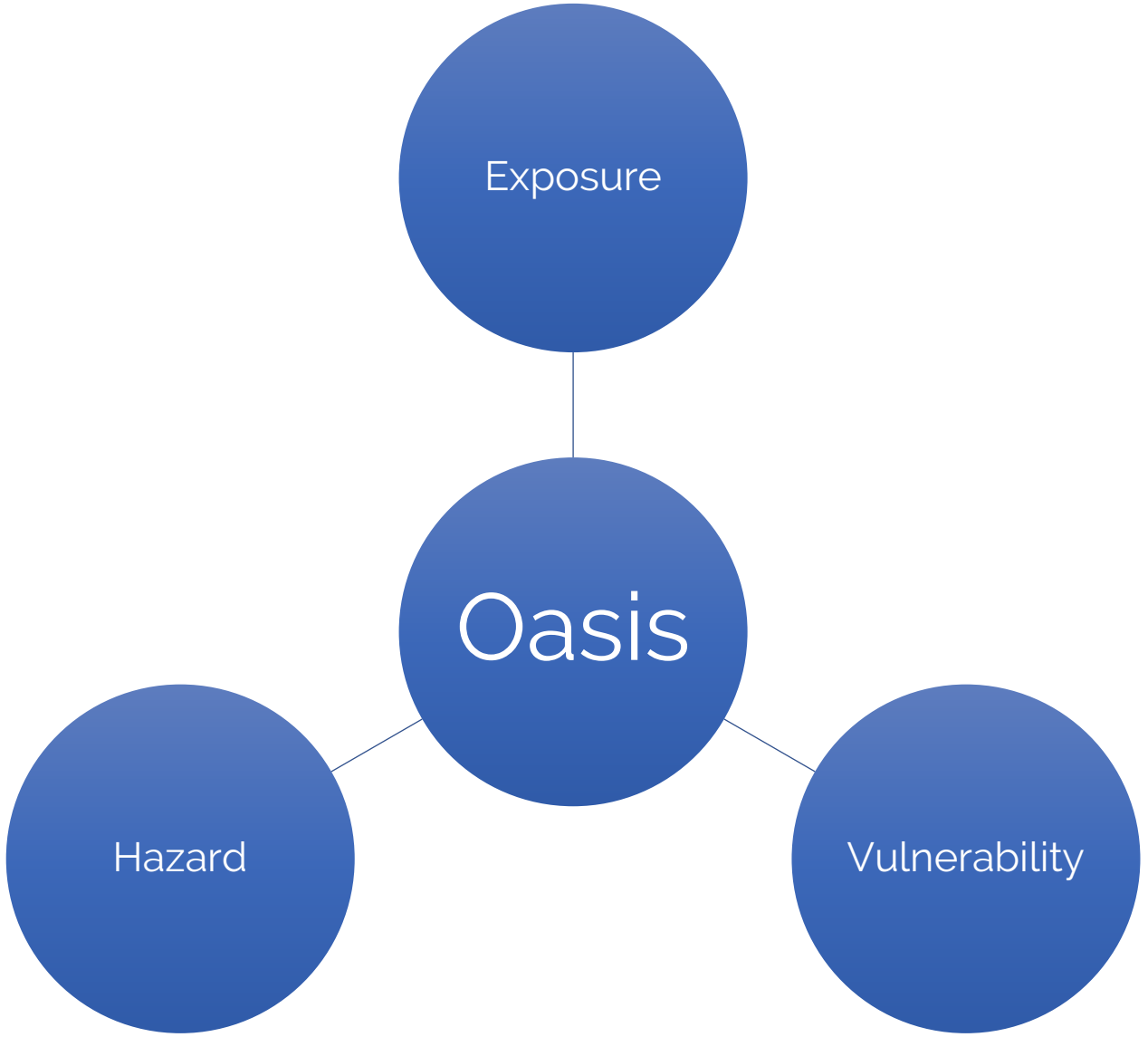
Oasis Workshop - Zurich

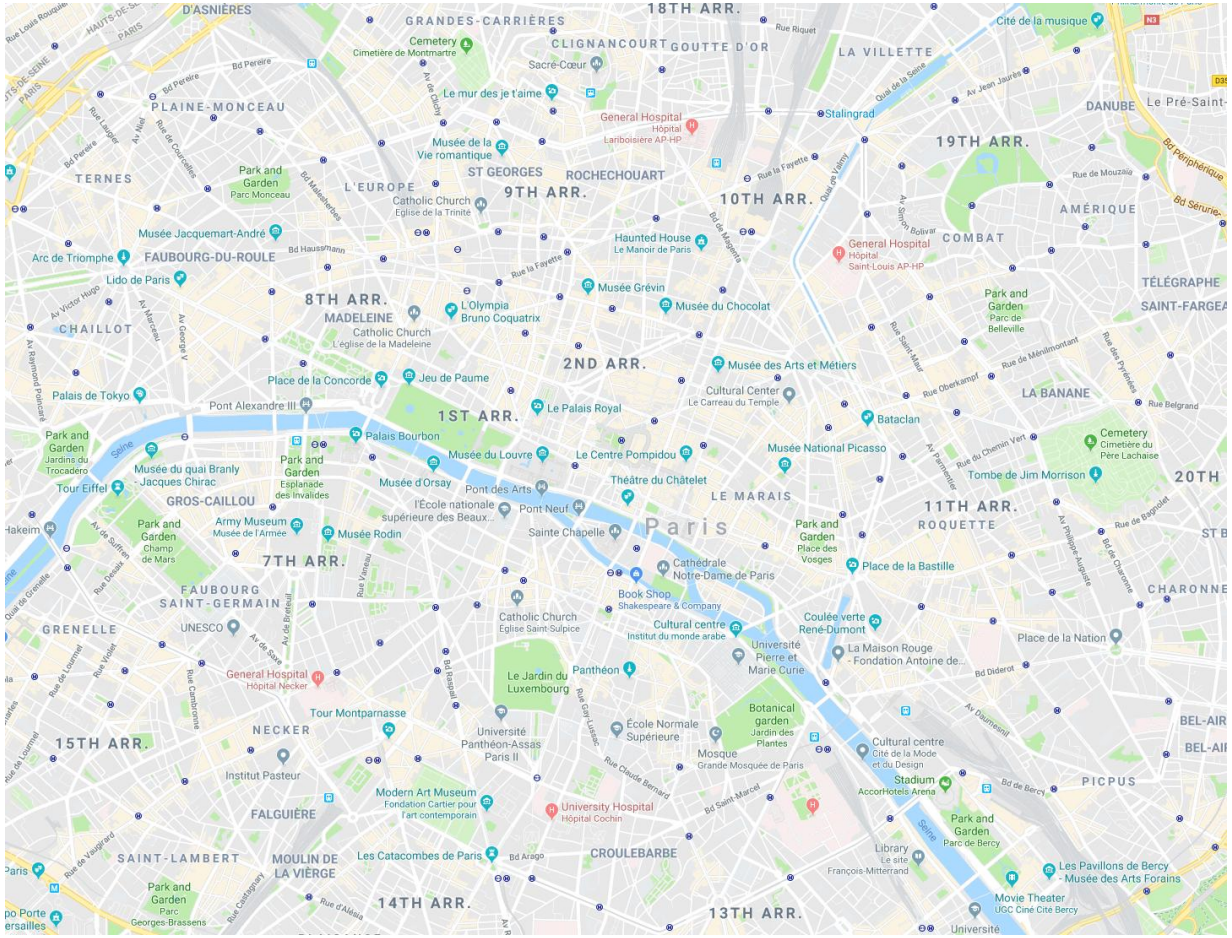
3 September 2021

Models in Oasis

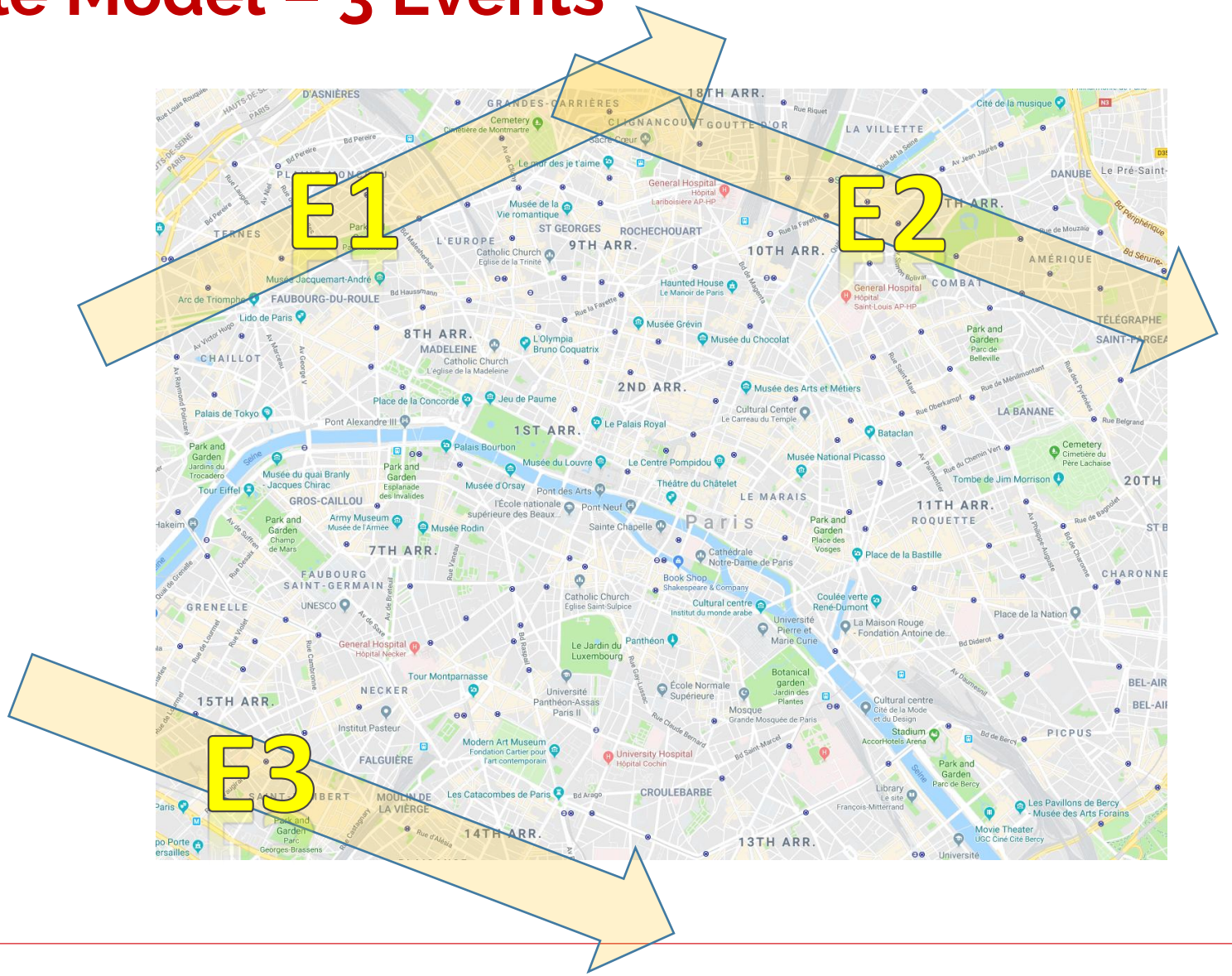
Modules



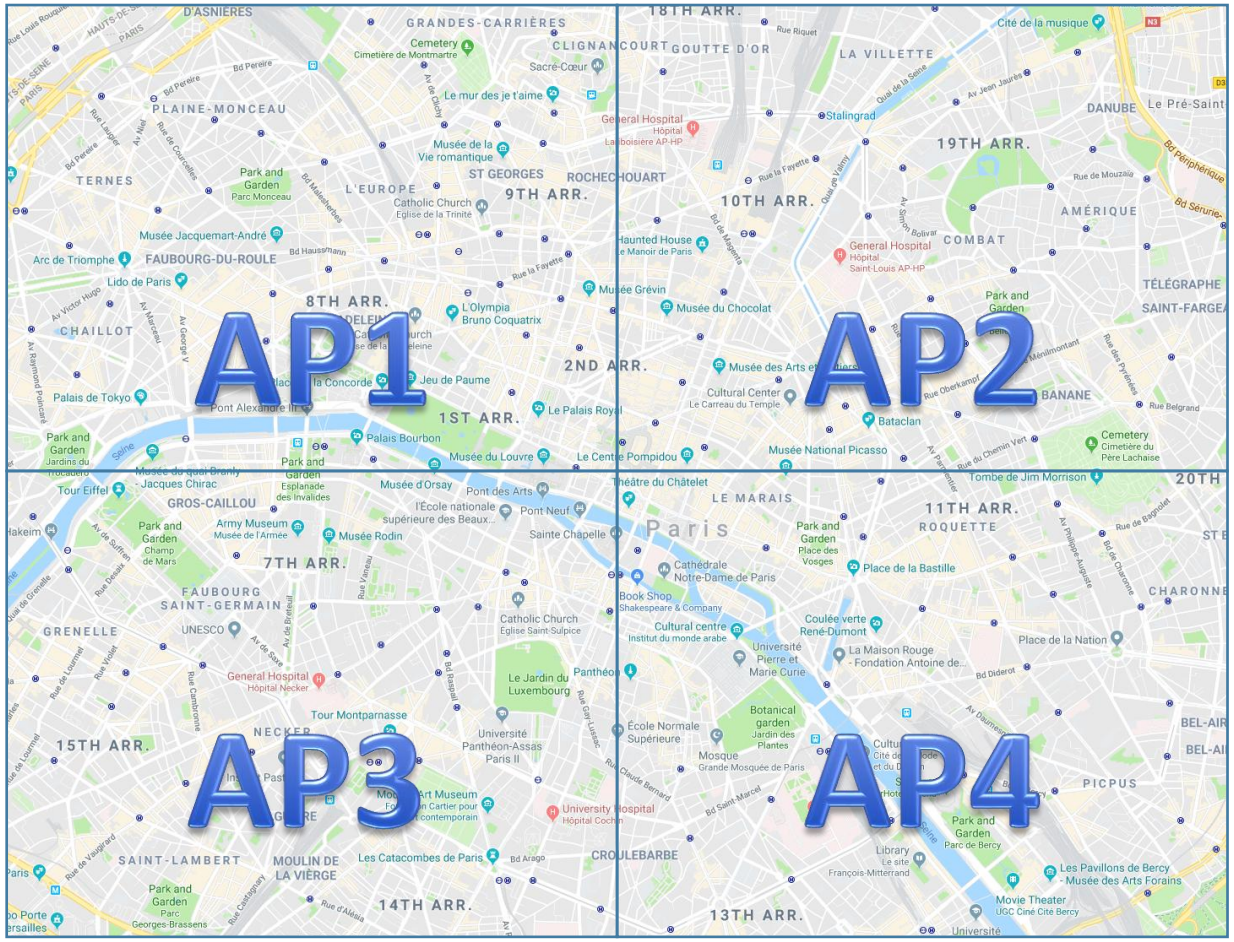
Example Model – Paris Windstorm



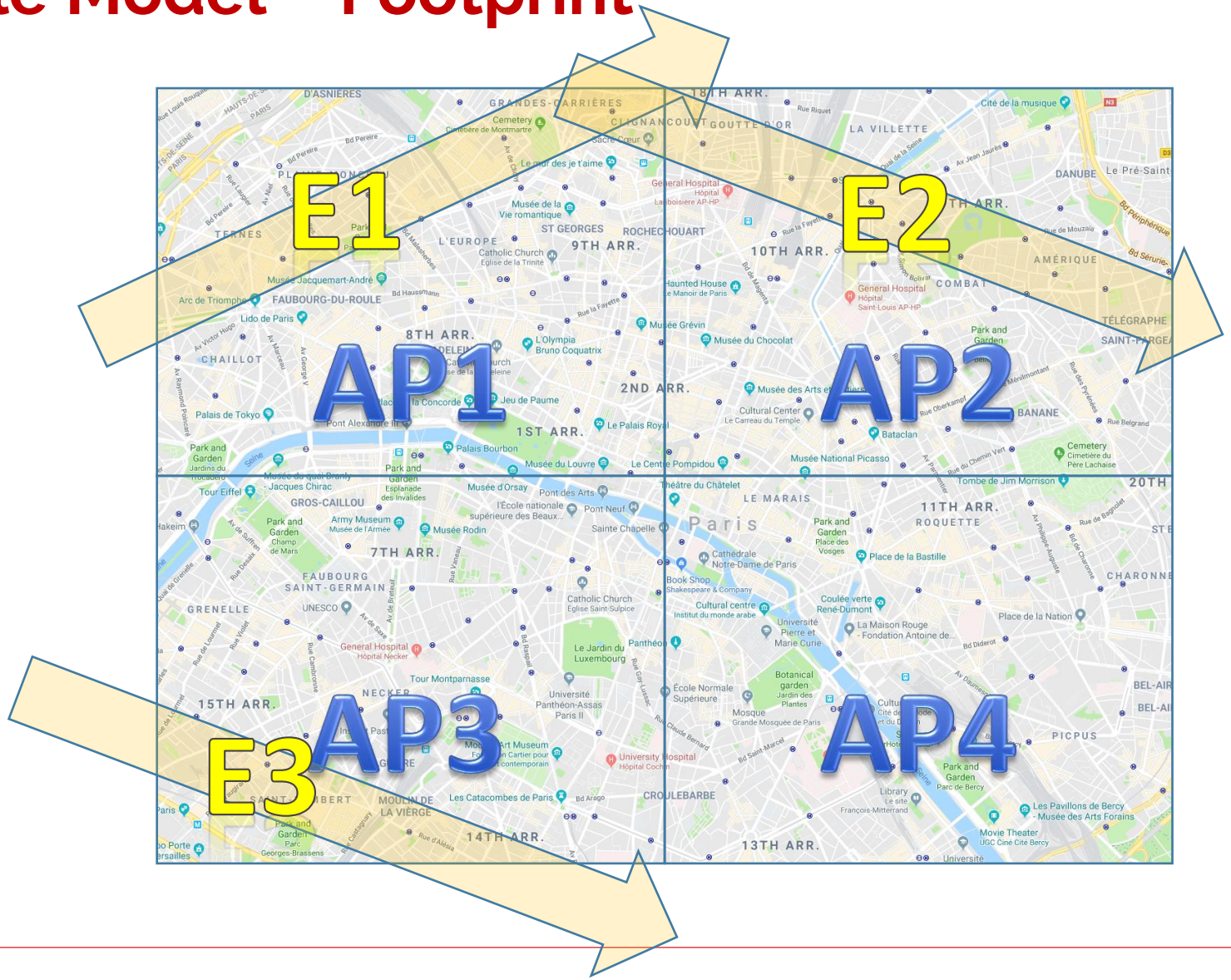
Example Model – 3 Events



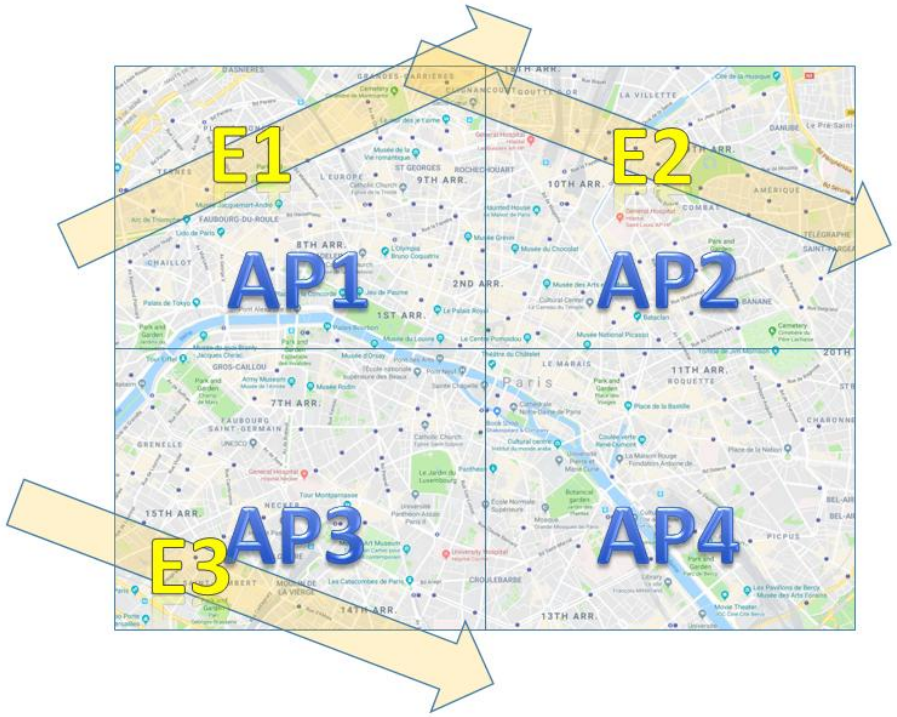
Example Model – 4 Area Perils



Example Model – Footprint



Model Files - Hazard



areaperil_dict

areaperil_id	lat	lon
1	48.88	2.31
2	48.88	2.34
3	48.85	2.31
4	48.85	2.34

footprint

event_id	areaperil_id	intensity_bin_index	prob
1	1	1	0.1
1	1	2	0.2
1	1	3	0.7
1	2	1	0.8
1	2	2	0.2
1	2	3	0
2	1	1	0.75
2	1	2	0.25
2	1	3	0
2	2	1	0.1
2	2	2	0.2
2	2	3	0.7
3	3	1	0.9
3	3	2	0.1
3	3	3	0

