Impact of weather on hotel booking cancellation

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Outline

- Business use case 
- Dataset overview 
- Tool stack 
- Price estimation 

Business use case

Hotel chains lose significant revenue from cancellations.

Looking on how weather impacts hotel bookings helps to:

- Predict cancellations based on weather forecasts
- Optimize pricing strategies during poor weather periods
- Adjust workforce according to expected arrivals
- Improve marketing campaigns targeting unpleasent weather condition periods to bring more customers

Stakeholders: Revenue manager, Operations director, Hotel Owners/Investors

Dataset: Hotel Booking Demand

Kaggle dataset contains information on hotels bookings for two types of hotels in two different cities of Portugal.

Resort hotel is located in Algarve, whereas city hotel is located in Lisbon.

Key columns include measurements like cancelled flag and average day revenue. This will be used for quantifying of success.

API: Open-Meteo Weather

Weather metrics for temperature, precipitation, rain, snow, wind and sun are derived through API call using Python script.
Open-Meteo API is a best choice as it does not require any method of authorization and has a high requests limit per day.

Data pipeline

Open-Meteo API

AWS Lambda - To fetch historical temperature values and other relevant measurments

AWS Eventbridge - To update weather information on a weekly basis

Load hotel booking dataset from Kaggle into S3 bucket folder

S3 bucket (data storage) To store data from Lambda and CSV file (dataset data and data from API)

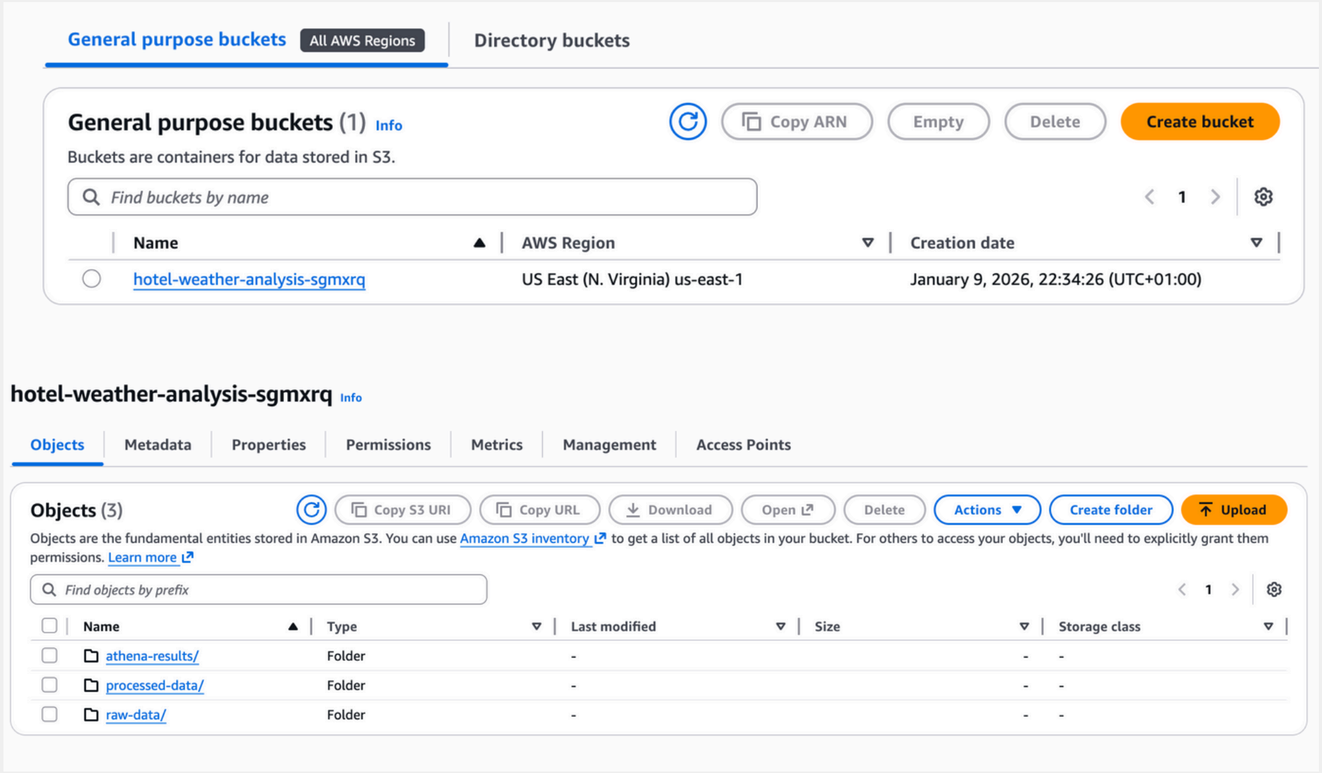
AWS Glue - To combine data from both CSV and API

