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CTO at **Dataddo**

pgq

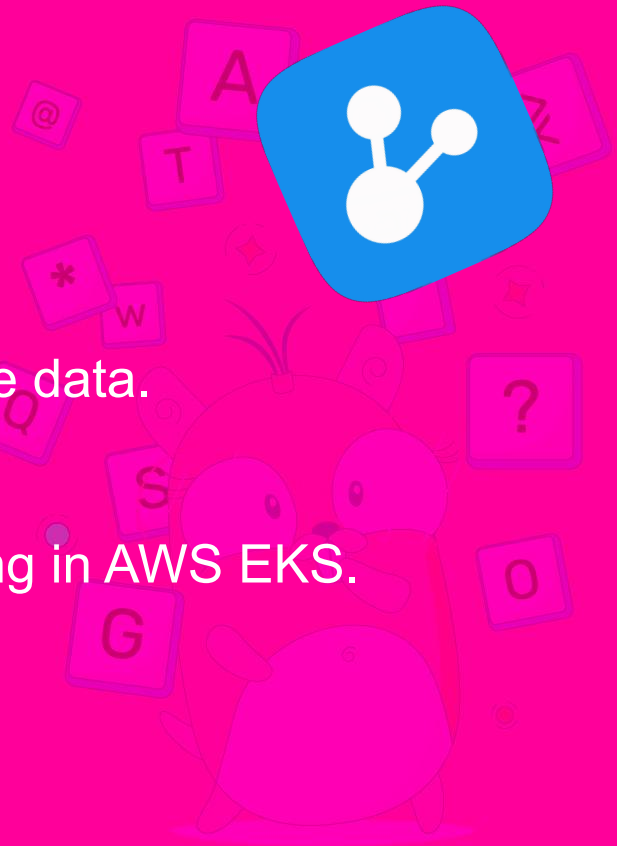
postgre queues

DATADDO

A data integration platform.

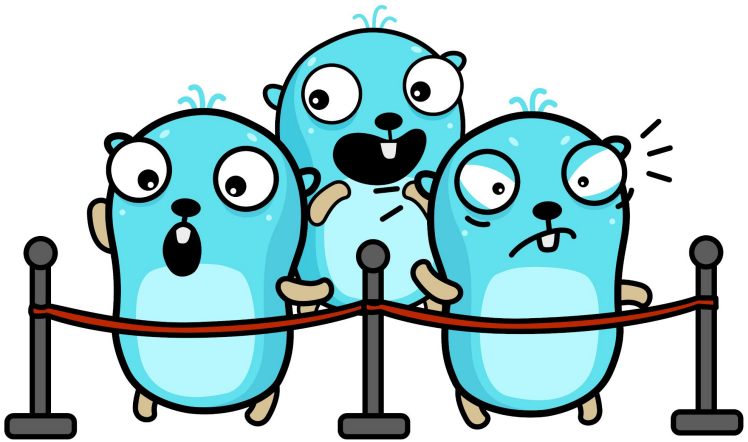
Extracting, Transforming and Loading the data.
databases, http, file storages, webhooks

Composed of various Go services running in AWS EKS.



QUEUES

The purpose of the queues in the SW design



- **Communication** channel
- Task **scheduling**
- **Background** processing (asynchronous)
- Load **balancing** (overload prevention)
- **Throttling** and rate limiting
- Handling **peak loads**, **Scalability**, **Event-driven** architecture, Task **distribution, Fault** tolerance with retries

and much more...

Available Open Source

MESSAGE QUEUES [BROKERS]

- RabbitMQ (`www.rabbitmq.com`)
- Apache Kafka (`kafka.apache.org`)
- Apache ActiveMQ (`activemq.apache.org`)
- NATS (`nats.io`)
- NSQ (`nsq.io`)
- Redis (`redis.io`)
- Amazon SQS, Google Cloud Pub/Sub, ...

