Let's build a name generator using LSTM. Topic is Dinosaurus name!!!

In [1]:
```python
# IMPORTANT: if set return_seq=True attr of LSTM will return a tensor of shape (batch_size, seq_len, feature)
#                otherwise, shape = (batch_size, feature)
```

Import necessary libraries

In [2]:
```python
import numpy as np

import os
import json

from tqdm import tqdm

%matplotlib inline
import matplotlib.pyplot as plt

import tensorflow as tf
import tensorflow.keras.layers as layers
import tensorflow.keras.utils as utils
```

Setup

In [3]:
```python
# Download dinosaurus name dataset
!wget --no-check-certificate 'https://drive.google.com/uc?export=download&id=1t1XTlM8cOMqD3uicQ7dpLLnwbKOH6FoU' -O dino.txt
```

```
--2024-03-23 11:25:04--  https://drive.google.com/uc?export=download&id=1t1XTlM8cOMqD3uicQ7dpLLnwbKOH6FoU
Resolving drive.google.com (drive.google.com)... 74.125.196.100, 74.125.196.101, 74.125.196.113, ...
Connecting to drive.google.com (drive.google.com)|74.125.196.100|:443... connected.
HTTP request sent, awaiting response... 303 See Other
Location: https://drive.usercontent.google.com/download?id=1t1XTlM8cOMqD3uicQ7dpLLnwbKOH6FoU&export=download [following]
--2024-03-23 11:25:04--  https://drive.usercontent.google.com/download?id=1t1XTlM8cOMqD3uicQ7dpLLnwbKOH6FoU&export=download
Resolving drive.usercontent.google.com (drive.usercontent.google.com)... 108.177.13.132, 2607:f8b0:400c:c09::84
Connecting to drive.usercontent.google.com (drive.usercontent.google.com)|108.177.13.132|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 19909 (19K) [application/octet-stream]
Saving to: ‘dino.txt’

dino.txt            100%[===================>]  19.44K  --.-KB/s    in 0s

2024-03-23 11:25:05 (86.1 MB/s) - ‘dino.txt’ saved [19909/19909]
```

In [267…
```python
# Model params and hyperpaprams
BUFFER_SIZE = 1024
BATCH_SIZE = 64
embedding_size = 256
hidden_units = 128
```

Inspect the data

In [5]:
```python
# Read data
with open("dino.txt", "r") as f:
    raw = f.read().lower()

vocab = ['\n', 'a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j', 'k', 'l', 'm', 'n', 'o', 'p', 'q', 'r', 's', 't', 'u',
         'v', 'w', 'x', 'y', 'z', ' ']
vocab_size = len(vocab)
```

In [6]:
```python
# Prepare dataset
context = []
target = []

for name in raw.split("\n"):
    context.append(name)
    target.append(name[1:] + "\n")
```

In [7]:
```python
# Let's take a look at the dataset. Notice that the end token is "\n"
for i in range(10):
    print("{:24s}    {:24s}".format(context[i], target[i]))
```

```
aachenosaurus               achenosaurus

aardonyx                    ardonyx

abdallahsaurus              bdallahsaurus

abelisaurus                 belisaurus

abrictosaurus               brictosaurus

abrosaurus                  brosaurus

abydosaurus                 bydosaurus

acanthopholis               canthopholis

achelousaurus               chelousaurus

acheroraptor                cheroraptor
```

Since the number of samples in dinosaurus name dataset is small, only 1536 samples, another dataset on Latin name of Vertebrate class will be used as the context dataset. The dataset is downloaded from gitHub.

In [8]:
```python
!git clone https://github.com/species-names/dataset.git
```

```
Cloning into 'dataset'...
remote: Enumerating objects: 5591, done.
remote: Counting objects: 100% (1613/1613), done.
remote: Compressing objects: 100% (1240/1240), done.
remote: Total 5591 (delta 1442), reused 502 (delta 364), pack-reused 3978
Receiving objects: 100% (5591/5591), 3.17 MiB | 12.10 MiB/s, done.
Resolving deltas: 100% (4865/4865), done.
```

This dataset is organized as JSON files. Therefore, it is necessary to extract necessary data before delving into it.