AWS Athena - Analyze how temperature and other weather measurements affect hotels revenue and booking cancelations

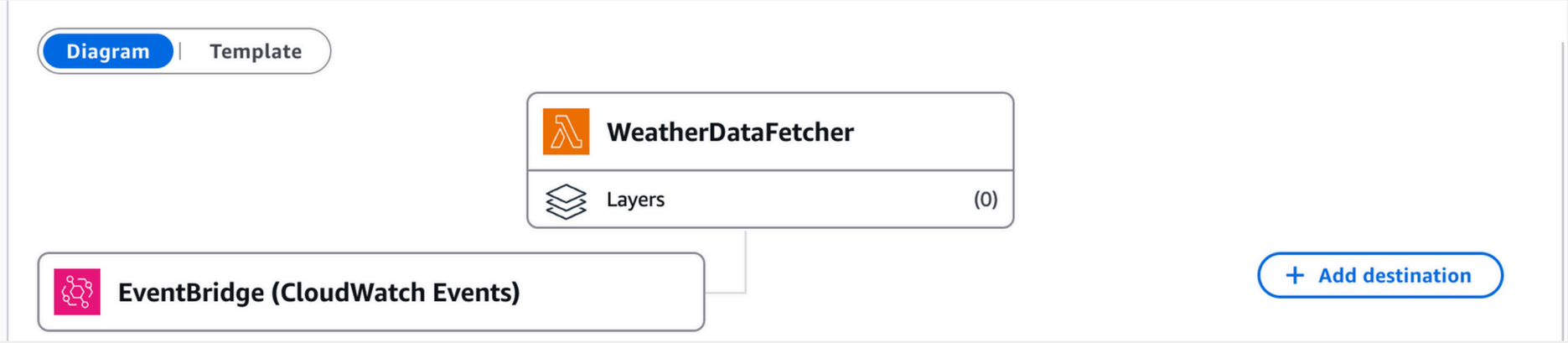
This setup lets stakeholders run queries on booking and weather data together, so they can spot patterns and make decisions on pricing, staffing, and marketing based on weather forecasts.

S3 bucket

S3 bucket is created with following folder structure:



Lambda and EventBridge



Lambda function to extract weather data was created and information is updated each 7 days as triggered by EventBridge rule

AWS Glue and Crawler

1.

