Задание 1

Запустить модель Stable Diffusion (в Jupyter Notebook от Anaconda или в Colab), придумать свой вариант промпта, связанный с вашим знаком зодиака, сгенерировать изображения, соответствующие промпту, прислать результат через ТУИС.

Задание 2

Загрузите из keras.datasets набор данных California Housing price regression dataset (https://keras.io/api/datasets/california_housing/), обучите нейронную сеть прогнозировать медианную цену домов в зависимости от количества комнат в доме, визуализируйте процесс обучения.

I'll put all my labs here https://github.com/hallame/deep_learning

Task01

```
!pip -q install -U keras-cv keras silence-tensorflow matplotlib
```

```
  Preparing metadata (setup.py) ... done
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 650.7/650.7 kB 10.7 MB/s eta 0:00:00
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.5/1.5 MB 57.4 MB/s eta 0:00:00
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 8.7/8.7 MB 145.6 MB/s eta 0:00:00
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 950.8/950.8 kB 63.8 MB/s eta 0:00:00
  Building wheel for silence-tensorflow (setup.py) ... done
```

```
!pip install ipywidgets
```

```
Requirement already satisfied: nbformat in /usr/local/lib/python3.12/dist-packages (from no
Requirement already satisfied: nbconvert>=5 in /usr/local/lib/python3.12/dist-packages (fro
```

```
Requirement already satisfied: anyio>=3.1.0 in /usr/local/lib/python3.12/dist-packages (fro
Requirement already satisfied: jupyter-events>=0.9.0 in /usr/local/lib/python3.12/dist-pack
Requirement already satisfied: jupyter-server-terminals>=0.4.4 in /usr/local/lib/python3.12
Requirement already satisfied: overrides>=5.0 in /usr/local/lib/python3.12/dist-packages (f
Requirement already satisfied: websocket-client>=1.7 in /usr/local/lib/python3.12/dist-pack
Requirement already satisfied: idna>=2.8 in /usr/local/lib/python3.12/dist-packages (from a
Requirement already satisfied: sniffio>=1.1 in /usr/local/lib/python3.12/dist-packages (fro
Requirement already satisfied: python-json-logger>=2.0.4 in /usr/local/lib/python3.12/dist-
Requirement already satisfied: pyyaml>=5.3 in /usr/local/lib/python3.12/dist-packages (from
Requirement already satisfied: rfc3339-validator in /usr/local/lib/python3.12/dist-packages
Requirement already satisfied: rfc3986-validator>=0.1.1 in /usr/local/lib/python3.12/dist-p
Requirement already satisfied: fqdn in /usr/local/lib/python3.12/dist-packages (from jsonsc
Requirement already satisfied: isoduration in /usr/local/lib/python3.12/dist-packages (from
Requirement already satisfied: jsonpointer>1.13 in /usr/local/lib/python3.12/dist-packages
Requirement already satisfied: rfc3987-syntax>=1.1.0 in /usr/local/lib/python3.12/dist-pack
Requirement already satisfied: uri-template in /usr/local/lib/python3.12/dist-packages (fro
Requirement already satisfied: webcolors>=24.6.0 in /usr/local/lib/python3.12/dist-packages
Requirement already satisfied: lark>=1.2.2 in /usr/local/lib/python3.12/dist-packages (from
Requirement already satisfied: arrow>=0.15.0 in /usr/local/lib/python3.12/dist-packages (fr
Requirement already satisfied: tzdata in /usr/local/lib/python3.12/dist-packages (from arro
Downloading jedi-0.19.2-py2.py3-none-any.whl (1.6 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.6/1.6 MB 19.9 MB/s eta 0:00:00
Installing collected packages: jedi
Successfully installed jedi-0.19.2
```

```
#import
import os
os.environ["KERAS_BACKEND"] = "tensorflow"

from silence_tensorflow import silence_tensorflow
silence_tensorflow()

import time, random, numpy as np, matplotlib.pyplot as plt

import keras            # Keras 3
import keras_cv         # KerasCV (Stable Diffusion)
import tensorflow as tf # ok après silence

#for ui
import ipywidgets as w
from IPython.display import display, clear_output

# Repro & outings
random.seed(42); np.random.seed(42)
