

# STOCK MARKET

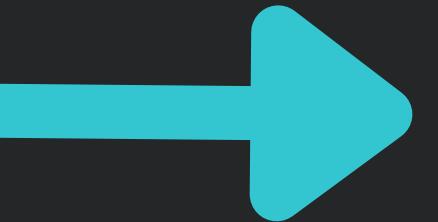


Gong Jiayu YD0443

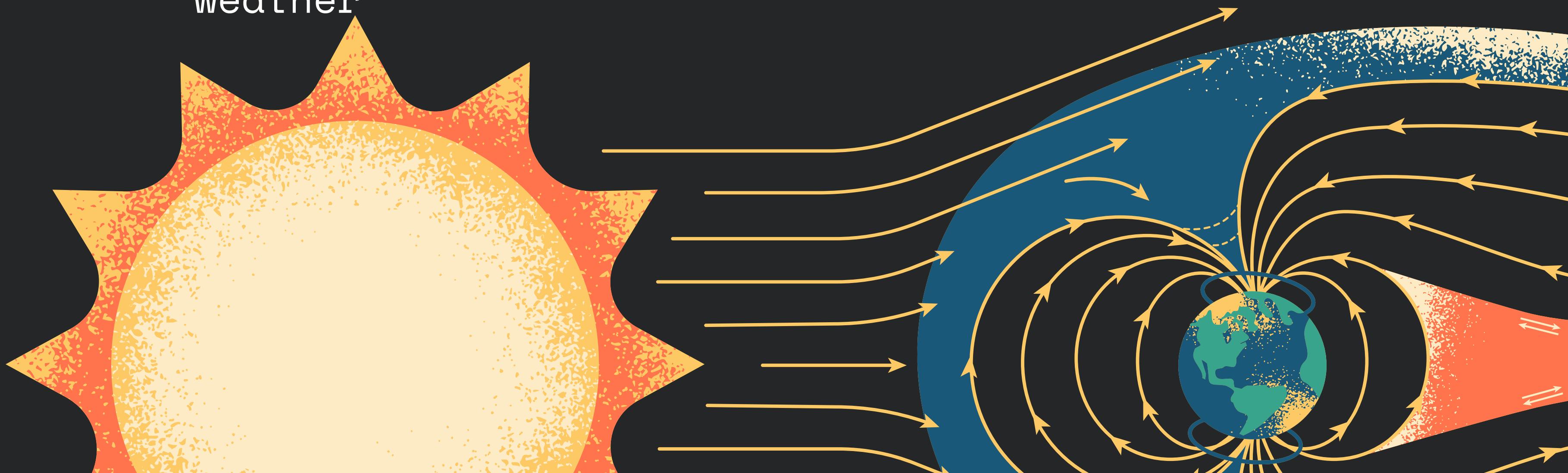
# CAN SUNSPOTS INFLUENCE THE VOLATILITY INDEX(VIX)?

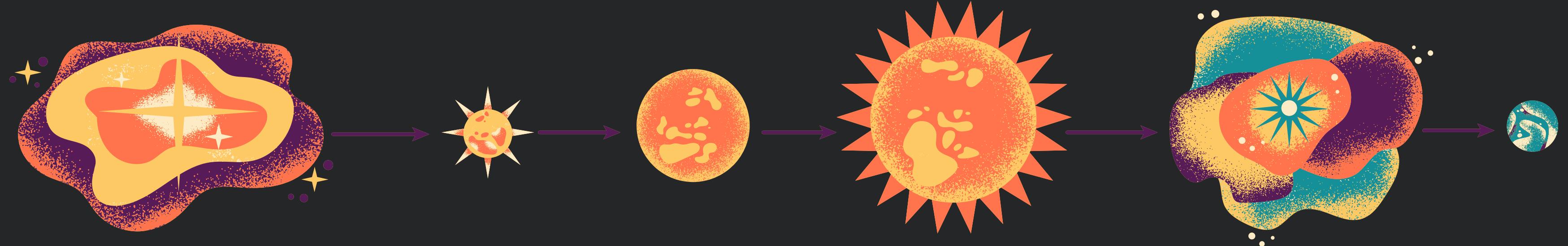
trigger geomagnetic storms  
disrupting:  
radio communication  
power grids  
navigation systems

weather



may influence human behavior  
and market sentiment  
market enthusiasm or anxiety  
influencing trading volumes  
and price movements