intensity_bin_dict

bin_index	bin_from	bin_to
1	50	60
2	60	70
3	70	80

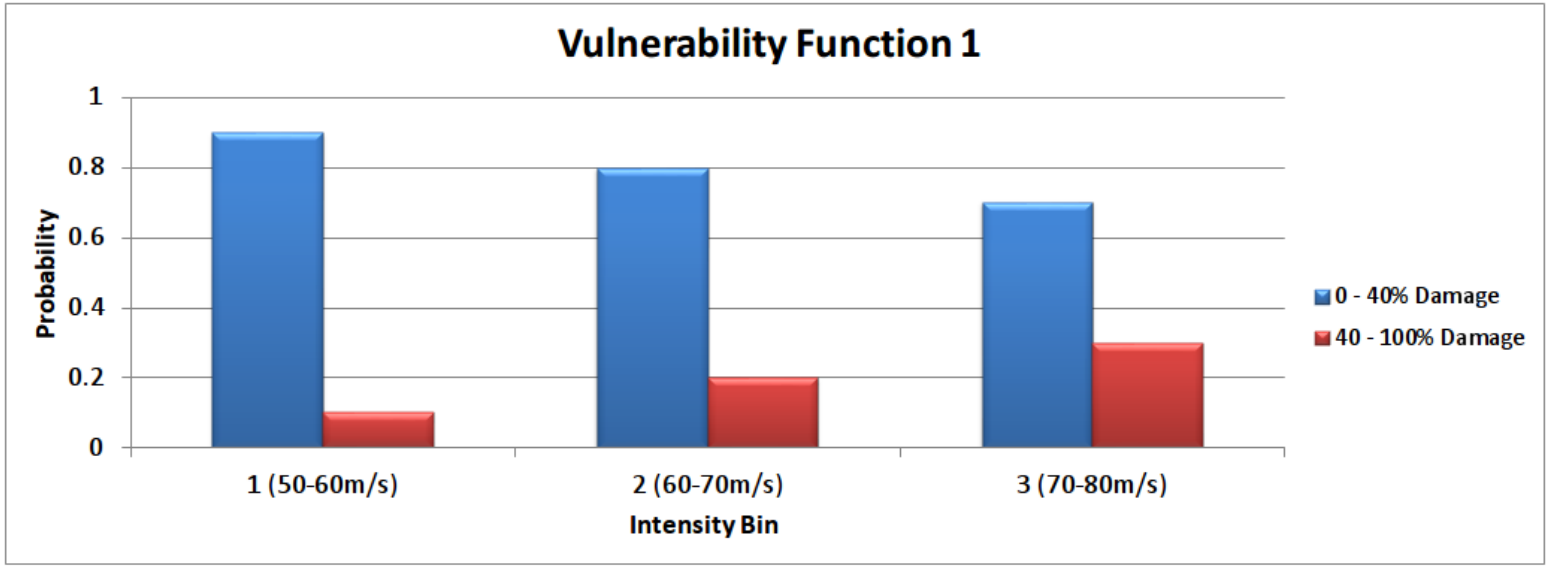
event

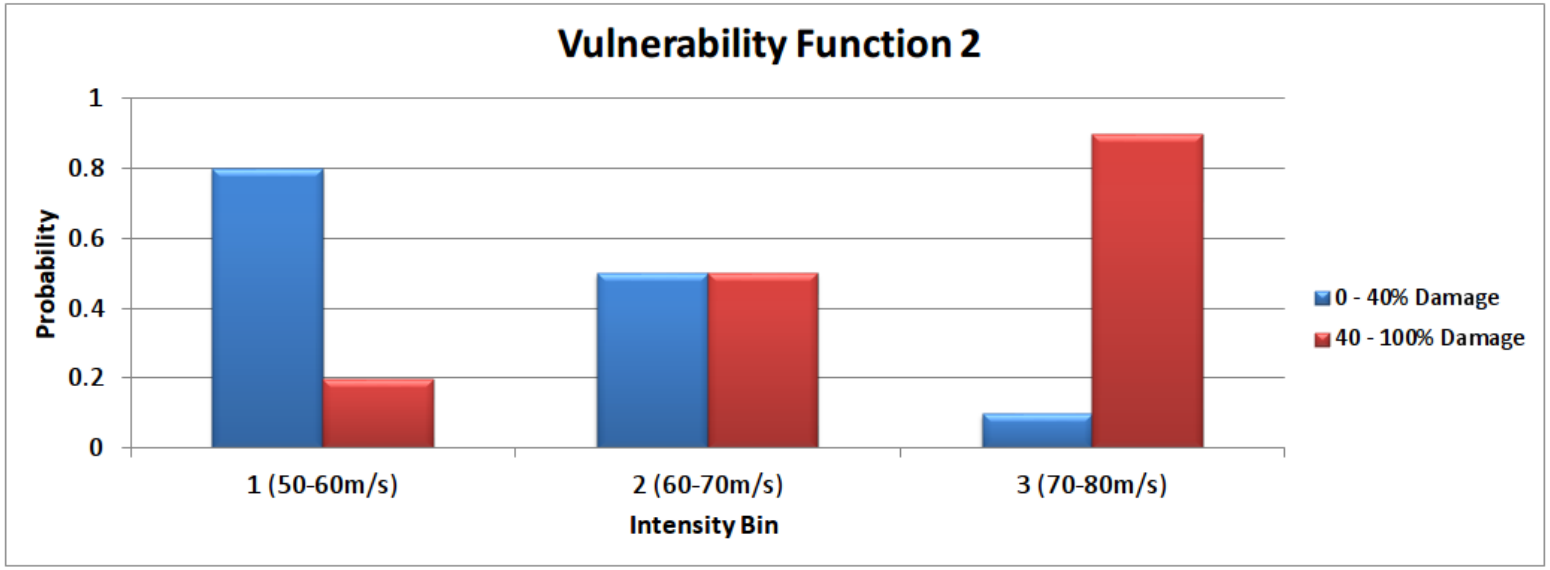
event_id
1
2
3

Exercise 1

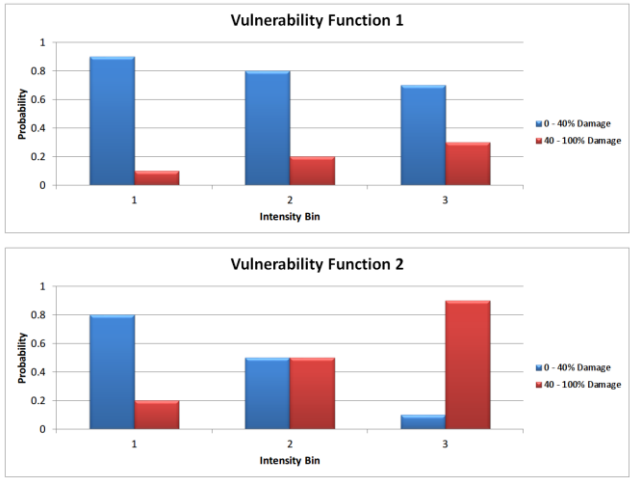
Vulnerability

- Two simple vulnerability functions
  - 1 – Good
  - 2 – Not so good
- Common intensity bins with hazard
  - {1,2,3}
- Binned damage factor ranges
  - 0 – 40%
  - 40 – 100%





Model Files - Vulnerability



intensity_bin_dict

bin_index	bin_from	bin_to
1	50	60
2	60	70
3	70	80

vulnerability_dict

vulnerability_id	construction_scheme	construction_code
1	OED	5150
2	OED	5050

vulnerability

vulnerability_id	intensity_bin_index	damage_bin_index	prob
1	1	1	0.9
1	1	2	0.1
1	2	1	0.8
1	2	2	0.2
1	3	1	0.7
1	3	2	0.3
2	1	1	0.8
2	1	2	0.2
2	2	1	0.5
2	2	2	0.5
2	3	1	0.1
2	3	2	0.9

damage_bin_dict

bin_index	bin_from	bin_to	interpolation
1	0	0.4	0.2
2	0.4	1	0.7

Model files – putting it all together

areaperil_dict

areaperil_id	lat	lon
1	48.88	2.31
2	48.88	2.34
3	48.85	2.31
4	48.85	2.34

footprint

event_id	areaperil_id	intensity_bin_index	prob