os.makedirs("outputs/sd", exist_ok=True)

print("TF:", tf.__version__, "| Keras:", keras.__version__, "| KerasCV:", keras_cv.__versior
```

```
TF: 2.19.0 | Keras: 3.12.0 | KerasCV: 0.9.0
```

```
#helpers utilities
def plot_images(images, title=None, figsize=(18, 6)):
    plt.figure(figsize=figsize)
    for i in range(len(images)):
        ax = plt.subplot(1, len(images), i + 1)
        plt.imshow(images[i])
        plt.axis("off")
    if title:
        plt.suptitle(title, fontsize=14)
    plt.show()
```

```
#model

import gc
import tensorflow as tf
import keras
import keras_cv

def reset_tf():
    """Session cleaning TF/Keras ."""
    keras.backend.clear_session()
    tf.keras.backend.clear_session()
    gc.collect()

_SD = {}  # cache by size

def get_sd(size: int):
    """Retourn  pipeline StableDiffusion for 'size'. """
    if size not in _SD:
        reset_tf()
        _SD[size] = keras_cv.models.StableDiffusion(
            img_width=size, img_height=size, jit_compile=False
        )
    return _SD[size]

# sd = keras_cv.models.StableDiffusion(
#     img_width=256,
#     img_height=256,
#     jit_compile=False  # robust on CPU/Metal
# )
```

```
#zodiac signs
zodiac_style = {
    "aries":       "ram made of stardust, fiery aura",
    "taurus":      "majestic bull, emerald forest, grounded strength",
    "gemini":      "twin spirits, mirrored neon, duality and motion",
    "cancer":      "lunar crab, silver tides, protective shell",
    "leo":         "golden lion, royal crown, sunlit glow",
    "virgo":       "celestial maiden, wheat field, precise elegance",
    "libra":       "ethereal scales, balance of light and shadow",
    "scorpio":     "obsidian scorpion, midnight desert, mystic sting",
    "sagittarius": "celestial archer, comet trail, boundless horizon",
    "capricorn":   "sea-goat on marble cliff, ancient wisdom",
    "aquarius":    "water bearer of stars, electric waves, futurism",
    "pisces":      "twin koi in nebula waters, dreamy currents"
}
```

```
def build_prompt(sign: str) -> str:
    return f"""{zodiac_style.get(sign, 'zodiac spirit')}, fantasy art,
high quality, highly detailed, elegant, sharp focus,
concept art, dramatic lighting, volumetric light, 8k render""".strip()

# Widgets
sign_dd = w.Dropdown(
    options=[
        ("♈ Aries", "aries"), ("♉ Taurus", "taurus"), ("♊ Gemini", "gemini"),
        ("♋ Cancer", "cancer"), ("♌ Leo", "leo"), ("♍ Virgo", "virgo"),
        ("♎ Libra", "libra"), ("♏ Scorpio", "scorpio"), ("♐ Sagittarius", "sagittarius"),
        ("♑ Capricorn", "capricorn"), ("♒ Aquarius", "aquarius"), ("♓ Pisces", "pisces"),
    ],
    value="aquarius",
    description="Signe:",
)
```

```
size_dd = w.Dropdown(options=[256, 512], value=256, description="Size:")
batch_slider = w.IntSlider(min=1, max=4, step=1, value=3, description="Batch:")
gen_btn = w.Button(description="Generate", button_style="success")
out = w.Output()



def on_generate(_):
    with out:
        clear_output()
        sign = sign_dd.value
        size = int(size_dd.value)
        batch = int(batch_slider.value)

        prompt = build_prompt(sign)
        print("Prompt:", prompt)
        print(f"Size: {size}×{size} | Batch: {batch}")

        # re-use un pipeline from  cache
        sd = get_sd(size)

        t0 = time.time()
        images = sd.text_to_image(prompt, batch_size=batch)
        print(f"Time: {time.time()-t0:.1f}s")

        plot_images(images, title=f"Stable Diffusion — {sign.capitalize()}")

        saved = []
        for i, im in enumerate(images):
            path = f"outputs/sd/{sign}_{i+1}_{size}.png"
            plt.imsave(path, im)
            saved.append(path)
        print("Files saved:", saved)

gen_btn.on_click(on_generate)

ui = w.VBox([
    w.HBox([sign_dd, size_dd, batch_slider]),
    gen_btn,
    out
])
display(ui)
```