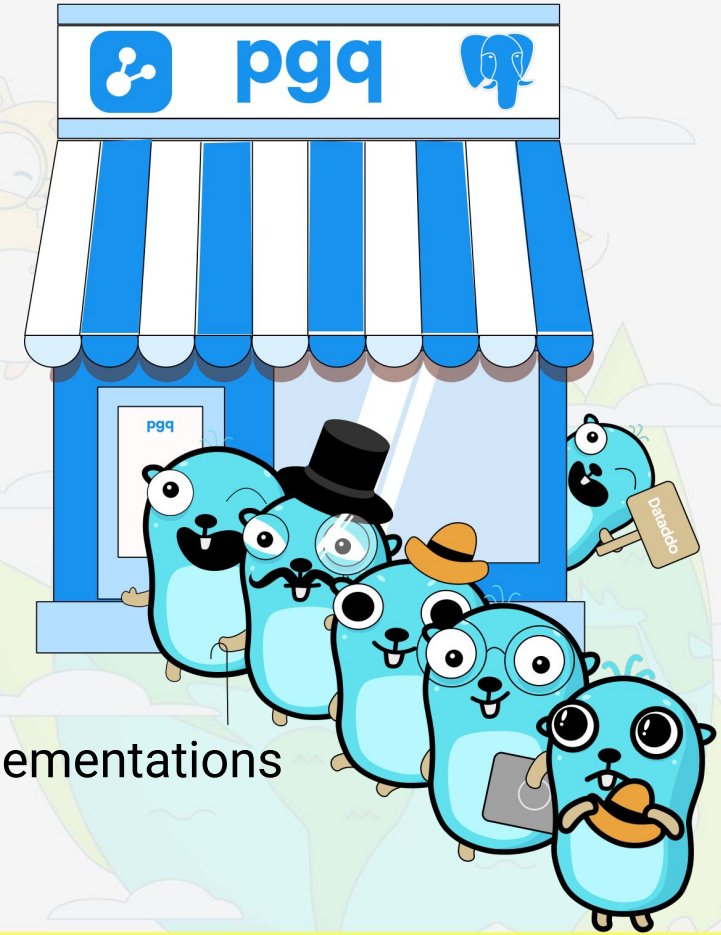
and much more...

what is the

pgq

`go.dataddo.com/pgq`

- **Open** source **go** package
- **Queues** on top of **postgres**
- Uses regular **SQL** statements
- Reliable and easily observable
- Basic **consumer** and **publisher** implementations



Why to use pgq?

- **postgres** just works!
- **postgres** is feature rich, scalable and performant
- **SQL** (your developers already know SQL, right?)
- **simple stack** (no need for maintaining additional component/technologies)
- **universally usable** for many scenarios

When to pick pgq ?

(satisfaction guaranteed)

- You want to build **resilient systems**
- You are already using **postgres** in your **stack**
- You do not want to **administer** another technology
- You want to easily **observe** the queues
- Your message rate is not measured in billions

Where do we use pgq in Dataddo ?

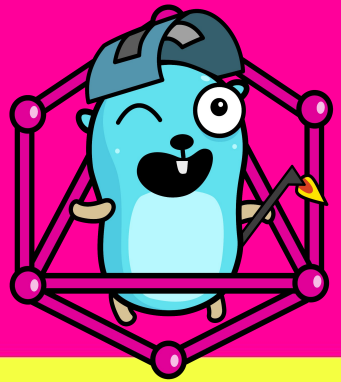
- Consumers of the **long-running** jobs
  loading & writing & processing data
  [200k+ of such jobs a day]
- Consumers of the **short** jobs
  sending emails & saving logs & updating entities
  [1000k+ of such jobs a day]
- Asynchronous apps **communication**
  go & php & node.js
- **Monitoring** of our platform
  consumers rate & errors & peaks
  [AWS RDS cluster 2x db.r6g.large, 2cpu & 16gb ram]

Creating the

Queue/Table

Every **queue** is just the single postgres **table**.

