Challenge: "Prediction of extremal precipitation"

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We propose a challenge to predict spatio-temporal extremes. The aim of the challenge is to estimate high quantiles and to extrapolate them both in time and space. The challenge is open to any team by free registration. The best teams will be invited to contribute at a discussion session at EVA 2017 in Delft. They will also be invited to explain their predictive algorithms in a note that will be published in the journal Extremes[1].

<u>About the data:</u> The data are daily maxima of precipitation $P_{j,t}$, $j = 1, \dots, 40$ at 40 stations active during the 50 years period from t=01/01/66 to t=12/31/16. The training sample corresponds to the 30 years period from t=01/01/66 to t=12/31/95. The aim is to predict from the training sample a quantile of level corresponding to extreme monthly precipitation over the next 20 years (the test period from t=01/01/96 to t=12/31/16) station by station. On the daily range, this event corresponds to a quantile of level

P: 일 최대 강수량

j: 연도

t: 날짜(일)

20년의 월 최대 강수량의 quantile 을 predict

$$0.998 = 1 - 0.002 \approx 1 - \frac{1}{20 * 30 \text{ days}}.$$

일 단위로 했을 시 600일 마다 한 번 정도 일어나는 사건 예측

Under strict stationarity, the quantile $q_{j,k}$ satisfies

$$\mathbb{P}(P_{j,t} > q_{j,k}) = 0.002, \qquad \text{day t of the test period in month k},$$

일 최대 강수량이 특정 월 최대 강수량을 초과할 확률이 0.002

q: quantile

j: 연도

t: 날짜(일)

k: 월(month)

for any $j = 1, \dots, 40$ and $k = 1, \dots, 12$.

<u>Evaluation:</u> The performances of the quantile predictions $\hat{q}_{j,k}$ for any $j = 1, \dots, 40$ and $k = 1, \dots, 12$, are evaluated thanks to the quantile loss function

alpha: level, x=P, y=q

$$\ell(x, y) = \alpha(x - y)1_{x>y} + (1 - \alpha)(y - x)1_{y \geq x}, \qquad x, y \in \mathbb{R},$$

quantile loss function

at level $\alpha = 0.998$. The quantile predictions $\hat{q}_{j,k}$ are compared with the daily maxima $P_{j,t}$ at each station $j = 1, \dots, 40$ and each month $k = 1, \dots, 12$:

즉 alpha=0.998일 때 P>qhat일 때의 페널티가 더 큰 것임

$$S_{j,k}(\hat{q}_{j,k}) = \underbrace{\sum_{\text{day t of the test period in month k}}}_{\text{(t에 대한 sum)}} \ell(P_{j,t}, \hat{q}_{j,k}).$$

j: 연도

k: 월(month)

특정 month에 대해 모든 날짜에 대한 loss를 계산해 더한다

Notice that, under strict stationarity, the risk $q \to \mathbb{E}[S_{j,k}(q)]$ is minimized in $q_{j,k}$, see [1]. The final score of the predictive algorithm $\hat{q} = (\hat{q}_{j,k})$ will be the sum of the quantile losses over the stations and the months

$$S_i(\hat{q}) = \sum_{j \in C_i} \underbrace{\sum_{k=1}^{12}}_{\text{(월에 대한 sum)}} S_{j,k}(\hat{q}_{j,k}), \qquad i = 1, 2.$$

i: 테스트 집합에 따라 1,2로 분류

12달치를 모두 더함

C_{1}, C_{2} 고려

[1] Any reverse-engineering algorithm is prohibited. The use of external data (i.e. data other than the provided data) is also prohibited.

There are two different challenges based on two different sets C_i, $i = 1, 2$ of test stations:

1. The final score is the sum over C_1, the set of the 29 stations of the training sample that were still open after the training period (see below),

2. The final score is the sum over C_2, the set of the 34 stations open during the test period.

Registration: The teams have to sign in by sending an email to `olivier.wintenberger@upmc.fr`.

The email must contain the name and the names of the members of the team with their emails in CC. The link to the online storage of the data will be provided after registration. The training sample of the daily maxima of the precipitation is provided in a data frame in the file precip_sample.csv. The longitude and latitude of the stations are provided in a data frame in the file stations_coord.csv. A row number from 1 to 40 has been assigned randomly to every stations. The coordinates of the stations have been shifted to be centered at Paris. Relative distances are unchanged.

Predictions format: Each team shall provide a data frame in csv format with the first column listing the numbers associated to the stations that are, for each challenge (see as examples the benchmarks in Figures 1 and 2 below)

1. $C_1 =$ "2" "4" "5" "6" "11" "12" "13" "15" "16" "18" "19" "20" "21" "22" "23" "24" "25" "26" "28" "29" "30" "32" "33" "34" "35" "36" "38" "39" "40",

2. $C_2 = C_1 \cup$ "7" "8" "9" "10" "37".

qhat: 연월별 일 (최대) 강수량의 0.998 - th 분위수를 예측

The other 12 columns shall correspond to the monthly predictions of the 0.998-th quantile of daily maximum $(\hat{q}_{j,k})$, $k = 1, \dots, 12$ ($k = 1$ corresponding to January). The teams have to provide the final predictions table on May 30, 2017. The final scores of the competition will be posted on the website of the EVA conference on June 7, 2017.