In [9]:
```python
data_path = "/content/dataset/data/Vertebrata"
animal_classes = os.listdir(data_path)

pretrain_context = []
pretrain_target = []

for cls in animal_classes:
    cls_path = os.path.join(data_path, cls)
    species = os.listdir(cls_path)

    for s in species:
        species_path = os.path.join(cls_path, s)

        with open(species_path, "r") as f:
            data = json.load(f)

        for obj in data:
            pretrain_context.append(obj["scientific_name"])
            pretrain_target.append(obj["scientific_name"][1:] + "\n")
```

In [10]:
```python
# Let's take a look at the pretrain dataset. Notice that the end token is "\n"
for i in range(10):
    print("{:28s}    {:28s}".format(pretrain_context[i], pretrain_target[i]))
```

```
Phasmatonycteris phiomensis     hasmatonycteris phiomensis

Phasmatonycteris butleri        hasmatonycteris butleri

Mammut giganteus                ammut giganteus

Mammut americanus               ammut americanus

Rucervus schomburgk             ucervus schomburgk

Rucervus duvaucelii             ucervus duvaucelii

Moschus moschiferus             oschus moschiferus

Moschus leucogaster             oschus leucogaster

Moschus fuscus                  oschus fuscus

Moschus cupreus                 oschus cupreus
```

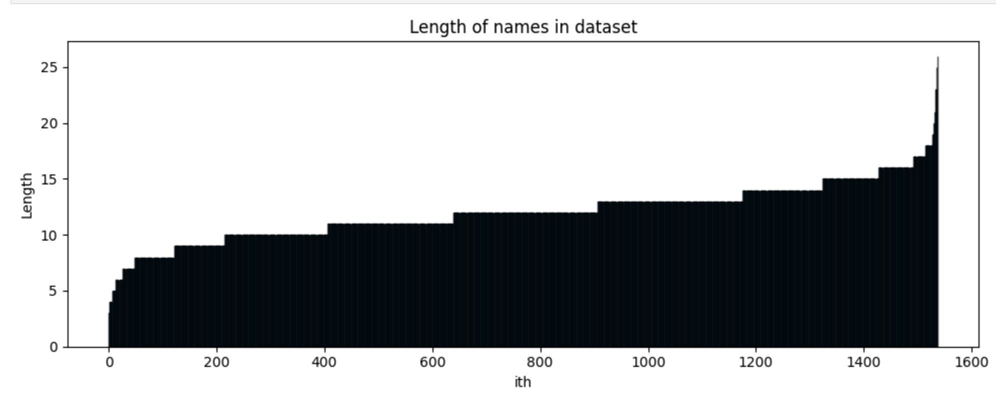
In [11]:
```python
src_len = [len(i) for i in sorted(context, key=len)]
time_periods = range(1, len(src_len) + 1)

fig, axs = plt.subplots(1, 1, figsize=(10, 4))  # Adjust figsize as needed

# Create the second bar plot
axs.bar(time_periods, src_len, alpha=0.7, edgecolor='black')
axs.set_title('Length of names in dataset')
axs.set_xlabel('ith')
axs.set_ylabel('Length')

# Adjust spacing between subplots
plt.tight_layout()

# Show the subplots
plt.show()
```



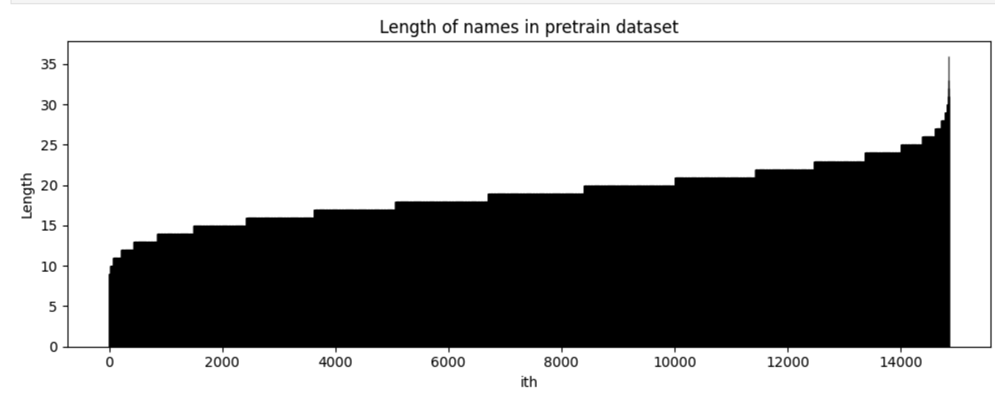
In [13]:
```python
src_len = [len(i) for i in sorted(pretrain_context, key=len)]
time_periods = range(1, len(src_len) + 1)

fig, axs = plt.subplots(1, 1, figsize=(10, 4))  # Adjust figsize as needed

# Create the second bar plot
axs.bar(time_periods, src_len, alpha=0.7, edgecolor='black')
axs.set_title('Length of names in pretrain dataset')
axs.set_xlabel('ith')
axs.set_ylabel('Length')

# Adjust spacing between subplots
plt.tight_layout()

# Show the subplots
plt.show()
```



Tokenization

As computer cannot handle text, we need to convert them to numeric representation. In the case of Dinosaurus Name Generation, we will use the character-based tokenization.