1	1	1	0.1
1	1	2	0.2
1	1	3	0.7
1	2	1	0.8
1	2	2	0.2
1	2	3	0
2	1	1	0.75
2	1	2	0.25
2	1	3	0
2	2	1	0.1
2	2	2	0.2
2	2	3	0.7
3	3	1	0.9
3	3	2	0.1
3	3	3	0

intensity_bin_dict

bin_index	bin_from	bin_to
1	50	60
2	60	70
3	70	80

vulnerability_dict

vulnerability_id	construction_scheme	construction_code
1	OED	5150
2	OED	5050

vulnerability

vulnerability_id	intensity_bin_index	damage_bin_index	prob
1	1	1	0.9
1	1	2	0.1
1	2	1	0.8
1	2	2	0.2
1	3	1	0.7
1	3	2	0.3
2	1	1	0.8
2	1	2	0.2
2	2	1	0.5
2	2	2	0.5
2	3	1	0.1
2	3	2	0.9

damage_bin_dict

bin_index	bin_from	bin_to	interpolation
1	0	0.4	0.2
2	0.4	1	0.7

event

event_id
1
2
3

occurrence

event_id	period_no	occ_year	occ_month	occ_day
1	1	1	9	3
2	1	1	10	18
1	4	4	8	16
2	10	10	9	24
3	10	10	10	30

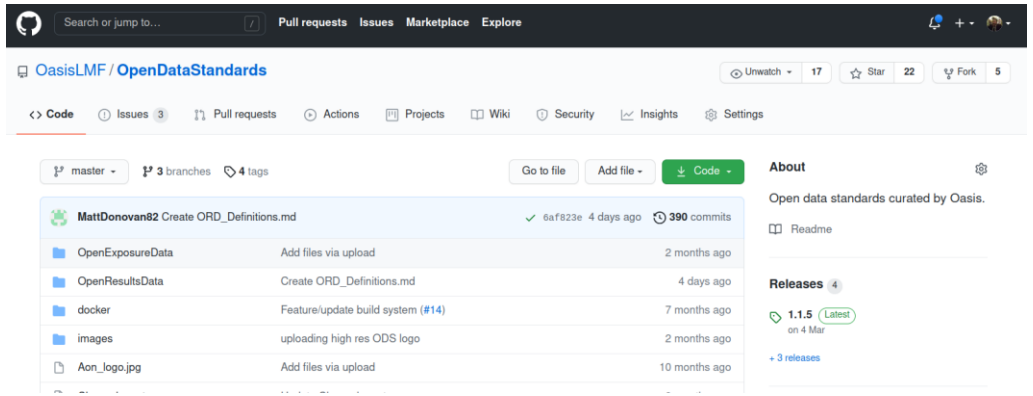
Exercise 2

Example Exposures

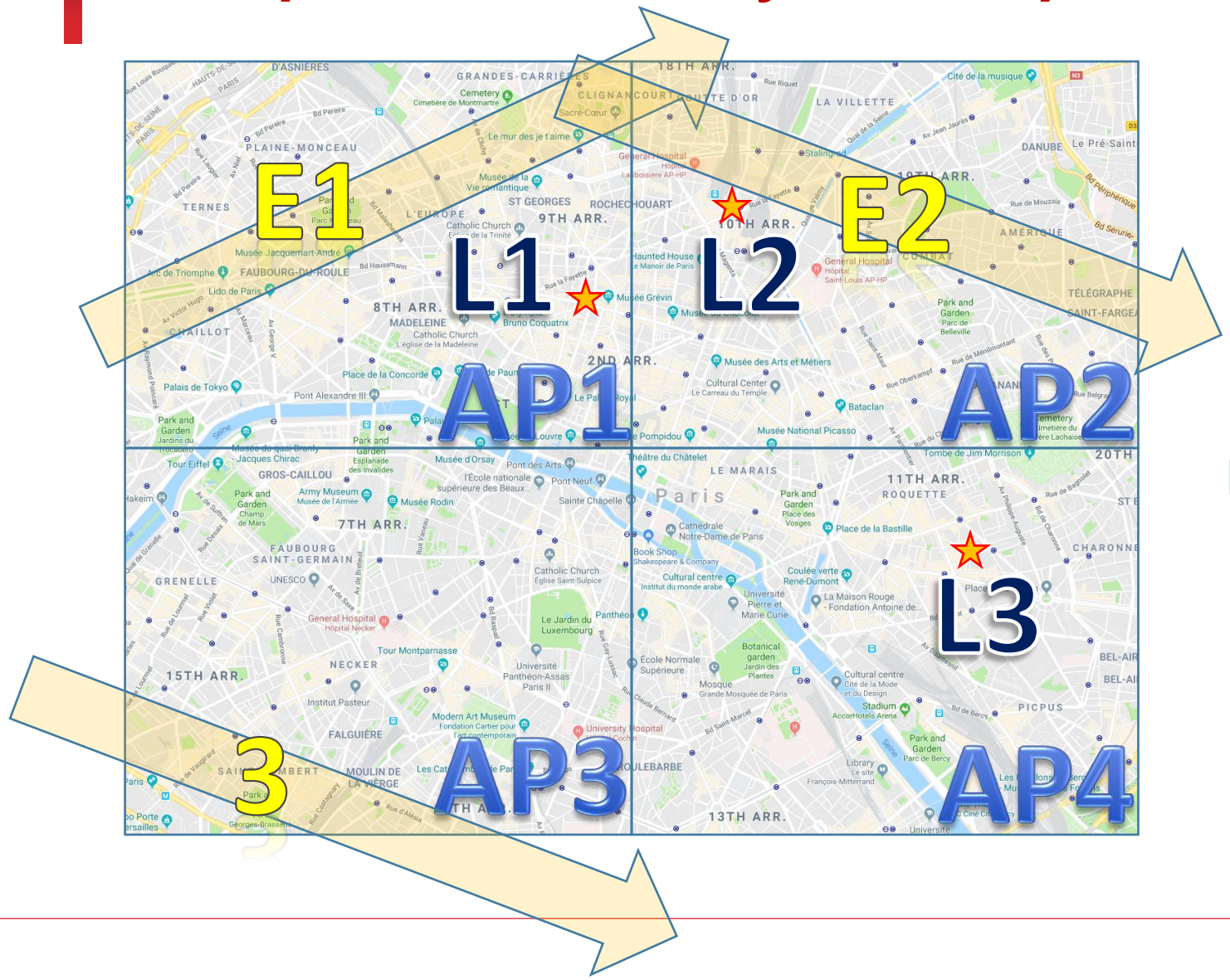
LocNumber	LocName	Latitude	Longitude	ConstructionCode	BuildingTIV
1	Hôtel Ronceray Opéra	48.874979	2.308870	5150	1,000,000
2	Gare Du Nord	48.876918	2.324729	5050	2,000,000
3	Art Supply Store	48.853240	2.387931	5150	500,000