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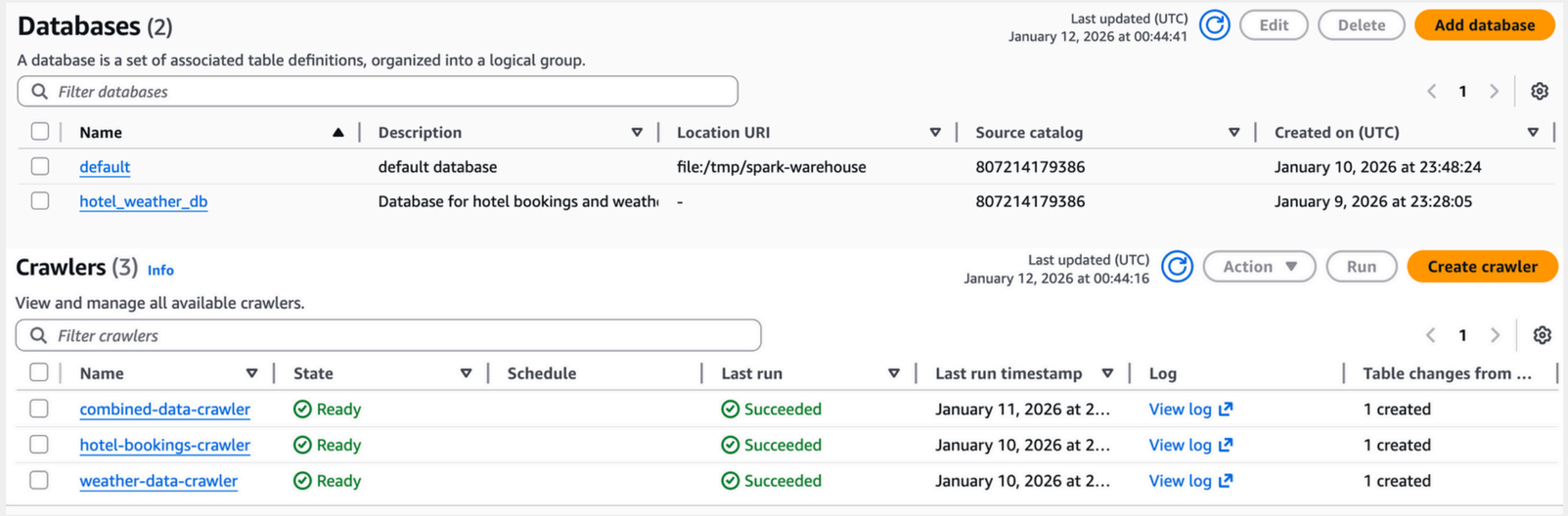
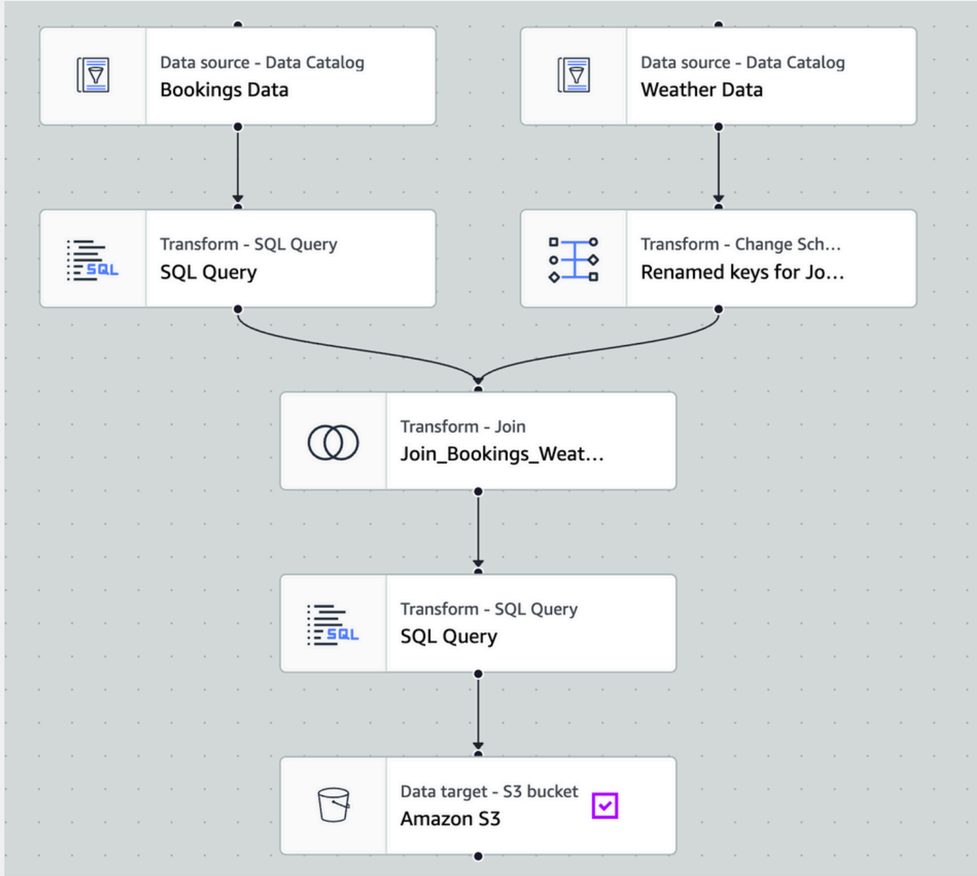


