



## Topic Models

Machine Learning: Jordan Boyd-Graber  
University of Colorado Boulder

LECTURE 20

## Content Questions

---

## Content Questions

---

## Content Questions

---

## Content Questions

---

## Content Questions

---

## Content Questions

---

## Content Questions

---



## Content Questions

---

## Content Questions

---

## Content Questions

---

.

## Administrivia

---

- Project proposals in (feedback)
- LDA HW released
- No class next Wed

## Sampling Token A

---

### Assignments

$\text{Doc}_0 : z_0 = 0, z_1 = 1, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger dog  
iron pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog iron cat

## Sampling Token A

---

### Assignments

Doc<sub>0</sub> :  $z_0 = 0, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger dog  
iron pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog iron cat

- $p(z_{0,0} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$

## Sampling Token A

### Assignments

Doc<sub>0</sub> :  $z_0 = 0, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger dog  
iron pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog iron cat

- $p(z_{0,0} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,0} = 1) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{4+5.000} \right) = 0.333 \times 0.111 = 0.037 = 0.037$

## Sampling Token A

### Assignments

Doc<sub>0</sub> :  $z_0 = 0, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger dog  
iron pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog iron cat

- $p(z_{0,0} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,0} = 1) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{4+5.000} \right) = 0.333 \times 0.111 = 0.037 = 0.037$
- $p(z_{0,0} = 2) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.333 \times 0.250 = 0.083 = 0.083$



## Sampling Token A

### Assignments

Doc<sub>0</sub> :  $z_0 = 0, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger dog  
iron pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog iron cat

- $p(z_{0,0} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,0} = 1) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{4+5.000} \right) = 0.333 \times 0.111 = 0.037 = 0.037$
- $p(z_{0,0} = 2) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.333 \times 0.250 = 0.083 = 0.083$

## Sampling Token A

### Assignments

$\text{Doc}_0 : z_0 = 0, z_1 = 1, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger dog  
iron pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog iron cat

- $p(z_{0,0} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,0} = 1) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{4+5.000} \right) = 0.333 \times 0.111 = 0.037 = 0.037$
- $p(z_{0,0} = 2) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.333 \times 0.250 = 0.083 = 0.083$

New assignment for (0, 0): 2

## Sampling Token B

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 1, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog dog iron cat

## Sampling Token B

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog dog iron cat

- $p(z_{0,1} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$

## Sampling Token B

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog dog iron cat

- $p(z_{0,1} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,1} = 1) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$

## Sampling Token B

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog dog iron cat

- $p(z_{0,1} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,1} = 1) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{0,1} = 2) = \left( \frac{2+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{4+5.000} \right) = 0.500 \times 0.222 = 0.111 = 0.111$

## Sampling Token B

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog dog iron cat

- $p(z_{0,1} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,1} = 1) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{0,1} = 2) = \left( \frac{2+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{4+5.000} \right) = 0.500 \times 0.222 = 0.111 = 0.111$

## Sampling Token B

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 1, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron cat

**Topic 2** :dog dog iron cat

- $p(z_{0,1} = 0) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,1} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{0,1} = 2) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{4+5.000}\right) = 0.500 \times 0.222 = 0.111 = 0.111$

New assignment for (0, 1): 2



## Sampling Token C

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

## Sampling Token C

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,2} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$

## Sampling Token C

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,2} = 0) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,2} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$

## Sampling Token C

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,2} = 0) = \left( \frac{1+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,2} = 1) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{0,2} = 2) = \left( \frac{2+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{4+5.000} \right) = 0.500 \times 0.222 = 0.111 = 0.111$

## Sampling Token C

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,2} = 0) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,2} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{0,2} = 2) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{4+5.000}\right) = 0.500 \times 0.222 = 0.111 = 0.111$

## Sampling Token C

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,2} = 0) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.333 \times 0.125 = 0.042 = 0.042$
- $p(z_{0,2} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{0,2} = 2) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{4+5.000}\right) = 0.500 \times 0.222 = 0.111 = 0.111$

New assignment for (0, 2): 2

## Sampling Token D

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

## Sampling Token D

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,3} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.167 \times 0.143 = 0.024 = 0.024$



## Sampling Token D

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{2+5.000}\right) = 0.167 \times 0.143 = 0.024 = 0.024$
- $p(z_{0,3} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{3+5.000}\right) = 0.167 \times 0.250 = 0.042 = 0.042$

## Sampling Token D

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{2+5.000}\right) = 0.167 \times 0.143 = 0.024 = 0.024$
- $p(z_{0,3} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{3+5.000}\right) = 0.167 \times 0.250 = 0.042 = 0.042$
- $p(z_{0,3} = 2) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{5+5.000}\right) = 0.667 \times 0.100 = 0.067 = 0.067$

## Sampling Token D

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,3} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.167 \times 0.143 = 0.024 = 0.024$
- $p(z_{0,3} = 1) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.167 \times 0.250 = 0.042 = 0.042$
- $p(z_{0,3} = 2) = \left( \frac{3+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{5+5.000} \right) = 0.667 \times 0.100 = 0.067 = 0.067$