ODS
Open Data Standards

Open Exposure Data (OED)



Example Model – Keys Lookup

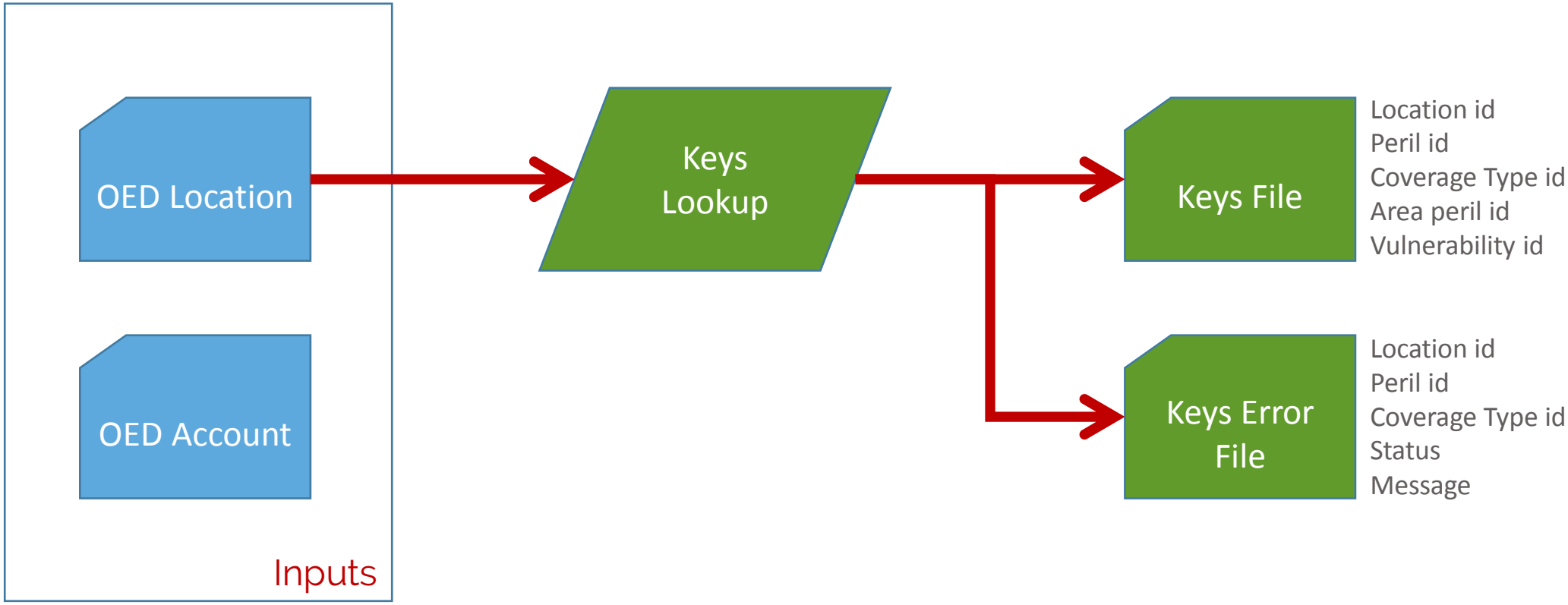


vulnerability_dict

vulnerability_id	construction_scheme	construction_code
1	OED	5150
2	OED	5050

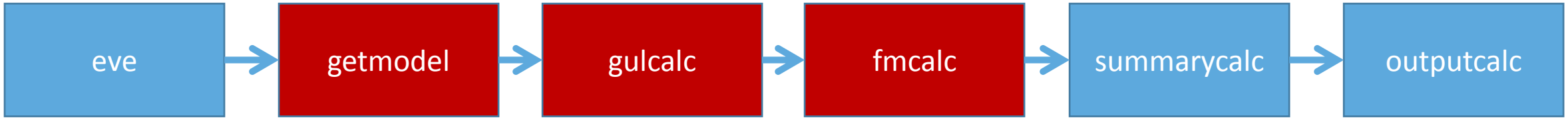
item_id	areaperil_id	vulnerability_id	tiv
1	1	1	1,000,000
2	2	2	2,000,000
3	4	1	500,000