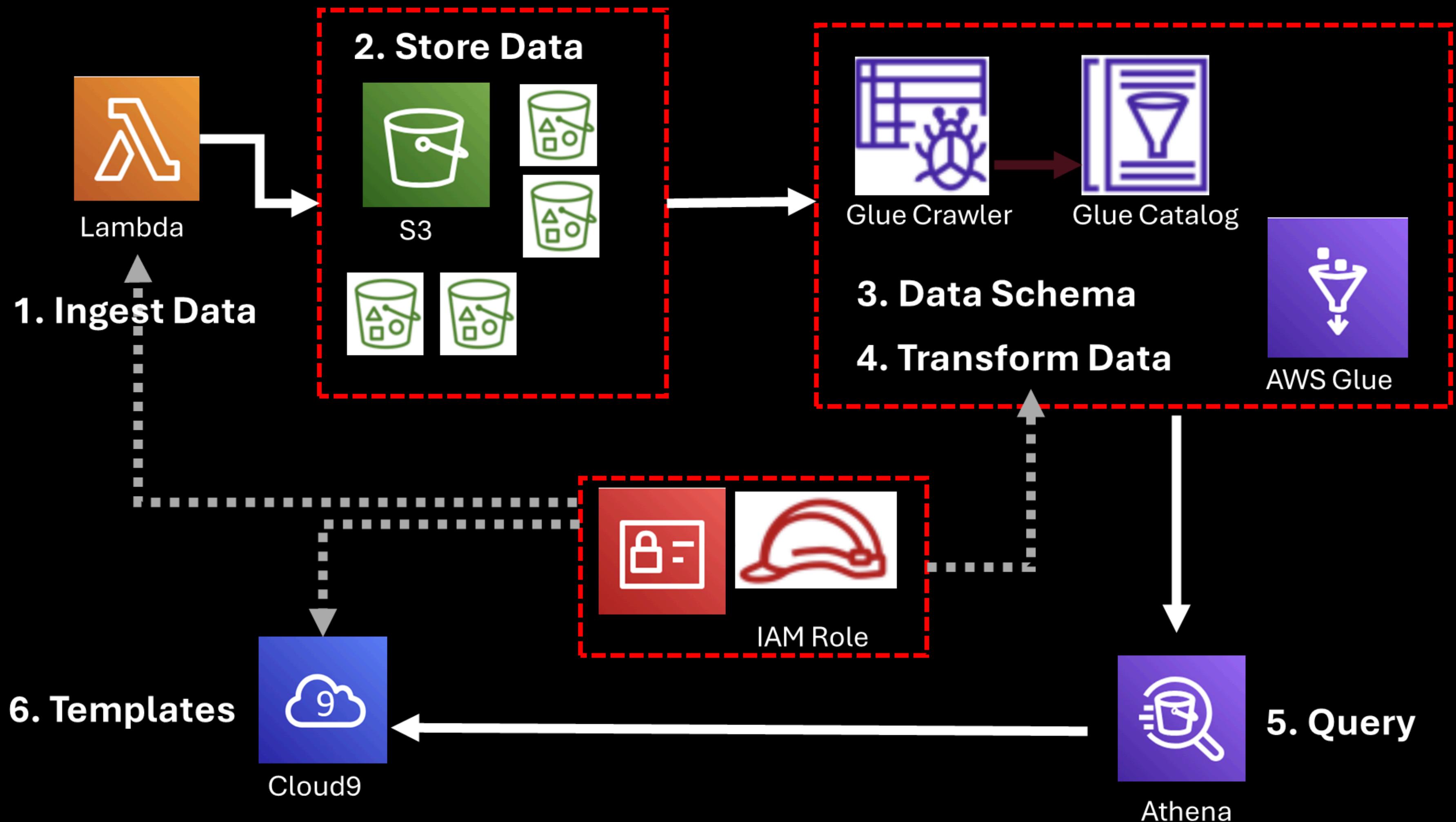
## STAKEHOLDERS

- Market and risk analysts
- Quantitative researchers
- Investors
- Academic researchers

## BUSINESS VALUE

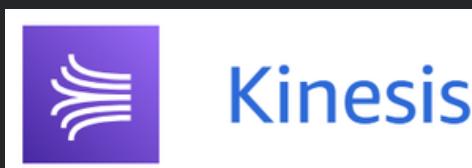
- Enhancing risk awareness by analyzing potential external indicators of market uncertainty
- Assisting decision-makers in determining whether solar activity data should be incorporated into market volatility.

**DATA  
PIPELINE**



# DATA

- Sunspot Data from SILSO (Sunspot Index and Long-term Solar Observations)
- VIX Through FRED API from Yahoo Finance



higher cost  
do not demand continuous real-time streaming

**sunspotbucket** Info

Objects    Metadata    Properties    Permissions

**Objects (1)**

Name	Type
<a href="#">sunspot_daily.parquet</a>	parquet

Objects are the fundamental entities stored in Amazon S3. To access your objects, you'll need to explicitly grant them permission.