Table has index for better performance.



```
CREATE TABLE IF NOT EXISTS my_queue
(
  id UUID DEFAULT,
  created_at TIMESTAMPTZ NOT NULL,
  started_at TIMESTAMPTZ NULL,
  locked_until TIMESTAMPTZ NULL,
  processed_at TIMESTAMPTZ NULL,
  consumed_count INTEGER,
  error_detail TEXT NULL,
  payload JSONB NOT NULL,
  metadata JSONB NOT NULL
);

CREATE INDEX IF NOT EXISTS my_index
ON my_queue(processed_at)
WHERE (processed_at IS NULL);
```

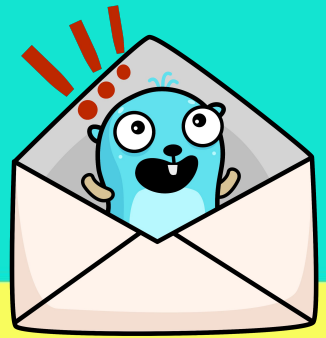
The message

The message is the single row/record in the queue table.

The processed messages are kept in the queue.

```
type Message interface {
    Metadata() map[string]string
    Payload() json.RawMessage
}
```

id	payload	metadata	created at	locked until	processed at	started at	error detail	consumed
UUID	JSON	JSON	Timestamp	Timestamp	Timestamp	Timestamp	String	Int
a0…	{foo:bar…}	{}	2023-…	2023-…	null	2023-…	null	1
e7…	{baz:bat}	null	2023-…	null	null	null	null	0
d2…	{go:lang…}	{o:1…}	2023-…	null	2023-…	2023-…	null	1
b6…	{lan:go…}	null	2023-…	null	2023-…	2023-…	null	1
b6…	{lag:ja…}	{f:1…}	2023-…	null	2023-…	2023-…	null	1



creating the

Publisher

Publish message which contains metadata and payload, the consumer understands.

Note: In fact the publisher just publishes the new row to the postgres table.

```
db, _ := sql.Open("postgres", dsn)
pub := pgq.NewPublisher(db)

payload := json.RawMessage(
    `{"foo":"bar"}`
)
msg := pgq.NewMessage(nil, payload)

pub.Publish(ctx, "my_queue", msg)
```

creating the

Consumer

Consumer searches for the messages to be processed in the queue. It updates the rows when the message is processed.

```
db, _ := sql.Open("postgres", dsn)
consumer := pgq.NewConsumer(
    db,
    "my_queue",
    myHandler,
)

consumer.Run(ctx)
```

creating the

Consumer handler

Handler treats the message and sets the result.

Note: The handler is your own struct and it can contain whatever custom logic you have in order to process the message.

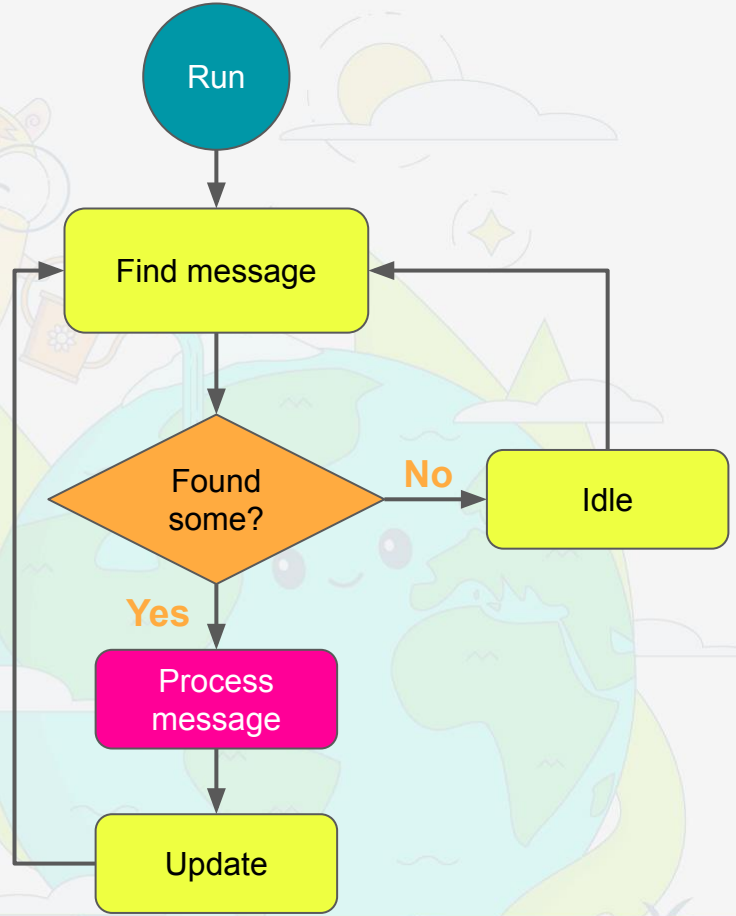
```go
type handler struct {}

func (h *handler) HandleMessage(
  _ context.Context,
  msg pgq.Message,
)(processed bool, err error) {
     fmt.Println(string(msg.Payload()))

     return true, nil
}
```