In [12]:
```python
tokenizer = layers.StringLookup(vocabulary=list(vocab))
chars_from_ids = layers.StringLookup(
    vocabulary=list(vocab), invert=True)
```

In [13]:
```python
def tokenize_by_character(dataset):
    return list(map(lambda x: tokenizer(list(x)), dataset))

tokenized_context = tokenize_by_character(context)
tokenized_target = tokenize_by_character(target)
tokenized_pretrain_context = tokenize_by_character(pretrain_context)
tokenized_pretrain_target = tokenize_by_character(pretrain_target)
```

In [14]:
```python
# Padding
max_len_dataset = max(len(i) for i in tokenized_context)
max_len_pretrain = max(len(i) for i in tokenized_pretrain_context)

padded_context = utils.pad_sequences(tokenized_context, max_len_dataset, padding="post")
padded_target = utils.pad_sequences(tokenized_target, max_len_dataset, padding="post")
padded_pretrain_context = utils.pad_sequences(tokenized_context, max_len_pretrain, padding="post")
padded_pretrain_target = utils.pad_sequences(tokenized_target, max_len_pretrain, padding="post")

# Convert dataset to tf.data.Dataset
dataset = (
    tf.data.Dataset
    .from_tensor_slices((padded_context, padded_target))
    .shuffle(BUFFER_SIZE)
    .batch(BATCH_SIZE, drop_remainder=True)
    .prefetch(tf.data.experimental.AUTOTUNE)
)

pretrain_dataset = (
    tf.data.Dataset
    .from_tensor_slices((padded_pretrain_context, padded_pretrain_target))
    .shuffle(BUFFER_SIZE)
    .batch(BATCH_SIZE, drop_remainder=True)
    .prefetch(tf.data.experimental.AUTOTUNE)
)
```

Model

This name generator model uses LSTM which predicts next character from previous inputs.

In [317…
```python
@tf.keras.utils.register_keras_serializable()
class Generator(tf.keras.Model):
    @classmethod
    def add_method(cls, fun):
        setattr(cls, fun.__name__, fun)
        return fun

    def __init__(self,
                 vocab_size,
                 embedding_size,
                 hidden_units):
        """
            Define the Text Generator instance.

        :param vocab_size: number of unique characters in vocabulary
        :param embedding_size: dimensionality of embedding layer
        :param hidden_units: dimensionality of the output
        """
        super(Generator, self).__init__()
        self.embedding_size = embedding_size
        self.hidden_units = hidden_units
        self.embedding = layers.Embedding(input_dim=vocab_size + 1,
                                          output_dim=embedding_size,
                                          mask_zero=True)
        self.lstm = layers.LSTM(units=hidden_units,
                                return_sequences=True,
                                return_state=True)
        self.dense = layers.Dense(units=vocab_size)

    def call(self,
             x,
             training=False,
             return_state=False,
             **kwargs):
        """
            Generate a new character.

        :param inputs: inputs
        """
        x = self.embedding(x)
        states, h, c = self.lstm(x, training=training,
                                 **kwargs)

        if return_state:
            return states, h, c
        else:
            return states
```

In [318…
```python
@Generator.add_method
def get_initial_state(self, batch_size=1):
    zeros_tensor = tf.ones((1, self.hidden_units))
    return self.lstm.get_initial_state(zeros_tensor)
```

In [319…
```python
@tf.function
def train_step(x, y,
               model,
               loss_fn,
               optimizer):
    with tf.GradientTape() as tape:
        states = model(x, training=True)
        logits = model.dense(states)
        loss_value = loss_fn(y, logits)

        grads = tape.gradient(loss_value, model.trainable_weights)
        optimizer.apply_gradients(zip(grads, model.trainable_weights))

        return loss_value
```