Find objects by prefix

**vix/**

Objects    Properties

**Objects (1)**

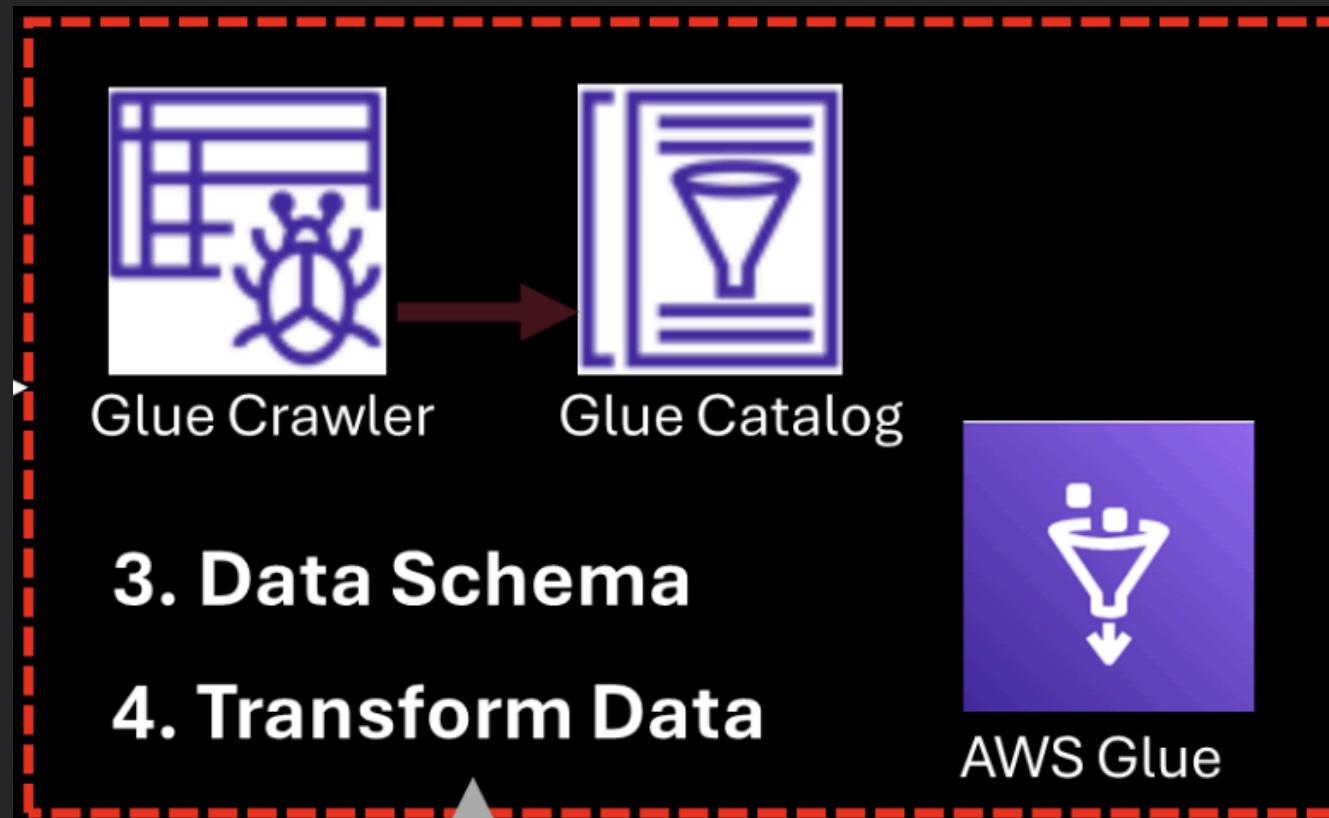
Name	Type
<a href="#">vix_daily.parquet</a>	parquet

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Find objects by prefix

**TO OPTIMIZE ANALYTICAL QUERIES AND JOINS**

# DATA SCHEMA



**Schema (2)**  
View and manage the table schema.

*Filter schemas*

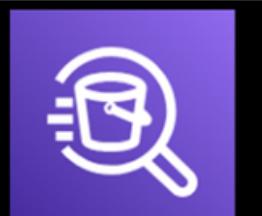
#	Column name	Data type
1	date	timestamp
2	vix_close	double