processed	err	description
false	<nil>	missing failure info, but the message can be retried
false	some error	not processed, because of some error, can be retried
true	<nil>	processed, no error.
true	some error	processed, ended with error. Don't retry!

Lifecycle

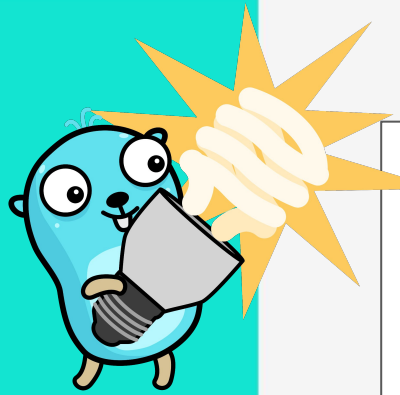
Every **consumer polls** the queue **table** in the given intervals and searches for the messages to process.

When there is no yet unprocessed message, it **idles** for a while and retries again.



consumer query to

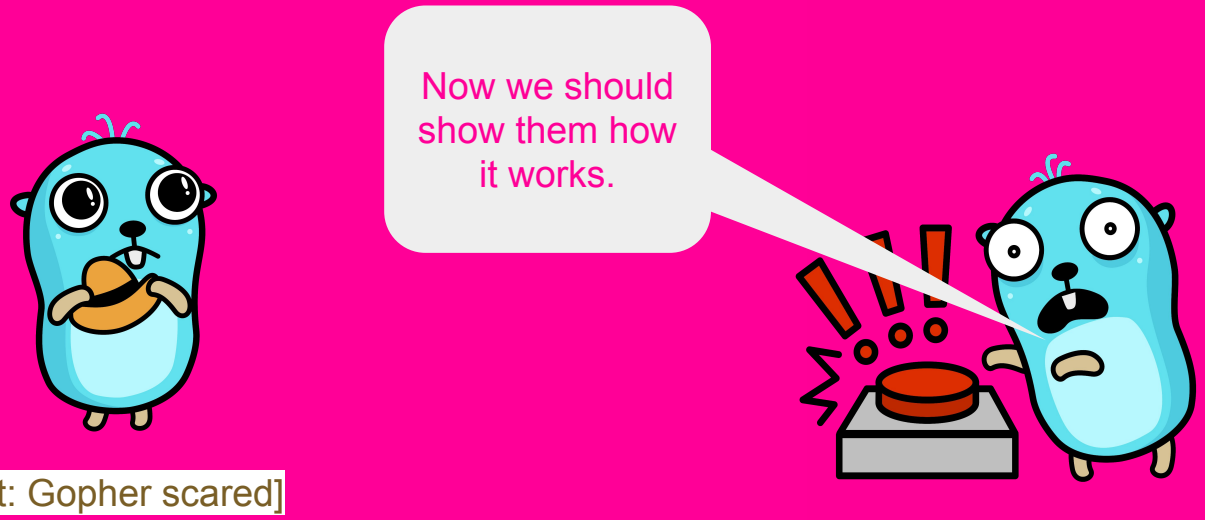
- Find message



FOR UPDATE SKIP LOCKED is useful in situations where multiple transactions are trying to update the same set of rows simultaneously. It locks the selected rows but skips over any rows already locked by other transactions, thereby reducing the likelihood of deadlocks.

```
UPDATE "my_queue"
  SET
    locked_until = $1,
    started_at = CURRENT_TIMESTAMP,
  WHERE id IN (
    SELECT id FROM "my_queue"
    WHERE (
      locked_until IS NULL OR
      locked_until < CURRENT_TIMESTAMP
    )
    AND processed_at IS NULL
    ORDER BY
      created_at ASC LIMIT $2
    FOR UPDATE SKIP LOCKED
  )
RETURNING id, payload, metadata;
```

Demo time



[alt: Gopher scared]

prerequisite

running Postgres

You can try it on your own machines too.

https://github.com/dataddo/pgq-demo

Note: You need to have the running postgre db available for the demo.

*Please see the **Makefile** in the **pgq-demo** repository to get started.*

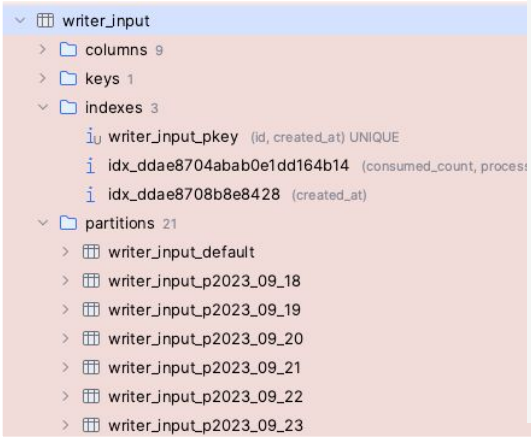
```
docker run
--name pgq-postgres
-e POSTGRES_USER=pgq
-e POSTGRES_PASSWORD=pgq
-p 5432:5432
-d
postgres:16.0
```