In [320…
```python
def train(model,
          dataset,
          loss_fn,
          optimizer,
          epochs=40):
    """
    """

    for epoch in range(epochs):
        loss = 0
        for step, (x, y) in enumerate(tqdm(dataset)):
            loss_value = train_step(x, y,
                                    model,
                                    loss_fn,
                                    optimizer)
            loss += loss_value

        if (epoch + 1) % 10 == 0:
            print(f"Epoch: {epoch + 1}, loss = {loss}")
```

In [321…
```python
@Generator.add_method
def predict(self,
            next_char,
            maxlen=40):
    """
    """
    def sampling(states):
        logits = self.dense(states)
        probs = tf.nn.softmax(logits)
        dist = probs.numpy().squeeze()
        next_idx = np.random.choice(range(len(vocab)), p=dist)

        return next_idx

    next_char = list(next_char)
    result = next_char.copy()
    h, c = self.get_initial_state()

    for i in range(maxlen):
        if next_char != "\n":
            next_char = tokenizer(next_char)

            while np.ndim(next_char) != 2:
                next_char = tf.expand_dims(next_char, axis=0)

            states, h, c = self(next_char,
                                return_state=True,
                                initial_state=[h, c])

            # Only take the last state from inner LSTM
            next_idx = sampling(states[:, -1])
            next_char = chars_from_ids(next_idx)

            if next_char == "[UNK]":
                continue

            # Retrieve value from tensor and decode from byte to ASCII
            result.append(next_char.numpy().decode('ascii'))
        else:
            break

    result = "".join(result)

    return result
```

In [322…
```python
loss_fn = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True)
optimizer = tf.keras.optimizers.Adam()
```

In [323…
```python
g = Generator(vocab_size, embedding_size, hidden_units)
```

In [324…
```python
# Pretraining on the pretrain dataset
train(g, pretrain_dataset, loss_fn, optimizer, epochs=40)
```

```
100%|██████████| 24/24 [00:04<00:00,  5.98it/s]
100%|██████████| 24/24 [00:00<00:00, 162.06it/s]
100%|██████████| 24/24 [00:00<00:00, 173.43it/s]
100%|██████████| 24/24 [00:00<00:00, 179.25it/s]
100%|██████████| 24/24 [00:00<00:00, 180.20it/s]
100%|██████████| 24/24 [00:00<00:00, 162.60it/s]
100%|██████████| 24/24 [00:00<00:00, 108.13it/s]
100%|██████████| 24/24 [00:00<00:00, 179.25it/s]
100%|██████████| 24/24 [00:00<00:00, 181.82it/s]
100%|██████████| 24/24 [00:00<00:00, 172.11it/s]
Epoch: 10, loss = 40.45672607421875
100%|██████████| 24/24 [00:00<00:00, 179.46it/s]
100%|██████████| 24/24 [00:00<00:00, 182.55it/s]
100%|██████████| 24/24 [00:00<00:00, 168.76it/s]
100%|██████████| 24/24 [00:00<00:00, 185.22it/s]
100%|██████████| 24/24 [00:00<00:00, 172.01it/s]
100%|██████████| 24/24 [00:00<00:00, 171.79it/s]
100%|██████████| 24/24 [00:00<00:00, 172.42it/s]
100%|██████████| 24/24 [00:00<00:00, 163.34it/s]
100%|██████████| 24/24 [00:00<00:00, 179.07it/s]
100%|██████████| 24/24 [00:00<00:00, 163.90it/s]
Epoch: 20, loss = 35.133216857910156
100%|██████████| 24/24 [00:00<00:00, 177.18it/s]
100%|██████████| 24/24 [00:00<00:00, 181.83it/s]
100%|██████████| 24/24 [00:00<00:00, 176.00it/s]
100%|██████████| 24/24 [00:00<00:00, 179.06it/s]
100%|██████████| 24/24 [00:00<00:00, 174.16it/s]
100%|██████████| 24/24 [00:00<00:00, 182.17it/s]
100%|██████████| 24/24 [00:00<00:00, 165.40it/s]
100%|██████████| 24/24 [00:00<00:00, 174.71it/s]
100%|██████████| 24/24 [00:00<00:00, 174.68it/s]
100%|██████████| 24/24 [00:00<00:00, 172.97it/s]
Epoch: 30, loss = 31.369417190551758
100%|██████████| 24/24 [00:00<00:00, 168.10it/s]
100%|██████████| 24/24 [00:00<00:00, 180.61it/s]
100%|██████████| 24/24 [00:00<00:00, 189.25it/s]
100%|██████████| 24/24 [00:00<00:00, 169.36it/s]
100%|██████████| 24/24 [00:00<00:00, 180.32it/s]
100%|██████████| 24/24 [00:00<00:00, 173.26it/s]
100%|██████████| 24/24 [00:00<00:00, 172.76it/s]
100%|██████████| 24/24 [00:00<00:00, 174.13it/s]
100%|██████████| 24/24 [00:00<00:00, 167.37it/s]
100%|██████████| 24/24 [00:00<00:00, 178.12it/s]
Epoch: 40, loss = 27.889951705932617
```