Glue database was created and crawlers for booking, weather and combined data were configured

ETL job with Glue



Visual ETL was created to combine data from Bookings and Weather sources. Certain new fields were created and final combined table is flattened out (to remove struct type objects)

KPI

- Weather impact on cancellation rate and revenue
- Lead time against cancellation risk
- Guest composition and weather preference

Weather impact on cancellation rate

hotel	temp_category	total_bookings	cancellations	cancellation_rate
City Hotel	Moderate (15-25°C)	51780	22241	42.95
City Hotel	Cold (<15°C)	24572	9781	39.81
Resort Hotel	Moderate (15-25°C)	25547	7283	28.51
Resort Hotel	Warm (>25°C)	5711	1970	34.49
Resort Hotel	Cold (<15°C)	8802	1869	21.23
City Hotel	Warm (>25°C)	2978	1080	36.27

hotel	wind_level	bookings	avg_wind_speed	cancel_rate	avg_rate
City Hotel	Strong (>40 km/h)	955	43.6	43.14	81.03
City Hotel	Calm (<20 km/h)	30270	16,1	42.41	106.82
City Hotel	Moderate (20-40 km/h)	46897	26,2	42.06	107.54
Resort Hotel	Moderate (20-40 km/h)	27408	27,5	28.22	100.28
Resort Hotel	Calm (<20 km/h)	10473	15,9	27.81	92.05
Resort Hotel	Strong (>40 km/h)	1427	44.7	27,4	63.93

City Hotel cancellation rates stay pretty much the same regardless of wind or temperature. Resort Hotel is more affected — prices drop hard when it's windy ($64 vs $100). Cold weather at the resort actually has lowest cancellations (21%) which is weird for a beach place

hotel	rain_category	bookings	avg_precipitation	cancel_rate	avg_rate	revenue
City Hotel	Dry (0mm)	54097	0.0	42.11	109.62	3474726.30
City Hotel	Light Rain (0-5mm)	16185	1,2	42.37	102.07	965201.04
City Hotel	Moderate Rain (5-15mm)	6173	8,4	44.45	95.47	331140.01
City Hotel	Heavy Rain (>15mm)	1667	22,1	35.39	109.44	117356.35
Resort Hotel	Dry (0mm)	30555	0.0	28.25	104.71	2198198.33
Resort Hotel	Light Rain (0-5mm)	5884	1,3	27,06	71.53	298406.82
Resort Hotel	Moderate Rain (5-15mm)	1771	8,5	30.77	63.66	77257.37
Resort Hotel	Heavy Rain (>15mm)	1098	23,5	24.59	64.59	53395.09

Surprisingly, heavy rain days have fewer cancellations than dry days (City: 35% vs 42%, Resort: 25% vs 28%). Maybe people who book knowing it'll rain are more committed to their trip? Either way, no reason to drop prices just because of rain.

Lead time against cancellation risk

hotel	booking_window	bookings	cancel_rate_pct	avg_daily_rate	realized_revenue
City Hotel	Early Bird (3+ months)	35048	55.87	102.7	1649171.95
City Hotel	Advance (1-3 months)	20662	40.08	108.02	1312004.04
Resort Hotel	Early Bird (3+ months)	15816	39.62	100.03	930841.00
City Hotel	Short Notice (8-30 days)	12393	31.21	114.65	961579.27
City Hotel	Last Minute (0-7 days)	10019	12.41	109.94	965668.44
Resort Hotel	Advance (1-3 months)	8645	32.75	106.14	600854.87
Resort Hotel	Last Minute (0-7 days)	8589	6.52	78.6	626846.17
Resort Hotel	Short Notice (8-30 days)	6258	22,05	100.53	468715.57

The earlier someone books, the more likely they cancel. City Hotel early bird bookings have 55.87% cancellation but last minute is only 12.41%. So people who book late actually show up.