Data Flow – Preparation 1 Keys Lookup



Exercise 3

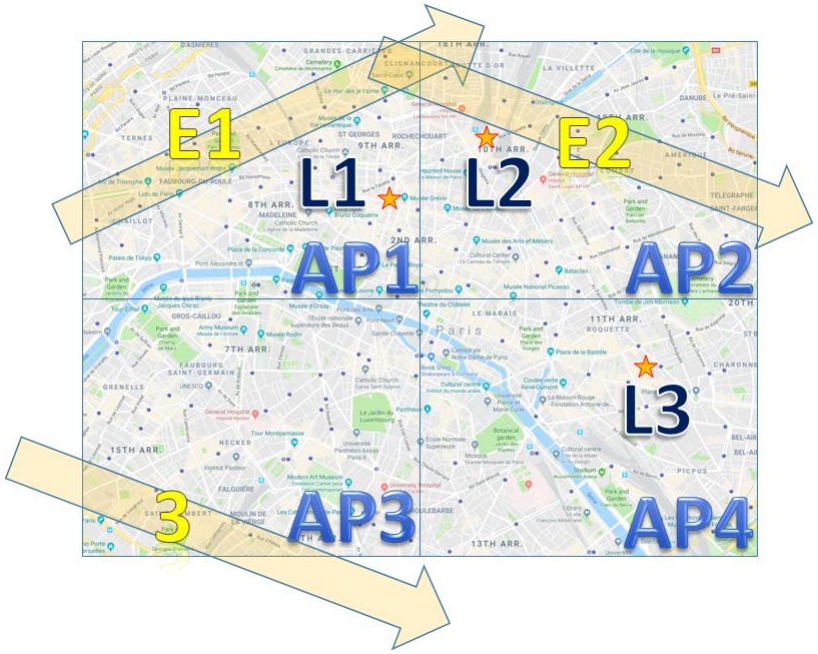
ktools



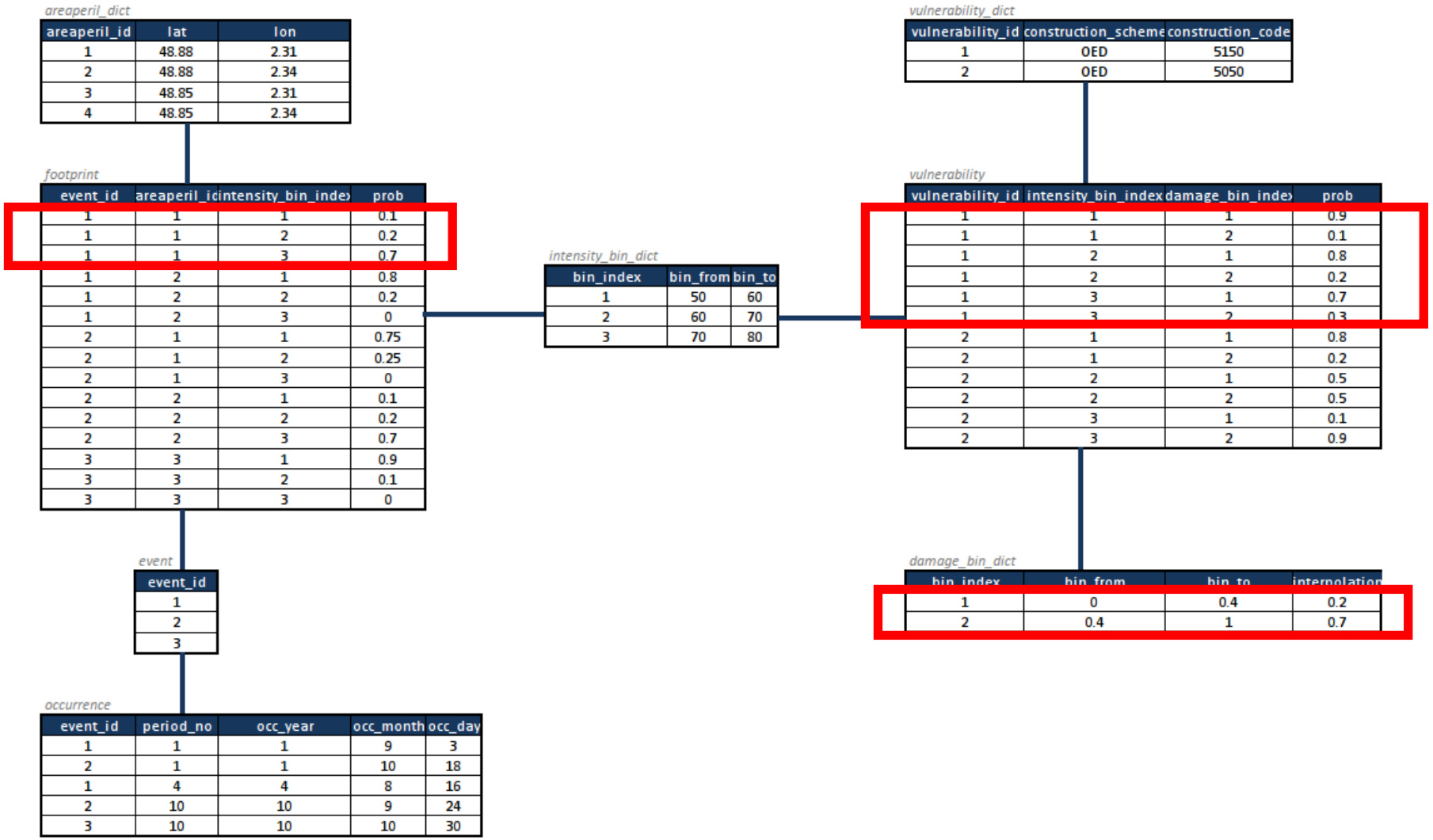
- Calculation **k**ernel
- Modular
- Example implementation

getmodel

- Function to generate “effective damageability distribution”
- Extracts relevant data from model files (footprint and vulnerability) based on input exposures and convolves into a single distribution
- For our example
  - No events in area_peril 4
  - No items in area_peril 3
  - Of interest:
    - Events {1,2}
    - Areaperils {1,2}
    - Vulnerabilities{1,2}



getmodel – extraction (event 1, areaperil 1, vulnerability 1)



areaperil_dict

areaperil_id	lat	lon
1	48.88	2.31
2	48.88	2.34
3	48.85	2.31
4	48.85	2.34

footprint

event_id	areaperil_id	intensity_bin_index	prob
1	1	1	0.1
1	1	2	0.2
1	1	3	0.7
1	2	1	0.8
1	2	2	0.2
1	2	3	0
2	1	1	0.75
2	1	2	0.25
2	1	3	0
2	2	1	0.1
2	2	2	0.2
2	2	3	0.7
3	3	1	0.9
3	3	2	0.1
3	3	3	0

event

event_id
1
2
3

occurrence

event_id	period_no	occ_year	occ_month	occ_day
1	1	1	9	3
2	1	1	10	18
1	4	4	8	16
2	10	10	9	24
3	10	10	10	30

intensity_bin_dict

bin_index	bin_from	bin_to
1	50	60
2	60	70
3	70	80

vulnerability_dict

vulnerability_id	construction_scheme	construction_code
1	OED	5150
2	OED	5050

vulnerability

vulnerability_id	intensity_bin_index	damage_bin_index	prob
1	1	1	0.9
1	1	2	0.1
1	2	1	0.8
1	2	2	0.2
1	3	1	0.7
1	3	2	0.3
2	1	1	0.8
2	1	2	0.2
2	2	1	0.5
2	2	2	0.5
2	3	1	0.1
2	3	2	0.9

damage_bin_dict

bin_index	bin_from	bin_to	interpolation
1	0	0.4	0.2
2	0.4	1	0.7

getmodel example – convolution

footprint

event_id	areaperil_id	intensity_bin_index	prob
1	1	1	0.1
1	1	2	0.2
1	1	3	0.7

vulnerability

vulnerability_id	intensity_bin_index	damage_bin_index	prob
1	1	1	0.9
1	1	2	0.1
1	2	1	0.8
1	2	2	0.2
1	3	1	0.7
1	3	2	0.3

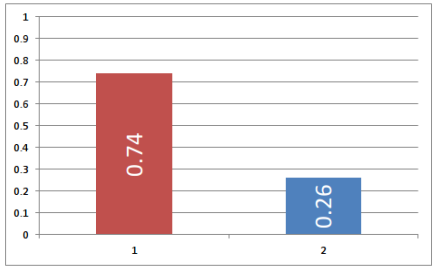
damage_bin_dict

bin_index	bin_from	bin_to	interpolation
1	0	0.4	0.2
2	0.4	1	0.7

Convolution

event_id	areaperil_id	vulnerability_id	intensity_bin_index	damage_bin_index	prob_f	prob_v	prob
1	1	1	1	1	0.1	0.9	0.09
1	1	1	1	2	0.1	0.1	0.01
1	1	1	2	1	0.2	0.8	0.16
1	1	1	2	2	0.2	0.2	0.04
1	1	1	3	1	0.7	0.7	0.49
1	1	1	3	2	0.7	0.3	0.21