## Sampling Token D

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 0$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron  
pig

**Topic 1** :pig hamburger  
iron

**Topic 2** :dog dog iron cat  
cat

- $p(z_{0,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{2+5.000}\right) = 0.167 \times 0.143 = 0.024 = 0.024$
- $p(z_{0,3} = 1) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{3+5.000}\right) = 0.167 \times 0.250 = 0.042 = 0.042$
- $p(z_{0,3} = 2) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{5+5.000}\right) = 0.667 \times 0.100 = 0.067 = 0.067$

New assignment for (0, 3): 2

## Sampling Token E

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 1, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron

**Topic 1** :pig hamburger  
iron

**Topic 2** :pig dog dog iron  
cat cat

## Sampling Token E

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron

**Topic 1** :pig hamburger  
iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,0} = 0) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{2+5.000} \right) = 0.400 \times 0.286 = 0.114 = 0.114$

## Sampling Token E

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron

**Topic 1** :pig hamburger  
iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,0} = 0) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{2+5.000} \right) = 0.400 \times 0.286 = 0.114 = 0.114$
- $p(z_{1,0} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$

## Sampling Token E

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron

**Topic 1** :pig hamburger  
iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,0} = 0) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{2+5.000} \right) = 0.400 \times 0.286 = 0.114 = 0.114$
- $p(z_{1,0} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,0} = 2) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{6+5.000} \right) = 0.400 \times 0.091 = 0.036 = 0.036$



## Sampling Token E

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron

**Topic 1** :pig hamburger  
iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,0} = 0) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{2+5.000} \right) = 0.400 \times 0.286 = 0.114 = 0.114$
- $p(z_{1,0} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,0} = 2) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{6+5.000} \right) = 0.400 \times 0.091 = 0.036 = 0.036$

## Sampling Token E

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 1, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger iron

**Topic 1** :pig hamburger  
iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,0} = 0) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{2+5.000} \right) = 0.400 \times 0.286 = 0.114 = 0.114$
- $p(z_{1,0} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,0} = 2) = \left( \frac{1+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{6+5.000} \right) = 0.400 \times 0.091 = 0.036 = 0.036$

New assignment for (1, 0): 0

## Sampling Token F

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger iron

**Topic 1** :pig iron

**Topic 2** :pig dog dog iron

cat cat

## Sampling Token F

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger iron

**Topic 1** :pig iron

**Topic 2** :pig dog dog iron

cat cat

- $p(z_{1,1} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.600 \times 0.125 = 0.075 = 0.075$

## Sampling Token F

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger iron

**Topic 1** :pig iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,1} = 0) = \left(\frac{2+1.000}{2+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.600 \times 0.125 = 0.075 = 0.075$
- $p(z_{1,1} = 1) = \left(\frac{0+1.000}{2+3.000}\right) \times \left(\frac{0+1.000}{2+5.000}\right) = 0.200 \times 0.143 = 0.029 = 0.029$

## Sampling Token F

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger iron

**Topic 1** :pig iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,1} = 0) = \left(\frac{2+1.000}{2+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.600 \times 0.125 = 0.075 = 0.075$
- $p(z_{1,1} = 1) = \left(\frac{0+1.000}{2+3.000}\right) \times \left(\frac{0+1.000}{2+5.000}\right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,1} = 2) = \left(\frac{0+1.000}{2+3.000}\right) \times \left(\frac{1+1.000}{5+5.000}\right) = 0.200 \times 0.200 = 0.040 = 0.040$

## Sampling Token F

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 2, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger iron

**Topic 1** :pig iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,1} = 0) = \left(\frac{2+1.000}{2+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.600 \times 0.125 = 0.075 = 0.075$
- $p(z_{1,1} = 1) = \left(\frac{0+1.000}{2+3.000}\right) \times \left(\frac{0+1.000}{2+5.000}\right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,1} = 2) = \left(\frac{0+1.000}{2+3.000}\right) \times \left(\frac{1+1.000}{5+5.000}\right) = 0.200 \times 0.200 = 0.040 = 0.040$

## Sampling Token F

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 2, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger iron

**Topic 1** :pig iron

**Topic 2** :pig dog dog iron  
cat cat

- $p(z_{1,1} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.600 \times 0.125 = 0.075 = 0.075$
- $p(z_{1,1} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,1} = 2) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{5+5.000} \right) = 0.200 \times 0.200 = 0.040 = 0.040$

New assignment for (1, 1): 0



## Sampling Token G

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

## Sampling Token G

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** : hamburger

hamburger dog iron

**Topic 1** : pig iron

**Topic 2** : pig dog iron cat  
cat

- $p(z_{1,2} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.600 \times 0.250 = 0.150 = 0.150$

## Sampling Token G

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{1,2} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.600 \times 0.250 = 0.150 = 0.150$
- $p(z_{1,2} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$

## Sampling Token G

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{1,2} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.600 \times 0.250 = 0.150 = 0.150$
- $p(z_{1,2} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,2} = 2) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{5+5.000} \right) = 0.200 \times 0.100 = 0.020 = 0.020$

