Temperature in LLMs

(a popular LLM interview question) 👉

Low temperature

DailyDoseofDS.com

```
response = openai_client.chat.completions.create(
    model = "gpt-3.5-turbo",
    messages = [{"role":"user", "content": "Continue this: In 2013,..."}
                ],
    temperature=0.1**50
)

print(response.choices[0].message.content)
```

```
 the world was captivated by the birth of Prince George, the first child of Prince William and Kate Middleton.
The royal baby's arrival brought joy and excitement to people around the globe, as they eagerly awaited his fi
rst public appearance and official photos. Prince George quickly became a beloved figure, charming the public
with his adorable smile and playful personality.
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    temperature=0.1**50
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Identical response

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```

Prompting the LLM with high temperature produces gibberish output

High temperature

```
response = openai_client.chat.completions.create(
    model = "gpt-3.5-turbo",
    messages = [{"role":"user", "content": "Continue this: In 2013,..."}
               ],
    temperature=2
)

print(response.choices[0].message.content)
```

Random output

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```

Prompting the LLM with low temperature produces identical output

Low temperature

```
response = openai_client.chat.completions.create(
    model = "gpt-3.5-turbo",
    messages = [{"role":"user", "content": "Continue this: In 2013,..."}
               ],
    temperature=0.1**50
)

print(response.choices[0].message.content)
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               ],
    temperature=0.1**50
)

print(response.choices[0].message.content)
```


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```
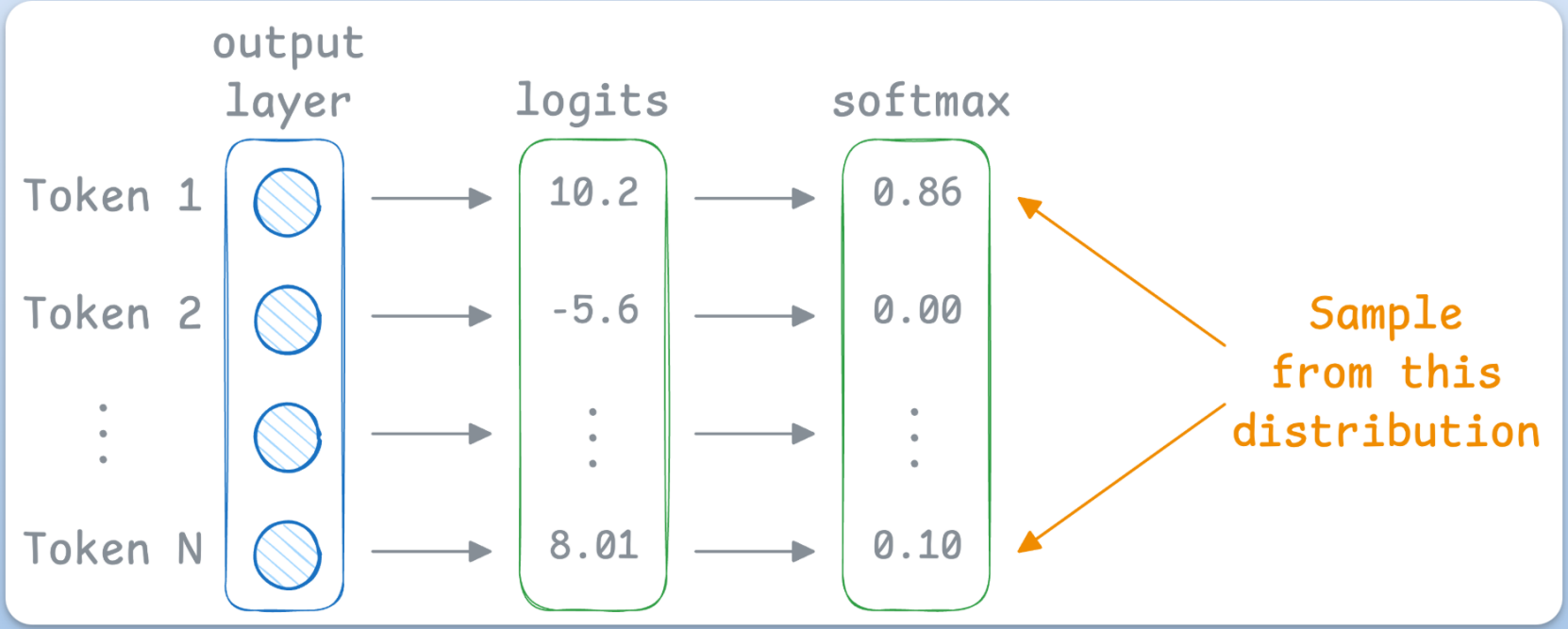

LLMs don't predict the most likely token. They sample from the softmax scores



The impact of sampling is controlled using the Temperature parameter.

$$\frac{e^{x_i}}{\sum e^{x_j}}$$

Traditional Softmax

$$\frac{e^{\frac{x_i}{T}}}{\sum e^{\frac{x_j}{T}}}$$

Temperature-adjusted Softmax

If the temperature is low, the probabilities look like a max value. This leads to similar outputs.

low temperature value

```
T = 0.01
a = np.array([1,2,3,4])

>>> softmax(a)
array([0.03, 0.09, 0.24, 0.64])

>>> softmax(a/T)
array([5.12e-131, 1.38e-087, 3.72e-044, 1.00e+000])
```

If the temperature is high, the probabilities look like a uniform distribution. This leads to gibberish output.

high temperature value

```
T = 10000000000
a = np.array([1,2,3,4])

>>> softmax(a)
array([0.03, 0.09, 0.24, 0.64])

>>> softmax(a/T)
array([0.25, 0.25, 0.25, 0.25])
```