Preliminary evaluation: A preliminary evaluation will consist of the scores of the preliminary predictions tables based on a fixed subsample of one quarter of the test period. Picking randomly five years within the 20 years of the test period from 1996 to 2016, the scores $S_i(\hat{q}) = \sum_{j \in C_i} \sum_{k=1}^{12} S_{j,k}(\hat{q}_{j,k})$ are based on

$$S_{j,k}(\hat{q}_{j,k}) = \sum_{\text{day t of the five years in the test period in month k}} \ell(P_{j,t}, \hat{q}_{j,k}).$$

중간집계때는 20년중 무작위로 5년을 채택해 loss 계산

Each team can provide a preliminary predictions table before March 31, 2017. The preliminary scores will be posted on the website of the EVA conference on April 7, 2017. The performances will also be compared with the score of a benchmark, predicting the quantiles by the maxima of the training sample for challenge 1, see Figure 1. For challenge 2, the benchmark predicts the quantiles of the 5 new stations by the average of the monthly maxima of the stations in the training sample, see Figure 2.

References

[1] Koenker, R. (2005) *Quantile regression.* Cambridge University Press, Cambridge.

"stations"	"X1"	"X2"	"X3"	"X4"	"X5"	"X6"	"X7"	"X8"	"X9"	"X10"	"X11"	"X12"
"2"	0.98	2.2	2.44	6.34	1.38	1.34	11.81	1.22	1.06	4.45	4.06	3.94
"4"	0.94	1.02	6.38	0.98	1.38	6.73	13.23	7.13	6.81	1.57	1.5	0.98
"5"	3.36	0.98	3.19	1.38	10.16	4.13	1.54	5.04	1.73	1.85	1.93	1.3
"6"	0.87	0.31	0.43	0.24	0.31	0.63	1.4	0.31	0.98	1.38	0.43	1.14
"11"	2.09	0.98	3.94	4.09	6.73	1.38	2.44	1.61	8.62	6.73	2.05	1.38
"12"	1.06	10.67	1.06	11.83	1.3	2.09	1.65	1.85	1.02	1.22	2.17	3.98
"13"	0.94	0.28	0.2	0.43	0.28	0.83	0.4	0.55	0.87	1.57	0.91	0.91
"15"	0.87	0.39	0.51	0.31	0.87	0.59	1.02	0.83	0.79	1.02	0.43	1.1
"16"	0.87	2.13	5.35	3.82	11.42	4.06	1.73	11.89	3.58	10.08	1.77	0.87
"18"	0.91	0.43	0.35	0.63	0.98	0.59	0.31	0.35	2.05	0.63	1.02	0.91
"19"	2.2	2.24	1.54	0.98	1.57	2.24	2.09	1.54	1.26	2.83	2.13	2.8
"20"	0.98	0.28	0.28	0.24	0.96	0.75	1.5	0.71	0.87	0.98	0.43	0.43
"21"	0.83	0.51	0.55	0.31	1.46	0.47	0.43	0.28	0.91	0.79	0.87	1.06
"22"	0.98	0.59	0.44	0.47	1.18	0.47	0.71	0.35	1.85	1.02	0.83	0.87
"23"	1.97	1.5	1.14	0.98	1.15	3.98	10.12	0.98	10.2	6.38	1.3	2.17
"24"	0.71	0.59	0.39	0.39	1.58	0.43	0.55	0.12	0.94	1.06	0.43	1.02
"25"	0.98	0.31	0.28	0.28	0.87	0.63	0.39	0.55	2.05	0.83	0.63	0.47
"26"	3.98	2.05	1.34	2.01	1.38	8.7	1.34	3.98	11.42	1.5	1.61	5.51
"28"	4.5	1.14	0.98	0.98	10.08	1.89	1.65	1.61	1.26	2.17	1.14	1.34
"29"	0.61	0.51	0.35	0.16	0.31	0.08	0.28	0.1	0.91	0.83	0.91	0.71
"30"	0.67	0.47	0.2	0.24	0.2	0.55	0.71	0.31	0.94	1.14	0.71	1.22
"32"	0	0	0	0	0.71	0.39	0.94	0.47	0.94	0.24	0.94	0.61
"33"	1.73	1.02	3.15	2.52	1.97	1.46	3.78	1.18	3.86	1.28	3.07	5.55
"34"	0.59	0.47	0.31	0.28	0.79	0.75	0.16	0.16	1.26	1.22	0.13	1.46
"35"	0.94	0.98	1.42	2.05	1.97	1.26	1.65	6.39	1.89	3.98	1.54	1.1
"36"	1.34	2.37	1.18	0.79	0.94	1.3	3.54	1.22	10.35	2.03	1.26	1.42
"38"	0.67	0.51	0.41	0.35	0.39	0.28	0.35	0.04	1.46	0.55	0.31	0.71
"39"	1.97	2.09	0.98	1.1	1.89	7.99	1.77	1.34	1.97	1.97	0.98	1.18
"40"	0.67	0.91	0.24	0.24	0.59	0.32	0.08	0.2	1.06	1.1	0.22	0.71

Figure 1: Benchmark 1

"stations"	"X1"	"X2"	"X3"	"X4"	"X5"	"X6"	"X7"	"X8"	"X9"	"X10"	"X11"	"X12"
"2"	0.98	2.2	2.44	6.34	1.38	1.34	11.81	1.22	1.06	4.45	4.06	3.94
"4"	0.94	1.02	6.38	0.98	1.38	6.73	13.23	7.13	6.81	1.57	1.5	0.98
"5"	3.36	0.98	3.19	1.38	10.16	4.13	1.54	5.04	1.73	1.85	1.93	1.3
"6"	0.87	0.31	0.43	0.24	0.31	0.63	1.4	0.31	0.98	1.38	0.43	1.14
"11"	2.09	0.98	3.94	4.09	6.73	1.38	2.44	1.61	8.62	6.73	2.05	1.38
"12"	1.06	10.67	1.06	11.83	1.3	2.09	1.65	1.85	1.02	1.22	2.17	3.98
"13"	0.94	0.28	0.2	0.43	0.28	0.83	0.4	0.55	0.87	1.57	0.91	0.91
"15"	0.87	0.39	0.51	0.31	0.87	0.59	1.02	0.83	0.79	1.02	0.43	1.1
"16"	0.87	2.13	5.35	3.82	11.42	4.06	1.73	11.89	3.58	10.08	1.77	0.87
"18"	0.91	0.43	0.35	0.63	0.98	0.59	0.31	0.35	2.05	0.63	1.02	0.91
"19"	2.2	2.24	1.54	0.98	1.57	2.24	2.09	1.54	1.26	2.83	2.13	2.8
"20"	0.98	0.28	0.28	0.24	0.96	0.75	1.5	0.71	0.87	0.98	0.43	0.43
"21"	0.83	0.51	0.55	0.31	1.46	0.47	0.43	0.28	0.91	0.79	0.87	1.06
"22"	0.98	0.59	0.44	0.47	1.18	0.47	0.71	0.35	1.85	1.02	0.83	0.87
"23"	1.97	1.5	1.14	0.98	1.15	3.98	10.12	0.98	10.2	6.38	1.3	2.17
"24"	0.71	0.59	0.39	0.39	1.58	0.43	0.55	0.12	0.94	1.06	0.43	1.02
"25"	0.98	0.31	0.28	0.28	0.87	0.63	0.39	0.55	2.05	0.83	0.63	0.47
"26"	3.98	2.05	1.34	2.01	1.38	8.7	1.34	3.98	11.42	1.5	1.61	5.51
"28"	4.5	1.14	0.98	0.98	10.08	1.89	1.65	1.61	1.26	2.17	1.14	1.34
"29"	0.61	0.51	0.35	0.16	0.31	0.08	0.28	0.1	0.91	0.83	0.91	0.71
"30"	0.67	0.47	0.2	0.24	0.2	0.55	0.71	0.31	0.94	1.14	0.71	1.22
"32"	0	0	0	0	0.71	0.39	0.94	0.47	0.94	0.24	0.94	0.61
"33"	1.73	1.02	3.15	2.52	1.97	1.46	3.78	1.18	3.86	1.28	3.07	5.55
"34"	0.59	0.47	0.31	0.28	0.79	0.75	0.16	0.16	1.26	1.22	0.13	1.46
"35"	0.94	0.98	1.42	2.05	1.97	1.26	1.65	6.39	1.89	3.98	1.54	1.1
"36"	1.34	2.37	1.18	0.79	0.94	1.3	3.54	1.22	10.35	2.03	1.26	1.42
"38"	0.67	0.51	0.41	0.35	0.39	0.28	0.35	0.04	1.46	0.55	0.31	0.71
"39"	1.97	2.09	0.98	1.1	1.89	7.99	1.77	1.34	1.97	1.97	0.98	1.18
"40"	0.67	0.91	0.24	0.24	0.59	0.32	0.08	0.2	1.06	1.1	0.22	0.71
"7"	1.34	1.22	1.33	1.37	1.98	1.75	2.12	1.91	2.53	1.98	1.25	1.49
"8"	1.34	1.22	1.33	1.37	1.98	1.75	2.12	1.91	2.53	1.98	1.25	1.49
"9"	1.34	1.22	1.33	1.37	1.98	1.75	2.12	1.91	2.53	1.98	1.25	1.49
"10"	1.34	1.22	1.33	1.37	1.98	1.75	2.12	1.91	2.53	1.98	1.25	1.49
"37"	1.34	1.22	1.33	1.37	1.98	1.75	2.12	1.91	2.53	1.98	1.25	1.49

Figure 2: Benchmark 2