Signe: Aquarius Size: 256 Batch: 3

Generate

```
Prompt: water bearer of stars, electric waves, futurism, fantasy art,
high quality, highly detailed, elegant, sharp focus,
concept art, dramatic lighting, volumetric light, 8k render
Size: 256×256 | Batch: 3
By using this model checkpoint, you acknowledge that its usage is subject to the terms of
the CreativeML Open RAIL-M license at https://raw.githubusercontent.com/CompVis/stable-
diffusion/main/LICENSE
Downloading data from
https://github.com/openai/CLIP/blob/main/clip/bpe_simple_vocab_16e6.txt.gz?raw=true
      0/1356917 ──────────────────── 0s 0s/step
1114112/1356917 ──────────────────── 0s 0us/step
1356917/1356917 ──────────────────── 0s 0us/step
Downloading data from https://huggingface.co/fchollet/stable-
diffusion/resolve/main/kcv_encoder.h5
        0/492466864 ──────────────────── 0s 0s/step
   622592/492466864 ──────────────────── 39s 0us/step
  9519104/492466864 ──────────────────── 5s 0us/step
 24076288/492466864 ──────────────────── 2s 0us/step
 37314560/492466864 ──────────────────── 2s 0us/step
 44498944/492466864 ──────────────────── 2s 0us/step
 52682752/492466864 ──────────────────── 2s 0us/step
 66748416/492466864 ──────────────────── 2s 0us/step
 83148800/492466864 ──────────────────── 1s 0us/step
 98983936/492466864 ──────────────────── 1s 0us/step
114638848/492466864 ──────────────────── 1s 0us/step
127172608/492466864 ──────────────────── 1s 0us/step
140361728/492466864 ──────────────────── 1s 0us/step
155623424/492466864 ──────────────────── 1s 0us/step
170328064/492466864 ──────────────────── 1s 0us/step
184991744/492466864 ──────────────────── 1s 0us/step
199974912/492466864 ──────────────────── 1s 0us/step
215244800/492466864 ──────────────────── 1s 0us/step
226869248/492466864 ──────────────────── 1s 0us/step
241246208/492466864 ──────────────────── 0s 0us/step
256720896/492466864 ──────────────────── 0s 0us/step
270712832/492466864 ──────────────────── 0s 0us/step
284819456/492466864 ──────────────────── 0s 0us/step
300212224/492466864 ──────────────────── 0s 0us/step
315252736/492466864 ──────────────────── 0s 0us/step
330596352/492466864 ──────────────────── 0s 0us/step
346505216/492466864 ──────────────────── 0s 0us/step
361914368/492466864 ──────────────────── 0s 0us/step
377397248/492466864 ──────────────────── 0s 0us/step
392642560/492466864 ──────────────────── 0s 0us/step
407584768/492466864 ──────────────────── 0s 0us/step
423256064/492466864 ──────────────────── 0s 0us/step
438247424/492466864 ──────────────────── 0s 0us/step
453992448/492466864 ──────────────────── 0s 0us/step
469811200/492466864 ──────────────────── 0s 0us/step
484483072/492466864 ──────────────────── 0s 0us/step
492466864/492466864 ──────────────────── 2s 0us/step
Downloading data from https://huggingface.co/fchollet/stable-
diffusion/resolve/main/kcv_diffusion_model.h5
         0/3439090152 ──────────────────── 0s 0s/step
    573440/3439090152 ──────────────────── 5:03 0us/step
   8880128/3439090152 ──────────────────── 38s 0us/step
  24993792/3439090152 ──────────────────── 20s 0us/step
  40312832/3439090152 ──────────────────── 16s 0us/step
  56115200/3439090152 ──────────────────── 15s 0us/step
  71475200/3439090152 ──────────────────── 14s 0us/step
  85123072/3439090152 ──────────────────── 13s 0us/step
 100294656/3439090152 ──────────────────── 13s 0us/step
 115163136/3439090152 ──────────────────── 13s 0us/step
 128557056/3439090152 ──────────────────── 12s 0us/step
 142155776/3439090152 ──────────────────── 12s 0us/step
 153280512/3439090152 ──────────────────── 12s 0us/step
 167395328/3439090152 ──────────────────── 12s 0us/step
```

```
182026240/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
196722688/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
211542016/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
223035392/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
237707264/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
252116992/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
267345920/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
281493504/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
295673856/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
302055424/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
305496064/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
308903936/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
317407232/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
321568768/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
326991872/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
336789504/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
345161728/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
354893824/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
363814912/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
374530048/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
385343488/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
395157504/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
406249472/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
415621120/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
426442752/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
434028544/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
443908096/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
454295552/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
464715776/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
474734592/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
485703680/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
495542272/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
506822656/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
517308416/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
527949824/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
538279936/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
548593664/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
558784512/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
569745408/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
581173248/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
591691776/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
603291648/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
613548032/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
623263744/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
634036224/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
645234688/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
657219584/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
671326208/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
684580864/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
695844864/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
709287936/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
723329024/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
737714176/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
749379584/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
758480896/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
764264448/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
767254528/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
770408448/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
774381568/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
777953280/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
784678912/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
789454848/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
793378816/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
801816576/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
809861120/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
821403648/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
833683456/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
847003648/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
862560256/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
877895680/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
```

```
892583936/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
893386752/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
893493248/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
893599744/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
893706240/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
893812736/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
893919232/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894025728/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894132224/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894230528/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894337024/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894443520/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894517248/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
894623744/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
894730240/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
894836736/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
894943232/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
895049728/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
895148032/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
895254528/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
895361024/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
895467520/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
895565824/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
895664128/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
895770624/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
895877120/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
895983616/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