Guest composition and weather preference

hotel	guest_type	bookings	pct_of_hotel_bookings	cancel_rate	avg_rate	avg_stay_length	avg_temp_celsius	avg_precipitation_mm	avg_sunshine_hrs	total_revenue
City Hotel	Couple	53111	67.98	45.27	101.16	3.0	17,8	1,4	10,6	3010655.49
City Hotel	Solo Traveler	14982	19.18	35.48	97.15	2,6	16,8	1,4	10,2	917600.00
City Hotel	Family	5121	6.56	34.64	154.26	3,4	18,4	1,1	11.0	508727.69
City Hotel	Group	4657	5.96	37.64	153.65	3,4	18,6	1,1	11,2	438637.25
City Hotel	Other	251	0.32	34.26	79.97	4.0	17,5	1,5	11,1	12803.27
Resort Hotel	Couple	27641	70.32	30.02	94.86	4,6	19,4	1,3	10,8	1802803.24
Resort Hotel	Family	3884	9.88	35.89	163.01	4,8	21,3	0.8	11,5	384620.47
Resort Hotel	Solo Traveler	6739	17.14	17.17	57.22	3,1	17.0	1,5	10.0	308512.71
Resort Hotel	Group	1043	2.65	18.22	156.36	5.0	21,6	0.5	11,6	131293.19
Resort Hotel	Other	1	0.0	0.0	28.0	10.0	13,9	0.0	8,7	28.0

Couples make up most bookings (around 70%). Families and groups come during warmer weather and spend more per booking. Solo travelers at Resort Hotel have really low cancellation (17%) — pretty reliable segment.

Service pricing estimate

Estimate summary

Upfront cost	Monthly cost	Total 12 months cost
0.00 USD	1.59 USD	19.08 USD Includes upfront cost

Detailed Estimate

Name	Group	Region	Upfront cost	Monthly cost
Amazon Simple Storage Service (S3)	-	US East (N. Virginia)	0.00 USD	0.02 USD

Status -

Description: -

Config summary S3 Standard storage (1 GB per month)

Name	Group	Region	Upfront cost	Monthly cost
AWS Glue	-	US East (N. Virginia)	0.00 USD	1.51 USD

Status -

Description: -

Config summary Number of DPUs for Apache Spark job (10), Number of DPUs for Python Shell job (0.0625)

Name	Group	Region	Upfront cost	Monthly cost
AWS Lambda	-	US East (N. Virginia)	0.00 USD	0.00 USD

Status -

Description: -

Config summary Architecture (x86), Architecture (x86), Invoke Mode (Buffered), Amount of ephemeral storage allocated (512 MB), Number of requests (4 per month)

Name	Group	Region	Upfront cost	Monthly cost
Amazon Athena	-	US East (N. Virginia)	0.00 USD	0.06 USD

Status -

Description: -

Config summary Total number of queries (20 per day), Amount of data scanned per query (20 MB)

Name	Group	Region	Upfront cost	Monthly cost
Amazon EventBridge	-	US East (N. Virginia)	0.00 USD	0.00 USD

Status -

Description: -

Config summary Size of the payload (1 KB), Number of events (4 per month)

Suggestions

Don't discount rooms when rain is forecasted — the data shows these bookings actually cancel less (7% lower). These guests probably planned for it.

Wind hurts Resort Hotel prices a lot (drops to $64 from $100). Maybe send guests early updates when strong wind is expected and adjust rates accordingly.

Early bookings cancel way more (55%), so it makes sense to require higher deposits for those. Last minute bookings are reliable so keep those flexible.

Families and groups pay more (~€154-163 vs €95 average) and prefer warm sunny weather. Could push marketing to them when forecasts look good.

Thank You