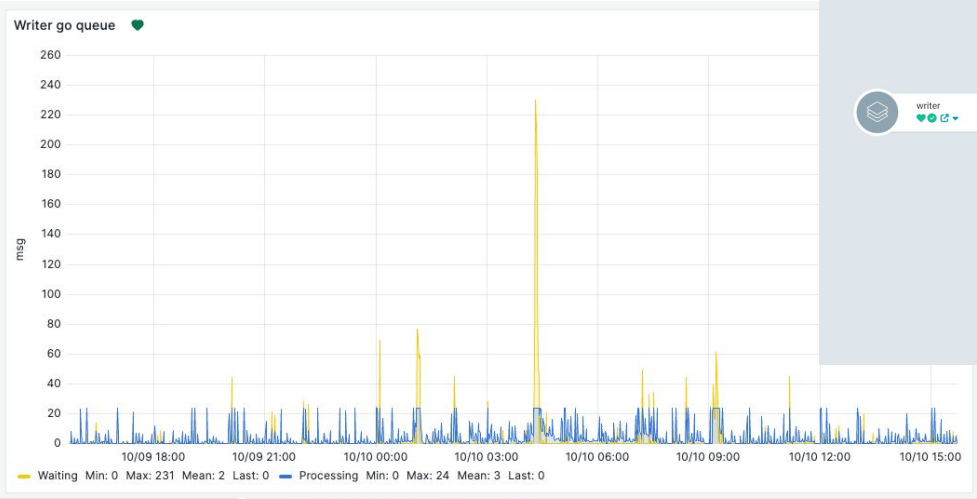
Recommendations

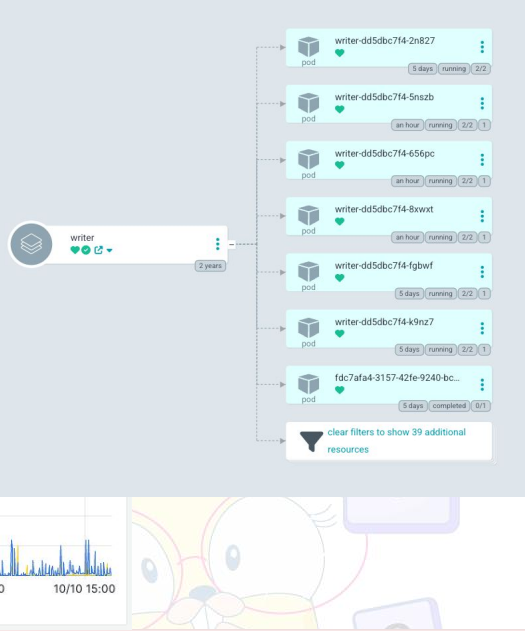
Following these principles will make your pgq usage smooth.

- Keep table **index**
- Configure the **consumer options** according to your concrete needs
  [lock duration, polling interval, max parallel]
- Enable table **partitioning** or clear old messages when you do not need it.
- **Observe** the **queue size**, setup alerts
- **Observe** the **errors** to detect application failures and bugs in your code
- Kubernetes **autoscaling** using **Keda**

HOW DOES IT LOOK LIKE IN A REAL LIFE?








```
ORDER BY created_at desc
```

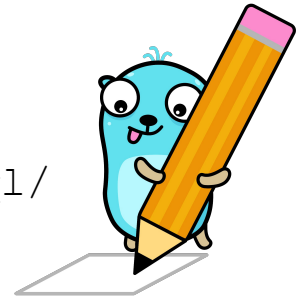
	id	created_at	payload	metadata	locked_until	processed_at	error_detail	started_at	consumed_count
1	bd294543-8eba-…	2023-10-10 13:40:02…	{"dpi": {"sources": [{"id": "6516c80cc09	{"app": "api-php", "actionId": "6516c85	2023-10-10 14:40…	<null>	<null>	2023-10-10 13:40:03 +00:00	1
2	ee7fd0d3-f069-…	2023-10-10 13:35:45…	{"config": {"config": {"table": "realtim	{"app": "dpi", "host": "dpi-6749595495-	<null>	2023-10-10 13:35:54 +00:00	<null>	2023-10-10 13:35:47 +00:00	1
3	37b9cba1-69d2-…	2023-10-10 13:35:41…	{"dpi": {"sources": [{"id": "6501820609d	{"app": "api-php", "actionId": "650187b	<null>	2023-10-10 13:36:19 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
4	2b9c5c03-255d-…	2023-10-10 13:35:40…	{"dpi": {"sources": [{"id": "64526cecbf0	{"app": "api-php", "actionId": "64526d4	<null>	2023-10-10 13:36:55 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