896090112/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
902045696/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
904101888/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
907706368/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
912957440/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
918609920/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
925343744/3439090152 ━━━━━━━━━━━━━━━━━━━━ 20s 0us/step
932798464/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
942030848/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
949231616/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
955596800/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
960208896/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
965705728/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
970178560/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
976322560/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
983105536/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
991518720/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
999522304/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1004068864/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1008590848/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1015119872/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1025638400/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1034027008/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1042456576/3439090152 ━━━━━━━━━━━━━━━━━━━━ 19s 0us/step
1050763264/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1058455552/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1066737664/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1075970048/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1085341696/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1093156864/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1102512128/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1115308032/3439090152 ━━━━━━━━━━━━━━━━━━━━ 18s 0us/step
1126588416/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
1140375552/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
1155022848/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
1169637376/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
1182334976/3439090152 ━━━━━━━━━━━━━━━━━━━━ 17s 0us/step
1197359104/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
1211408384/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
1225424896/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
1241407488/3439090152 ━━━━━━━━━━━━━━━━━━━━ 16s 0us/step
1254637568/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
1269309440/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
1281556480/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
```

```
1292369920/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
1303511040/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
1316749312/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
1329037312/3439090152 ━━━━━━━━━━━━━━━━━━━━ 15s 0us/step
1339351040/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1352974336/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1367662592/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1375051776/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1384579072/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1394786304/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1403510784/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1414922240/3439090152 ━━━━━━━━━━━━━━━━━━━━ 14s 0us/step
1427693568/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1435058176/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1441570816/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1453195264/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1466646528/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1478852608/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1490862080/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1503494144/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1516290048/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1525792768/3439090152 ━━━━━━━━━━━━━━━━━━━━ 13s 0us/step
1532354560/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1538826240/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1551523840/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1563566080/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1575501824/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1587904512/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1599651840/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1612144640/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1624088576/3439090152 ━━━━━━━━━━━━━━━━━━━━ 12s 0us/step
1635647488/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1644183552/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1655439360/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1666260992/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1679982592/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1692803072/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1706631168/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1717051392/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1727283200/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1737981952/3439090152 ━━━━━━━━━━━━━━━━━━━━ 11s 0us/step
1749385216/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1758478336/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1770692608/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1783652352/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1794285568/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1806458880/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1818345472/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1827299328/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1840398336/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1852801024/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1864327168/3439090152 ━━━━━━━━━━━━━━━━━━━━ 10s 0us/step
1874436096/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1884913664/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1896554496/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1909702656/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1920581632/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1931214848/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1941643264/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1956200448/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1970782208/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1984299008/3439090152 ━━━━━━━━━━━━━━━━━━━━ 9s 0us/step
1997119488/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2012094464/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2026905600/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2039177216/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2053906432/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2068160512/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2083332096/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2096136192/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
2111045632/3439090152 ━━━━━━━━━━━━━━━━━━━━ 8s 0us/step
```

```
2125783040/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2140643328/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2150711296/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2159149056/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2168242176/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2179661824/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2190008320/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2200838144/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2213208064/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2226069504/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2231328768/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2236964864/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2242248704/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2247491584/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2253266944/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2263146496/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2271100928/3439090152 ━━━━━━━━━━━━━━━━━━━━ 7s 0us/step
2280112128/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2292023296/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2304909312/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2320252928/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2335629312/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2346541056/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2353643520/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2357379072/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2370609152/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2382061568/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2396151808/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2409521152/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2420858880/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2435252224/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2450636800/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2456862720/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2456961024/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457067520/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457165824/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457272320/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457370624/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457468928/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457575424/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457681920/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457788416/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