In [325…
```python
train(g, dataset, loss_fn, optimizer, epochs=40)
```

```
100%|██████████| 24/24 [00:01<00:00, 14.13it/s]
100%|██████████| 24/24 [00:00<00:00, 172.89it/s]
100%|██████████| 24/24 [00:00<00:00, 177.70it/s]
100%|██████████| 24/24 [00:00<00:00, 79.44it/s]
100%|██████████| 24/24 [00:00<00:00, 113.75it/s]
100%|██████████| 24/24 [00:00<00:00, 126.51it/s]
100%|██████████| 24/24 [00:00<00:00, 119.23it/s]
100%|██████████| 24/24 [00:00<00:00, 121.32it/s]
100%|██████████| 24/24 [00:00<00:00, 116.47it/s]
100%|██████████| 24/24 [00:00<00:00, 114.36it/s]
Epoch: 10, loss = 24.584348678588867
100%|██████████| 24/24 [00:00<00:00, 103.58it/s]
100%|██████████| 24/24 [00:00<00:00, 125.45it/s]
100%|██████████| 24/24 [00:00<00:00, 176.10it/s]
100%|██████████| 24/24 [00:00<00:00, 170.24it/s]
100%|██████████| 24/24 [00:00<00:00, 176.53it/s]
100%|██████████| 24/24 [00:00<00:00, 179.15it/s]
100%|██████████| 24/24 [00:00<00:00, 174.46it/s]
100%|██████████| 24/24 [00:00<00:00, 177.78it/s]
100%|██████████| 24/24 [00:00<00:00, 178.38it/s]
100%|██████████| 24/24 [00:00<00:00, 177.42it/s]
Epoch: 20, loss = 21.648019790649414
100%|██████████| 24/24 [00:00<00:00, 162.74it/s]
100%|██████████| 24/24 [00:00<00:00, 178.67it/s]
100%|██████████| 24/24 [00:00<00:00, 172.30it/s]
100%|██████████| 24/24 [00:00<00:00, 172.39it/s]
100%|██████████| 24/24 [00:00<00:00, 170.74it/s]
100%|██████████| 24/24 [00:00<00:00, 178.47it/s]
100%|██████████| 24/24 [00:00<00:00, 174.25it/s]
100%|██████████| 24/24 [00:00<00:00, 154.71it/s]
100%|██████████| 24/24 [00:00<00:00, 170.28it/s]
100%|██████████| 24/24 [00:00<00:00, 164.49it/s]
Epoch: 30, loss = 19.080230712890625
100%|██████████| 24/24 [00:00<00:00, 165.50it/s]
100%|██████████| 24/24 [00:00<00:00, 175.62it/s]
100%|██████████| 24/24 [00:00<00:00, 176.08it/s]
100%|██████████| 24/24 [00:00<00:00, 163.29it/s]
100%|██████████| 24/24 [00:00<00:00, 165.51it/s]
100%|██████████| 24/24 [00:00<00:00, 177.92it/s]
100%|██████████| 24/24 [00:00<00:00, 175.08it/s]
100%|██████████| 24/24 [00:00<00:00, 178.73it/s]
100%|██████████| 24/24 [00:00<00:00, 170.33it/s]
100%|██████████| 24/24 [00:00<00:00, 176.88it/s]
Epoch: 40, loss = 17.01385498046875
```

In [332…
```python
g.save_weights("model_v2.h5")
```

In [327…
```python
g.predict("v")
```

Out[327]:
```
'vetirhonis\n'
```

In [328…
```python
g.save("model_v2.keras")
```

In [ ]:
```python
h = tf.keras.models.load_model("model_v2.keras")
```

In [335…
```python
i = Generator(vocab_size, embedding_size, hidden_units)
i.predict("x")
i.load_weights("model_v2.h5")
```

In [342…
```python
i.predict("a")
```

Out[342]:
```
'anaosaurus\n'
```

In [ ]: