

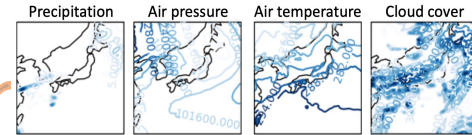
Introduction

- We propose a model for automatically generating weather comments from meteorological simulations.

- Three characteristic problems of this task.

- How can we consider the changes in numerical values for various physical quantities?
- Weather comments should be dependent on delivery time and area information.
- Weather comments should provide useful information for users.

Simulation Results of Numerical Weather Prediction



Delivery time: 05:51 a.m. on 06 April, Tokyo

Today patches of blue sky will appear, but the sky will become cloudy and it will gradually start to rain in the evening. Please bring an umbrella when you go out, even if it's not raining.

Proposed Methods

(1) Encoding numerical forecast maps

- Since numerical forecast maps are composed of a sequence of two-dimensional data, the task can be seen as "video captioning".
- We use either a CNN or MLP to capture the numeric features of forecast maps.
- We also use Bi-RNN to capture time-series data.

(2) Introducing meta-data

- Weather comments contain expressions that depend on their delivery time and date.
- We use delivery date and time of weather comments and area name in order to generate such expressions.

(3) Predicting weather labels

- Consumers are primarily interested in weather information such as sunny and rain.
- We need to explicitly perform "content selection" to help the model describe useful information.
- However, it is hard to find content plans from the complicated input-data.

How can we define "content plans"?

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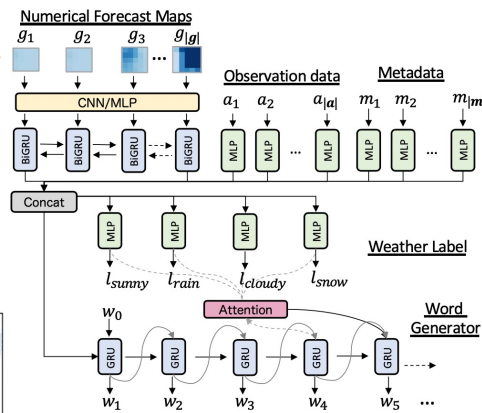
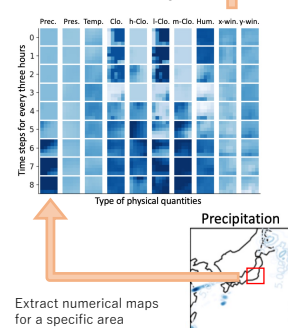
Weather label extraction



Example of clue words

Label	Clue words
SUNNY	晴れ (sunny), 日差し (sunlight), 青空 (blue sky)
RAIN	雨 (rain), 大雨 (heavy rain), にわか雨 (shower)
CLOUDY	曇り (cloudy), 曇 (cloudy), 雲 (cloud)
SNOW	雪 (snow), 吹雪 (blizzard), 小雪 (light snowfall)

Sequence of numerical forecast maps (10 types)



Experiments

Dataset

- Weather comments
- Numerical forecast maps
- Weather observation data

Statistics of weather comments

	Train	Valid	Test
Comments	28,555	14,464	14,393

Evaluation metrics

- Word-based metrics
 - BLEU, ROUGE
- Content-based metrics
 - Precision/Recall/F1 of weather labels, extracted from generated texts
- Human evaluation (w/ five evaluators)
 - Informativeness, Consistency, Grammaticality (1/2/3)

Results

- In the results of automatic evaluation, models (3) and (4) significantly improved F1 scores for the sunny and snow labels by around 5% in comparison to the baselines.
- Model (5) significantly improved the correctness of each weather label since it can use the oracle labels, but the improvement in BLEU and ROUGE scores was limited.
- In the results of human evaluation, model (4), which explicitly performs content selection outperformed model (2), which does not, in terms of informativeness.

Results of automatic evaluation

Model	Components			Word Overlap		SUNNY			RAIN			CLOUDY			SNOW		
	Enc.	Weather	CL	BLEU	ROUGE	P%	R%	F ₁ %	P%	R%	F ₁ %	P%	R%	F ₁ %	P%	R%	F ₁ %
(1)	CNN	—	—	12.7	42.8	83.5	67.6	74.7	72.8	83.6	77.8	58.5	59.8	59.0	75.2	50.1	60.2
(2)	MLP	—	—	13.0	43.5	83.2	68.4	74.9	74.6	83.5	78.8	59.8	60.3	59.9	75.7	53.3	62.3
(3)	MLP	Pred.	—	12.9	43.8	81.0	78.5	79.7	78.6	80.0	79.3	62.5	55.9	58.9	75.9	60.4	67.2
(4)	MLP	Pred.	✓	13.2	43.9	81.0	78.4	79.7	76.6	84.1	80.2	60.6	59.3	59.8	77.7	58.5	66.6
(5)	MLP	Orac.	✓	14.6	45.5	94.9	84.5	89.4	84.4	92.9	88.4	84.7	85.6	85.1	91.3	63.8	75.1

Results of Human evaluation

Label	Model(2)			Model(4)			# of cases
	Info.	Con.	Gra.	Info.	Con.	Gra.	
SUNNY	1.92	2.91	2.91	2.10	2.82	2.88	26
RAIN	2.02	2.93	2.92	2.13	2.88	2.90	26
CLOUDY	1.99	2.93	2.94	2.12	2.83	2.89	19
SNOW	1.88	2.95	2.92	1.95	2.91	2.94	13
Overall	1.98	2.92	2.92	2.10	2.86	2.90	40

Effect of Meta-data

Expression	Model (4)	w/o Meta	Δ
今日 (Today)	99.3	97.3	+2.0
明日 (Tomorrow)	95.1	91.1	+4.0
月 (Monday)	29.3	0.0	+29.3
火 (Tuesday)	29.2	0.0	+29.2
春 (Spring)	14.0	2.4	+11.6
夏 (Summer)	19.1	12.4	+6.7
BLEU	13.2	12.7	+0.5

Results of weather label prediction

Label	Precision	Recall	F1 score
SUNNY	79.7	84.9	82.1
RAIN	79.9	80.5	80.2
CLOUDY	61.5	62.5	61.6
SNOW	73.9	67.1	70.3

Conclusion

- We proposed a data-to-text model and incorporated three types of encoders for forecast maps, observation data, and meta-data into the model.
- We introduced weather labels representing the content of weather information to improve the correctness of information in generated comments.