457886720/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2457993216/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458099712/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458206208/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458312704/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458419200/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458525696/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458624000/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458730496/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458836992/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2458935296/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459041792/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459148288/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459254784/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459361280/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459467776/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459574272/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459680768/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459787264/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2459893760/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460000256/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460106752/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460213248/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460319744/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460426240/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460524544/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460622848/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2460712960/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
```

```
2460811264/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2466635776/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2468757504/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2472869888/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2478702592/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2484666368/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2492522496/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2500730880/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2510422016/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2519580672/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2528854016/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2539896832/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2548375552/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2559909888/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2570141696/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2574901248/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2579554304/3439090152 ━━━━━━━━━━━━━━━━━━━━ 6s 0us/step
2587090944/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2597519360/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2605604864/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2611838976/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2620039168/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2629885952/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2641854464/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2656190464/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2670960640/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2685739008/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2698444800/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2712264704/3439090152 ━━━━━━━━━━━━━━━━━━━━ 5s 0us/step
2727067648/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2740518912/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2755461120/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2769666048/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2783059968/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2797527040/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2810093568/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2810126336/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2810159104/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2814173184/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2828214272/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2841927680/3439090152 ━━━━━━━━━━━━━━━━━━━━ 4s 0us/step
2856878080/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2872492032/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2887532544/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2903048192/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2911805440/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915041280/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915074048/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915106816/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915139584/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915188736/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915254272/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915352576/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915508224/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2915762176/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2916204544/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2916909056/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2918113280/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2920128512/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2923667456/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2929778688/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2940305408/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2956050432/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2971820032/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2983043072/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
2995052544/3439090152 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
3007045632/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3017916416/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3032588288/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3046776832/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3061317632/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
```

```
3075342336/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3089694720/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3103801344/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3118768128/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3133038592/3439090152 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
3146620928/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3161554944/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3175129088/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3187326976/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3199295488/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3213287424/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3227418624/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3242270720/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3257114624/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3271540736/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3285467136/3439090152 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
3300081664/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3314352128/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3329392640/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3344359424/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3359072256/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3373932544/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3389030400/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3404341248/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3416850432/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3426795520/3439090152 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
3439090152/3439090152 ━━━━━━━━━━━━━━━━━━━━ 22s 0us/step
 1/50 ━━━━━━━━━━━━━━━━━━━━ 1:09:06 85s/step
 2/50 ━━━━━━━━━━━━━━━━━━━━ 20s 427ms/step
 3/50 ━━━━━━━━━━━━━━━━━━━━ 20s 426ms/step
 4/50 ━━━━━━━━━━━━━━━━━━━━ 19s 426ms/step
 5/50 ━━━━━━━━━━━━━━━━━━━━ 19s 427ms/step
 6/50 ━━━━━━━━━━━━━━━━━━━━ 18s 427ms/step
 7/50 ━━━━━━━━━━━━━━━━━━━━ 18s 428ms/step
 8/50 ━━━━━━━━━━━━━━━━━━━━ 17s 429ms/step
 9/50 ━━━━━━━━━━━━━━━━━━━━ 17s 429ms/step
10/50 ━━━━━━━━━━━━━━━━━━━━ 17s 429ms/step
11/50 ━━━━━━━━━━━━━━━━━━━━ 16s 429ms/step
12/50 ━━━━━━━━━━━━━━━━━━━━ 16s 429ms/step
13/50 ━━━━━━━━━━━━━━━━━━━━ 15s 429ms/step
14/50 ━━━━━━━━━━━━━━━━━━━━ 15s 429ms/step
15/50 ━━━━━━━━━━━━━━━━━━━━ 15s 429ms/step
16/50 ━━━━━━━━━━━━━━━━━━━━ 14s 430ms/step
17/50 ━━━━━━━━━━━━━━━━━━━━ 14s 430ms/step
18/50 ━━━━━━━━━━━━━━━━━━━━ 13s 430ms/step
19/50 ━━━━━━━━━━━━━━━━━━━━ 13s 429ms/step
20/50 ━━━━━━━━━━━━━━━━━━━━ 12s 430ms/step
21/50 ━━━━━━━━━━━━━━━━━━━━ 12s 430ms/step
22/50 ━━━━━━━━━━━━━━━━━━━━ 12s 430ms/step
23/50 ━━━━━━━━━━━━━━━━━━━━ 11s 430ms/step
24/50 ━━━━━━━━━━━━━━━━━━━━ 11s 430ms/step
25/50 ━━━━━━━━━━━━━━━━━━━━ 10s 430ms/step
26/50 ━━━━━━━━━━━━━━━━━━━━ 10s 431ms/step
27/50 ━━━━━━━━━━━━━━━━━━━━ 9s 431ms/step
28/50 ━━━━━━━━━━━━━━━━━━━━ 9s 431ms/step
29/50 ━━━━━━━━━━━━━━━━━━━━ 9s 431ms/step
30/50 ━━━━━━━━━━━━━━━━━━━━ 8s 431ms/step
31/50 ━━━━━━━━━━━━━━━━━━━━ 8s 432ms/step
32/50 ━━━━━━━━━━━━━━━━━━━━ 7s 432ms/step
33/50 ━━━━━━━━━━━━━━━━━━━━ 7s 432ms/step
34/50 ━━━━━━━━━━━━━━━━━━━━ 6s 432ms/step
35/50 ━━━━━━━━━━━━━━━━━━━━ 6s 433ms/step
36/50 ━━━━━━━━━━━━━━━━━━━━ 6s 433ms/step
37/50 ━━━━━━━━━━━━━━━━━━━━ 5s 433ms/step
38/50 ━━━━━━━━━━━━━━━━━━━━ 5s 433ms/step
39/50 ━━━━━━━━━━━━━━━━━━━━ 4s 433ms/step
40/50 ━━━━━━━━━━━━━━━━━━━━ 4s 433ms/step
41/50 ━━━━━━━━━━━━━━━━━━━━ 3s 433ms/step
42/50 ━━━━━━━━━━━━━━━━━━━━ 3s 434ms/step
43/50 ━━━━━━━━━━━━━━━━━━━━ 3s 434ms/step
44/50 ━━━━━━━━━━━━━━━━━━━━ 2s 434ms/step
```

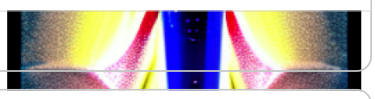
```
45/50 ━━━━━━━━━━━━━━━━━━━━ 2s 434ms/step
46/50 ━━━━━━━━━━━━━━━━━━━━ 1s 434ms/step
47/50 ━━━━━━━━━━━━━━━━━━━━ 1s 434ms/step
```

Task 02

```
#import
import os
os.environ["KERAS_BACKEND"] = "tensorflow"

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

import tensorflow as tf
import keras
from keras import layers

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_absolute_error, r2_score

# cut the logs TF
try:
    from silence_tensorflow import silence_tensorflow
    silence_tensorflow()
except Exception:
    pass

# Reproducibility
tf.keras.backend.clear_session()
np.random.seed(42)
tf.random.set_seed(42)

print("TF:", tf.__version__, "| Keras:", keras.__version__)
```

```
TF: 2.19.0 | Keras: 3.12.0
```





```
#uploading data
USE_SKLEARN_FALLBACK = False
try:
    from keras.datasets import california_housing
    _ = california_housing.load_data
except Exception:
    USE_SKLEARN_FALLBACK = True

FEATURE_NAMES = ["MedInc","HouseAge","AveRooms","AveBedrms",
                 "Population","AveOccup","Latitude","Longitude"]

if not USE_SKLEARN_FALLBACK:
    (x_train, y_train), (x_test, y_test) = california_housing.load_data()
    X = np.vstack([x_train, x_test]).astype(np.float32)
    y = np.concatenate([y_train, y_test]).astype(np.float32)  # unit
    from sklearn.datasets import fetch_california_housing
    data = fetch_california_housing()
    X = data.data.astype(np.float32)
    y = data.target.astype(np.float32)  # unit = 100k$

df = pd.DataFrame(X, columns=FEATURE_NAMES)
df["MedHouseVal"] = y

print(df.shape, " | y min/med/max:", float(y.min()), float(np.median(y)), float(y.max()))
df.head()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/california_
743530/743530 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
(20640, 9)  | y min/med/max: 0.1499900072813034 1.7970000505447388 5.000010013580322
```

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longitude	MedHous
0	8.3252	41.0	6.984127	1.023810	322.0	2.555556	37.880001	-122.230003	
1	8.3014	21.0	6.238137	0.971880	2401.0	2.109842	37.860001	-122.220001	
2	7.2574	52.0	8.288136	1.073446	496.0	2.802260	37.849998	-122.239998	
3	5.6431	52.0	5.817352	1.073059	558.0	2.547945	37.849998	-122.250000	
4	3.8462	52.0	6.281853	1.081081	565.0	2.181467	37.849998	-122.250000	

Étapes suivantes : New interactive sheet

```
#selct only AveRooms +split (baseline 1D)
X_one = df[["AveRooms"]].values.astype(np.float32)
y_all = df["MedHouseVal"].values.astype(np.float32)  # 100k$

# Split 80/10/10
X_train, X_temp, y_train, y_temp = train_test_split(
    X_one, y_all, test_size=0.2, random_state=42
)
X_val, X_test, y_val, y_test = train_test_split(
    X_temp, y_temp, test_size=0.5, random_state=42
)

# Standardisation X
x_scaler = StandardScaler().fit(X_train)
X_train_s = x_scaler.transform(X_train)
X_val_s   = x_scaler.transform(X_val)
X_test_s  = x_scaler.transform(X_test)

# Standardisation y (stability ++)
y_scaler = StandardScaler().fit(y_train.reshape(-1,1))
y_train_s = y_scaler.transform(y_train.reshape(-1,1))
y_val_s   = y_scaler.transform(y_val.reshape(-1,1))
y_test_s  = y_scaler.transform(y_test.reshape(-1,1))

X_train_s[:3], y_train_s[:3].ravel()[:3]
```

```
(array([[-0.17491654],
        [-0.4028354 ],
        [ 0.08821608]], dtype=float32),
 array([-0.90118915,  1.5127715 , -0.2992126 ], dtype=float32))
```

```
#Keras model (1D regression) + compilation
def build_reg():
    m = keras.Sequential([
        layers.Input(shape=(1,)),
        layers.Dense(64, activation="relu"),
        layers.Dense(64, activation="relu"),
        layers.Dense(1)
    ])
    m.compile(
        optimizer=keras.optimizers.Adam(learning_rate=1e-3, clipnorm=1.0),
        loss="mse",
        metrics=[keras.metrics.MeanAbsoluteError(name="mae")]
    )
    return m
```