PDF

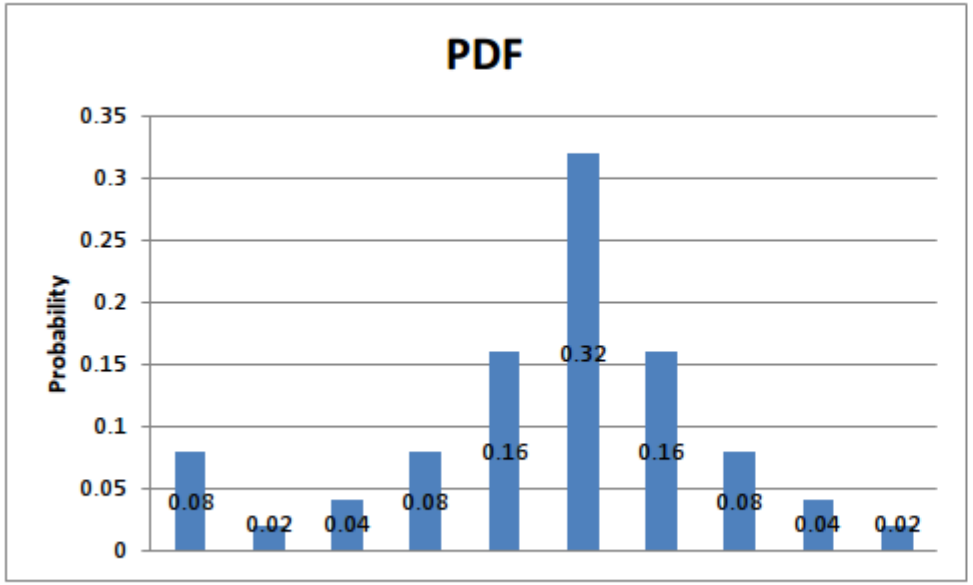


P(1) = 0.09 + 0.16 + 0.49 = 0.74

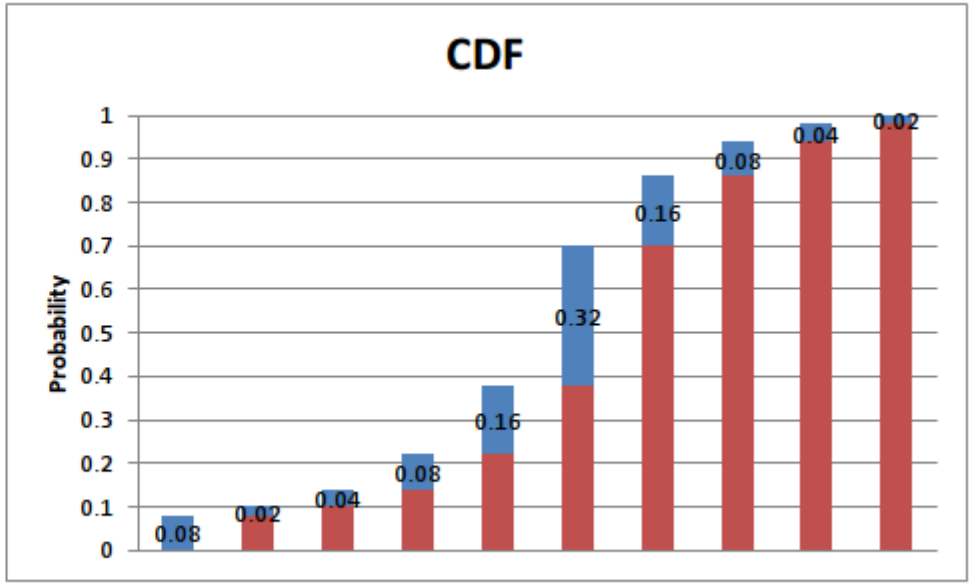
P(2) = 0.01 + 0.04 + 0.21 = 0.26

A note on PDF to CDF conversions

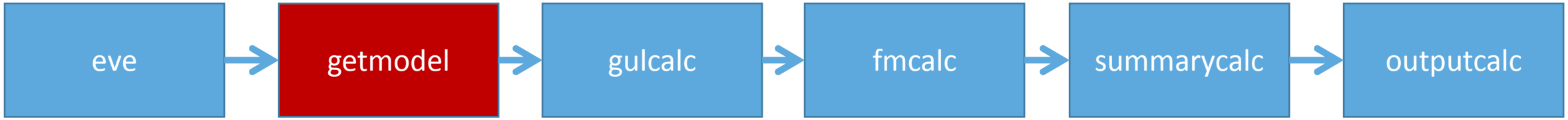
Probability Distribution Function



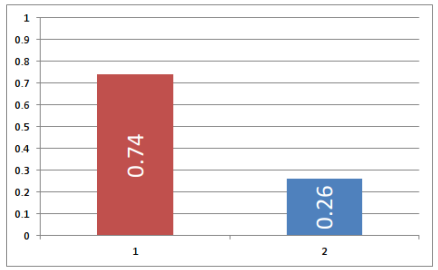
Cumulative Distribution Function



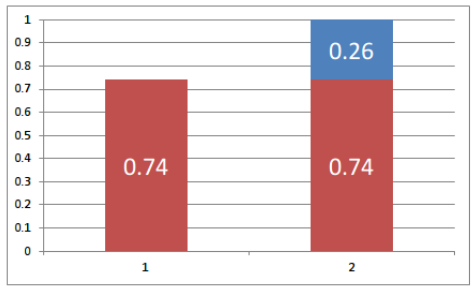
getmodel example – cumulative distribution function



PDF



CDF

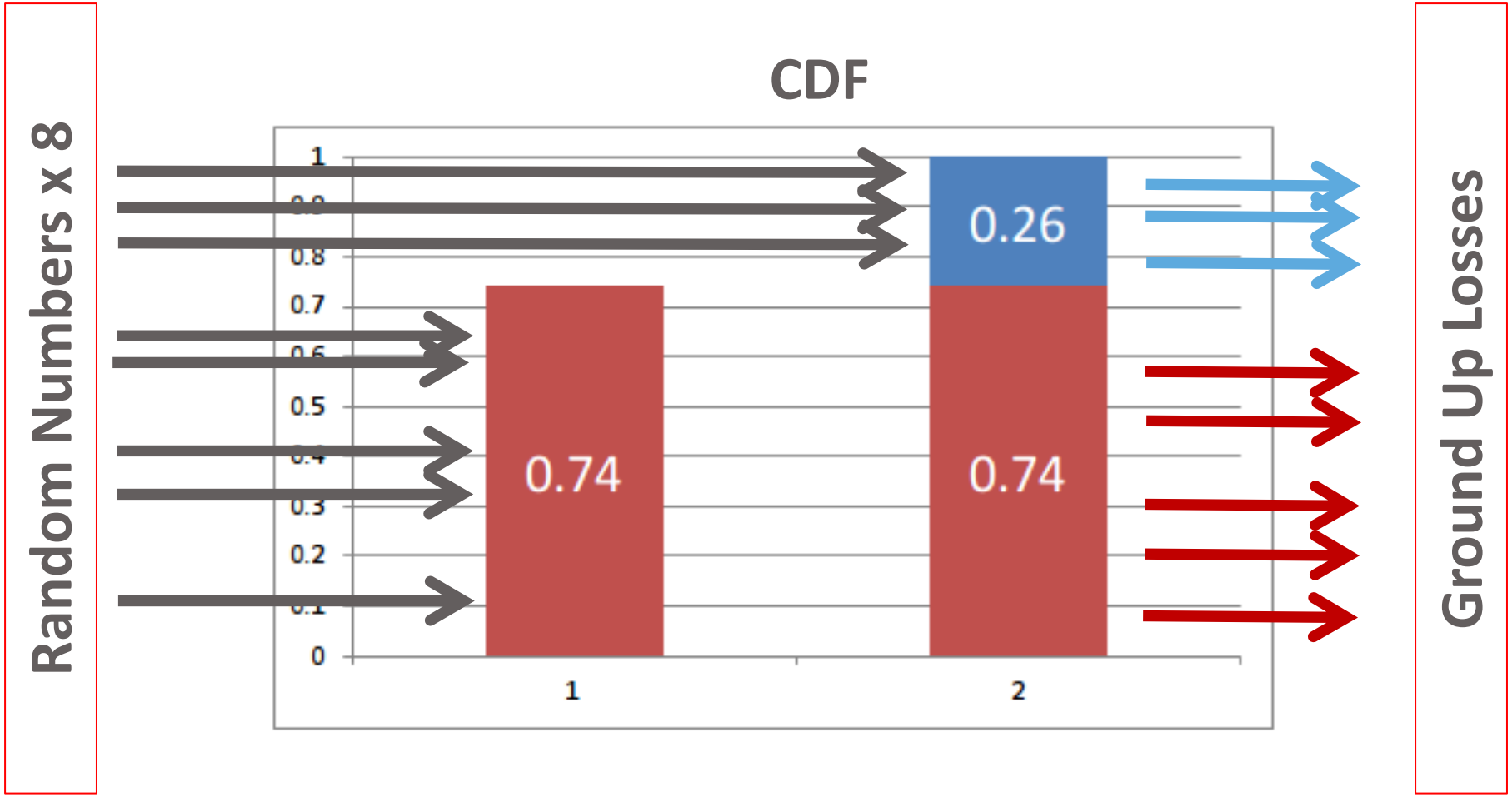


event_id	areaperil_id	vulnerability_id	bin_index	prob_to
1	1	1	1	0.74
1	1	1	2	1
1	2	2	1	0.74
1	2	2	2	1
2	1	1	1	0.875
2	1	1	2	1
2	2	2	1	0.25
2	2	2	2	1

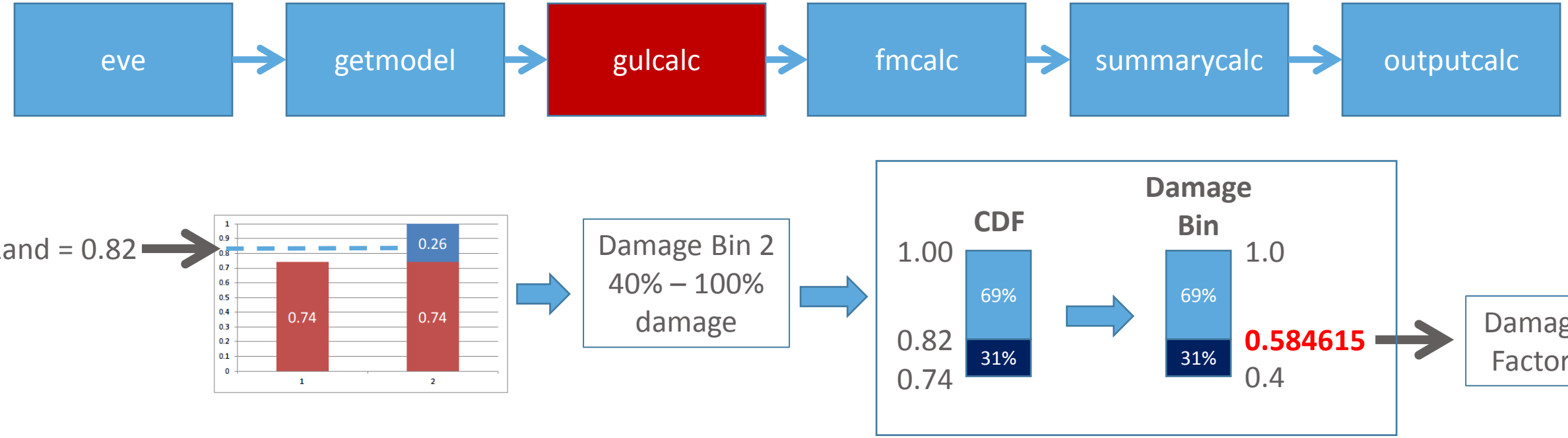
gulcalc

- Ground Up Loss calculation
- Randomly samples from the generated CDF
- Performs Monte Carlo simulation
- Outputs simulated losses