**Schema (2)**  
View and manage the table schema.

*Filter schemas*

#	Column name	Data type
1	date	date
2	sunspot_number	double

# QUERY



Athena

## 5. Query

```
1 SELECT
2     CAST(v.date AS DATE) AS date,
3     v.vix_close,
4     s.sunspot_number
5 FROM market_data.vix_daily v
6 LEFT JOIN market_data.sunspot_daily s
7     ON CAST(v.date AS DATE) = s.date
8 ORDER BY date
9 LIMIT 10;
```

```
1 CREATE EXTERNAL TABLE market_data.vix_daily (
2     date TIMESTAMP,
3     vix_close DOUBLE
4 )
5 STORED AS PARQUET
6 LOCATION 's3://vixdatabucket/vix/';
7
```

```
1 CREATE EXTERNAL TABLE market_data.sunspot_daily (
2     date DATE,
3     sunspot_number DOUBLE
4 )
5 STORED AS PARQUET
6 LOCATION 's3://sunspotbucket/sunspot/';
```

### Results (10)

Copy

#	date	vix_close	sunspot_number
1	2007-01-03	12.04	44.0
2	2007-01-04	11.51	44.0
3	2007-01-05	12.14	49.0
4	2007-01-08	12.0	52.0
5	2007-01-09	11.91	47.0
6	2007-01-10	11.47	42.0
7	2007-01-11	10.87	40.0
8	2007-01-12	10.15	28.0
9	2007-01-15	10.445	19.0
10	2007-01-16	10.74	19.0

# TEMPLATE

**Enables reproducible, cross-environment deployment**

**IAM Console → Roles → gluelab → Summary → ARN**

**market\_data\_crawlers.yml**

**CloudFormation stack**

✖ There was an error creating the IAM resources needed for SSM connection.

✖ You don't have the permission required to perform this operation. Ask your administrator to give you permissions.

✖ User: arn:aws:sts::703307606050:assumed-role/voclabs/user4414459=Jiayu\_Gong is not authorized to perform: iam:CreateRole on resource: arn:aws:iam::703307606050:role/service-role/AWSCloud9SSMAccessRole because no identity-based policy allows the iam:CreateRole action

**6. Templates**



Cloud9

# KEY PERFORMANCE INDICATOR



# VIX Level and Volatility on Sunspot Regimes

$$R_t = \begin{cases} \text{HIGH\_SUNSPOT}, & \text{if } SN_t \geq q_{0.75}^{SN}, \\ \text{LOW\_SUNSPOT}, & \text{if } SN_t < q_{0.75}^{SN}. \end{cases}$$

sunspot_regime	obs	avg_vix	vix_std
HIGH_SUNSPOT	1239	17.874	5.885
LOW_SUNSPOT	3717	20.431	9.464

Periods of high sunspot activity are associated with lower levels and lower dispersion of the VIX. Market volatility is lower and more stable during high-sunspot periods.

# Extreme Market Fear Probability under High Sunspot Activity

$$\text{extreme\_vix}_t = \begin{cases} 1, & \text{if } VIX_t \geq VIX_{95} \\ 0, & \text{otherwise} \end{cases}$$

$$\text{high\_sunspot}_t = \begin{cases} 1, & \text{if } Sunspot_t \geq Sunspot_{75} \\ 0, & \text{otherwise} \end{cases}$$

$P(\text{Extreme } VIX_t = 1 \mid \text{Sunspot Regime}_t)$

**Results (2)**

< 1 > ⚙️

#	high_sunspot	total_days	extreme_days	extreme_probability
1	0	3717	225	0.06053268765133172
2	1	1239	21	0.01694915254237288

**Extreme market fear occurs much more often when sunspot activity is low.**

# Volatility Persistence under Sunspot Regimes

$VIX_t \geq 75\text{th percentile of historical VIX}$

$$N_r = \sum_k \mathbf{1}(\text{run}_k \in r)$$

$$\bar{L}_r = \frac{1}{N_r} \sum_{k \in r} L_k$$

sunspot_regime	num_runs	avg_run_length
HIGH_SUNSPOT	26	6.769
LOW_SUNSPOT	94	11.181

**Low sunspot periods are associated not only with higher and more volatile VIX levels, but also with more persistent high-volatility episodes.**

# COST

Monthly cost

3.18 USD

Total 12 months cost

**38.16 USD**

Includes upfront cost

Service Name	Status	Upfront cost	Monthly cost
AWS Lambda	-	0.00 USD	0.00 USD
Amazon Simple Storage ...	-	0.00 USD	0.02 USD
AWS Glue	-	0.00 USD	1.10 USD
Amazon Athena	-	0.00 USD	0.22 USD
AWS CloudFormation	-	0.00 USD	1.84 USD

**Most services (Lambda, S3)  
incur minimal or near-zero cost**

**The architecture is cost-efficient and suitable  
for small-scale research projects**



## Limitations and Future Improvements

This study does not claim causality, but examines empirical co-movements between solar activity and market volatility.

Results may be sensitive to threshold choices (e.g., 75th or 95th percentiles).

The use of SQL-based aggregation limits the ability to do time series model

Apply formal time-series frameworks, such as Cointegration model, Granger causality or VAR models



# THANKS