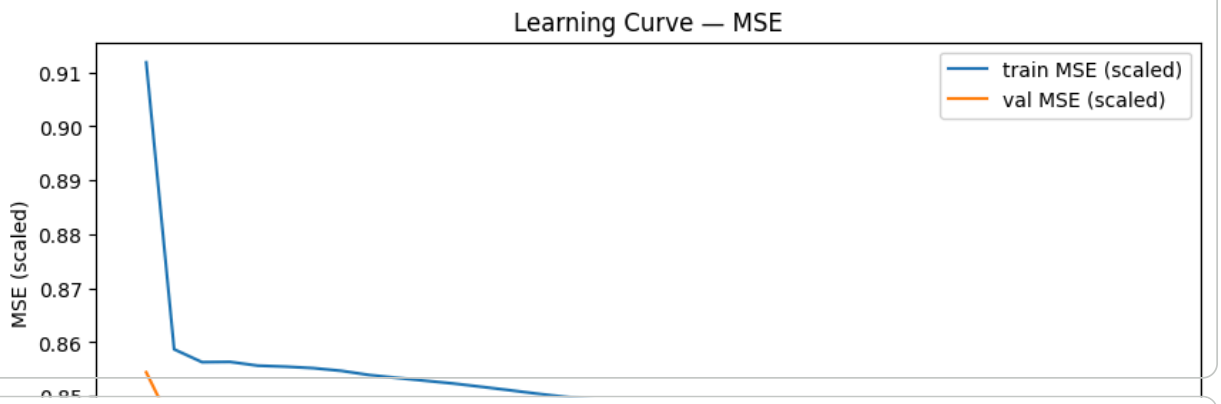
```
reg = build_reg()
reg.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 64)	128
dense_1 (Dense)	(None, 64)	4,160
dense_2 (Dense)	(None, 1)	65

Total params: 4,353 (17.00 KB)
Trainable params: 4,353 (17.00 KB)

```
#train &  curves
early = keras.callbacks.EarlyStopping(
    monitor="val_loss", patience=10, restore_best_weights=True
)

hist = reg.fit(
    X_train_s, y_train_s,
    validation_data=(X_val_s, y_val_s),
    epochs=200, batch_size=128, verbose=0, callbacks=[early]
)

# Courbes (loss/mae in normal standardized scale)
plt.figure(figsize=(10,4))
plt.plot(hist.history["loss"], label="train MSE (scaled)")
plt.plot(hist.history["val_loss"], label="val MSE (scaled)")
plt.xlabel("Epoch"); plt.ylabel("MSE (scaled)"); plt.legend(); plt.title("Learning Curve — MS

plt.figure(figsize=(10,4))
plt.plot(hist.history["mae"], label="train MAE (scaled)")
plt.plot(hist.history["val_mae"], label="val MAE (scaled)")
plt.xlabel("Epoch"); plt.ylabel("MAE (scaled)"); plt.legend(); plt.title("Learning Curve — MA
```




```
# Evaluation test & visualization (+ inverse transform)
y_pred_s = reg.predict(X_test_s, verbose=0)
y_pred   = y_scaler.inverse_transform(y_pred_s).ravel()  # 100k$

# Metrics in origin  unit (100k$)
mse = np.mean((y_pred - y_test)**2)
mae = np.mean(np.abs(y_pred - y_test))
print(f"Test MSE: {mse:.4f} | Test MAE: {mae:.4f}  (unit = 100k$)")

# Scatter reel vs predict (100k$)
plt.figure(figsize=(5,5))
plt.scatter(y_test, y_pred, s=10)
mn, mx = float(min(y_test.min(), y_pred.min())), float(max(y_test.max(), y_pred.max()))
plt.plot([mn, mx], [mn, mx], lw=2)
plt.xlabel("Reel price (100k$)"); plt.ylabel("Prediction (100k$)")
plt.title("Vrai vs Prédit — AveRooms → MedHouseVal")
plt.show()

print("MAE (100k$):", mean_absolute_error(y_test, y_pred))
print("R²:", r2_score(y_test, y_pred))
```

```
Test MSE: 1.0879 | Test MAE: 0.8180  (unit = 100k$)
```