gulcalc example – sampling



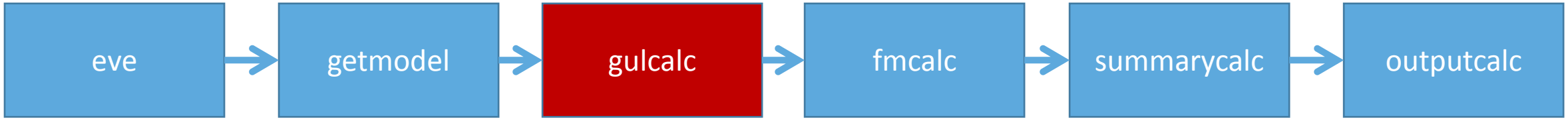
gulcalc example – sample calculation



loss= (bin_from + ((random - prob_from) / (prob_to - prob_from) * (bin_to - bin_from))) * tiv

Sample 1: Loss = (0.4 + ((0.82 - 0.74) / (1 - 0.74) * (1 – 0.4))) * 1,000,000 = 584,615

gulcalc example – Event 1, Item 1, 8 samples



event_id	item_id	sample no	random no	bin	bin_from	bin_to	bin_mean	prob_from	prob_to	damage_factor	tiv	loss
1	1	1	0.82	2	0.4	1	0.7	0.74	1	0.584615	1,000,000	584,615
1	1	2	0.81	2	0.4	1	0.7	0.74	1	0.561538	1,000,000	561,538
1	1	3	0.94	2	0.4	1	0.7	0.74	1	0.861538	1,000,000	861,538
1	1	4	0.44	1	0	0.4	0.2	0	0.74	0.237838	1,000,000	237,838
1	1	5	0.37	1	0	0.4	0.2	0	0.74	0.200000	1,000,000	200,000
1	1	6	0.74	1	0	0.4	0.2	0	0.74	0.400000	1,000,000	400,000
1	1	7	0.01	1	0	0.4	0.2	0	0.74	0.005405	1,000,000	5,405
1	1	8	0.3	1	0	0.4	0.2	0	0.74	0.162162	1,000,000	162,162

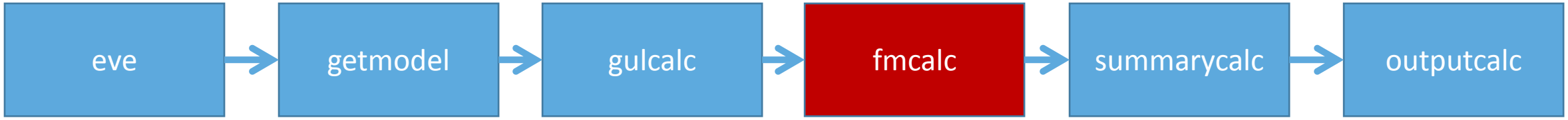
loss= (bin_from + ((random - prob_from) / (prob_to - prob_from) * (bin_to - bin_from))) * tiv

Sample 1: Loss = (0.4 + ((0.82 - 0.74) / (1 - 0.74) * (1 – 0.4))) * 1,000,000 = 584,615

fmcalc

- Financial Module calculation
- Applies (re)insurance terms and conditions to simulated ground up losses
- Applies hierarchical structures
- Outputs simulated insured losses

fmcalc example – Event 1, Item 1, 8 samples



Location Level Terms

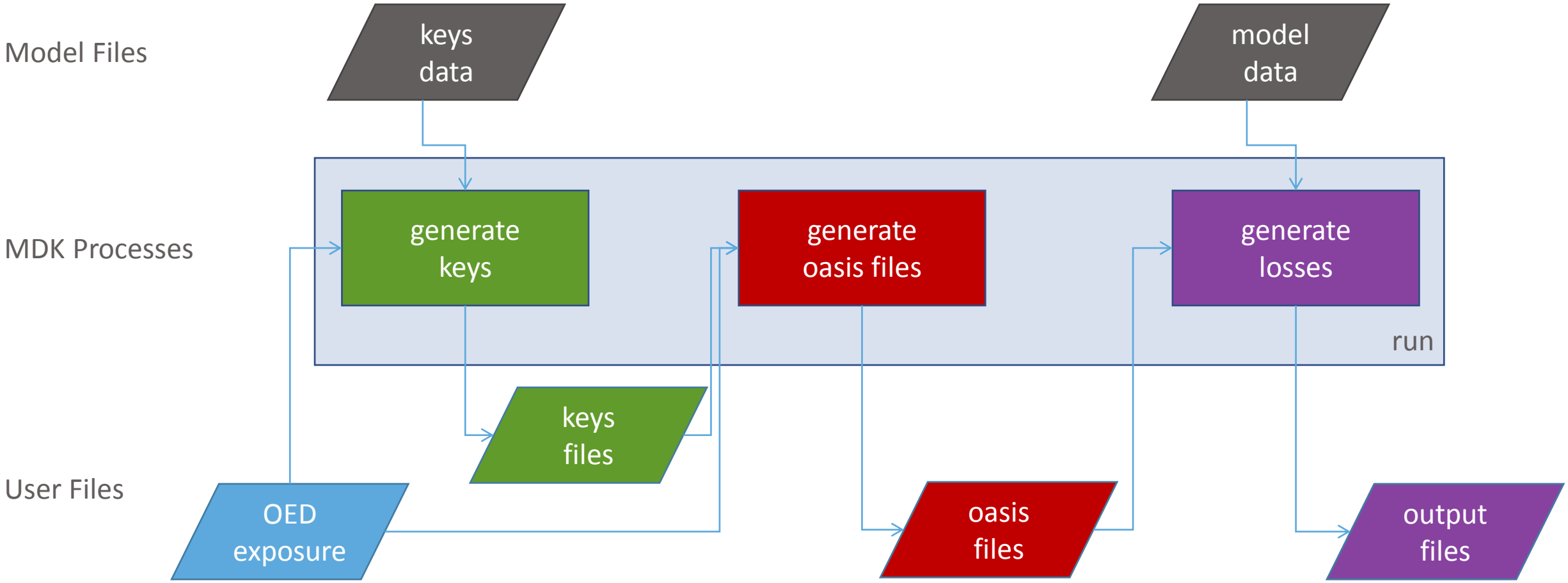
item_id	sample no	Ground Up Loss	Deductible	Limit	Gross Loss
1	1	584,615	10,000	500,000	500,000
1	2	561,538	10,000	500,000	500,000
1	3	861,538	10,000	500,000	500,000
1	4	237,838	10,000	500,000	227,838
1	5	200,000	10,000	500,000	190,000
1	6	400,000	10,000	500,000	390,000
1	7	5,405	10,000	500,000	0
1	8	162,162	10,000	500,000	152,162
2	1	448,054	25,000	1,000,000	423,054
2	2	1,977,185	25,000	1,000,000	1,000,000
2	3	658,093	25,000	1,000,000	633,093
2	4	867,394	25,000	1,000,000	842,394
2	5	1,263,411	25,000	1,000,000	1,000,000
2	6	345,894	25,000	1,000,000	320,894
2	7	141,051	25,000	1,000,000	116,051
2	8	1,048,963	25,000	1,000,000	1,000,000

Aggregate

Account Level Terms

sample no	Gross Loss	Deductible	Limit	Gross Loss
1	923,054	50,000	2,000,000	873,054
2	1,500,000	50,000	2,000,000	1,450,000
3	1,133,093	50,000	2,000,000	1,083,093
4	1,070,232	50,000	2,000,000	1,020,232
5	1,190,000	50,000	2,000,000	1,140,000
6	710,894	50,000	2,000,000	660,894
7	116,051	50,000	2,000,000	66,051
8	1,152,162	50,000	2,000,000	1,102,162

MDK Workflow



Exercise 4