5	c8cbbdca-940f-…	2023-10-10 13:35:40…	{"dpi": {"sources": [{"id": "64229fe9da0	{"app": "api-php", "actionId": "6422a17	<null>	2023-10-10 13:35:51 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
6	19331123-f296-…	2023-10-10 13:35:40…	{"dpi": {"sources": [{"id": "6492aed5103	{"app": "api-php", "actionId": "64c773e	<null>	2023-10-10 13:35:42 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
7	70fd7c2a-6c85-…	2023-10-10 13:35:40…	{"dpi": {"sources": [{"id": "613b2de2720	{"app": "api-php", "actionId": "613b2e0	<null>	2023-10-10 13:35:42 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
8	4a228af2-73cc-…	2023-10-10 13:35:40…	{"dpi": {"sources": [{"id": "6333fcff8b6	{"app": "api-php", "actionId": "633412b	2023-10-10 14:35…	<null>	<null>	2023-10-10 13:35:42 +00:00	1
9	786f83ef-545a-…	2023-10-10 13:35:40…	{"dpi": {"sources": [{"id": "6333ff7624a	{"app": "api-php", "actionId": "6334123	<null>	2023-10-10 13:36:17 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
10	19f92a74-cad0-…	2023-10-10 13:35:39…	{"dpi": {"sources": [{"id": "612ce38b99c	{"app": "api-php", "actionId": "612ce3c	<null>	2023-10-10 13:35:42 +00:00	<null>	2023-10-10 13:35:42 +00:00	1
11	c9c8cfd1-20d4-…	2023-10-10 13:35:39…	{"dpi": {"sources": [{"id": "63584feeafd	{"app": "api-php", "actionId": "6358504	<null>	2023-10-10 13:35:42 +00:00	<null>	2023-10-10 13:35:39 +00:00	1

Links and resources

PGQ:
`go.dataddo.com/pgq`
`github.com/dataddo/pgq-demo`

Gopher images and icons:
`github.com/MariaLetta/free-gophers-pack`

KEDA PostgreSQL:
`https://keda.sh/docs/2.12/scalers/postgresql/`



TOMAS SEDLACEK

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Presentation slides buffer

The following slides will be used only in case of enough free time at the end of the presentation.

Inspecting the queue table

SELECT * FROM my_queue;

id	payload	metadata	created at	locked until	processed at	started at	error detail	consumed
UUID	JSON	JSON	Timestamp	Timestamp	Timestamp	Timestamp	String	Int
a0…	{foo:bar…}	{}	2023-…	2023-…	null	2023-…	null	1
e7…	{baz:bat}	null	2023-…	null	null	null	null	0
d2…	{go:lang…}	{o:1…}	2023-…	null	2023-…	2023-…	null	1
b6…	{lan:go…}	null	2023-…	null	2023-…	2023-…	null	1
b6…	{lag:ja…}	{f:1…}	2023-…	null	2023-…	2023-…	null	1

The message struct

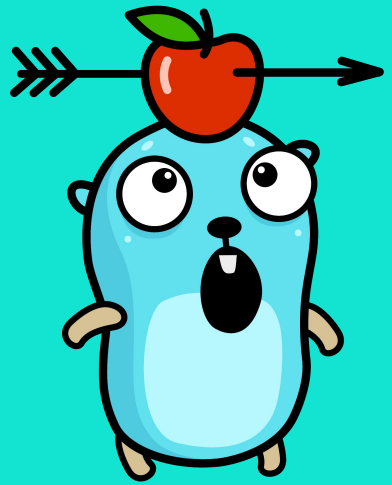
Under the hood the message contains the fields and functions necessary for operating pgq.

```
type message struct {
  id uuid.UUID
  metadata map[string][string]
  payload json.RawMessage
  once sync.Once
  ackFn func(ctx Context) error
  nackFn func(Context, string) error
  discardFn func(Context, string) error
}
```

pgq consumer

Finish queries

When the message is processed (ack/nack)



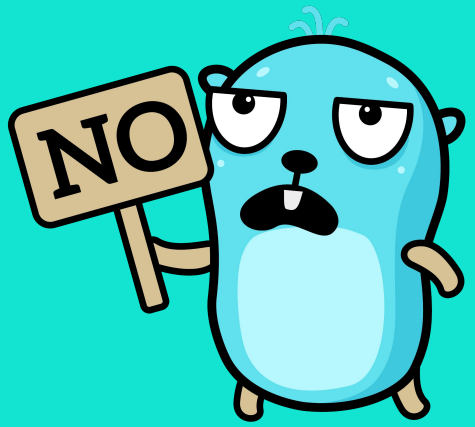
```
# Ack [acknowledge] when all went fine:
UPDATE my_queue
   SET
     locked_until = NULL,
     processed_at = CURRENT_TIMESTAMP
   WHERE id = $1;


# Nack: when something went wrong:
UPDATE my_queue
   SET
     locked_until = NULL,
     error_detail = $2
WHERE id = $1;
```

pgq consumer

Reject query

Discard the message when it is not valid.



Discard [reject] on invalid message:

```
UPDATE my_queue
  SET
    locked_until = NULL,
    processed_at = CURRENT_TIMESTAMP,
    error_detail = $2
  WHERE id = $1;
```