## Sampling Token G

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{1,2} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.600 \times 0.250 = 0.150 = 0.150$
- $p(z_{1,2} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,2} = 2) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{5+5.000} \right) = 0.200 \times 0.100 = 0.020 = 0.020$

## Sampling Token G

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{1,2} = 0) = \left( \frac{2+1.000}{2+3.000} \right) \times \left( \frac{1+1.000}{3+5.000} \right) = 0.600 \times 0.250 = 0.150 = 0.150$
- $p(z_{1,2} = 1) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{2+5.000} \right) = 0.200 \times 0.143 = 0.029 = 0.029$
- $p(z_{1,2} = 2) = \left( \frac{0+1.000}{2+3.000} \right) \times \left( \frac{0+1.000}{5+5.000} \right) = 0.200 \times 0.100 = 0.020 = 0.020$

New assignment for (1, 2): 0

## Sampling Token H

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

## Sampling Token H

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** : hamburger

hamburger dog iron

**Topic 1** : pig iron

**Topic 2** : pig dog iron cat  
cat

- $p(z_{2,0} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$



## Sampling Token H

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,0} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,0} = 1) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{2+5.000}\right) = 0.500 \times 0.286 = 0.143 = 0.143$

## Sampling Token H

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,0} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,0} = 1) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{2+5.000}\right) = 0.500 \times 0.286 = 0.143 = 0.143$
- $p(z_{2,0} = 2) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{5+5.000}\right) = 0.333 \times 0.200 = 0.067 = 0.067$

## Sampling Token H

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,0} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,0} = 1) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{2+5.000}\right) = 0.500 \times 0.286 = 0.143 = 0.143$
- $p(z_{2,0} = 2) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{5+5.000}\right) = 0.333 \times 0.200 = 0.067 = 0.067$

## Sampling Token H

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 0, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog iron

**Topic 1** :pig iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,0} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,0} = 1) = \left(\frac{2+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{2+5.000}\right) = 0.500 \times 0.286 = 0.143 = 0.143$
- $p(z_{2,0} = 2) = \left(\frac{1+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{5+5.000}\right) = 0.333 \times 0.200 = 0.067 = 0.067$

New assignment for (2, 0): 1

## Sampling Token I

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 1, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron

**Topic 2** :pig dog iron cat  
cat

## Sampling Token I

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,1} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$

## Sampling Token I

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,1} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,1} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$

## Sampling Token I

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,1} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,1} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$
- $p(z_{2,1} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{4+5.000}\right) = 0.167 \times 0.111 = 0.019 = 0.019$



## Sampling Token I

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,1} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,1} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$
- $p(z_{2,1} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{4+5.000}\right) = 0.167 \times 0.111 = 0.019 = 0.019$

## Sampling Token I

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 1, z_1 = 2, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron

**Topic 2** :pig dog iron cat  
cat

- $p(z_{2,1} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,1} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$
- $p(z_{2,1} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{4+5.000}\right) = 0.167 \times 0.111 = 0.019 = 0.019$

New assignment for (2, 1): 1

## Sampling Token J

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 1, z_1 = 1, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

## Sampling Token J

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 1, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $$p(z_{2,2} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$$

## Sampling Token J

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,2} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,2} = 1) = \left( \frac{3+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.667 \times 0.125 = 0.083 = 0.083$

## Sampling Token J

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,2} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,2} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.667 \times 0.125 = 0.083 = 0.083$
- $p(z_{2,2} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{4+5.000}\right) = 0.167 \times 0.222 = 0.037 = 0.037$

## Sampling Token J

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,2} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,2} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.667 \times 0.125 = 0.083 = 0.083$
- $p(z_{2,2} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{4+5.000}\right) = 0.167 \times 0.222 = 0.037 = 0.037$

## Sampling Token J

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger

hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,2} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,2} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.667 \times 0.125 = 0.083 = 0.083$
- $p(z_{2,2} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{1+1.000}{4+5.000}\right) = 0.167 \times 0.222 = 0.037 = 0.037$

New assignment for (2, 2): 1



## Sampling Token K

---

### Assignments

$\text{Doc}_0 : z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

$\text{Doc}_1 : z_0 = 0, z_1 = 0, z_2 = 0$

$\text{Doc}_2 : z_0 = 1, z_1 = 1, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

## Sampling Token K

---

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 1, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,3} = 0) = \left( \frac{0+1.000}{3+3.000} \right) \times \left( \frac{0+1.000}{3+5.000} \right) = 0.167 \times 0.125 = 0.021 = 0.021$

## Sampling Token K

### Assignments

Doc<sub>0</sub> :  $z_0 = 2, z_1 = 2, z_2 = 2, z_3 = 2$

Doc<sub>1</sub> :  $z_0 = 0, z_1 = 0, z_2 = 0$

Doc<sub>2</sub> :  $z_0 = 1, z_1 = 1, z_2 = 1, z_3 = 1$

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,3} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$

## Sampling Token K

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,3} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$
- $p(z_{2,3} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{4+5.000}\right) = 0.167 \times 0.111 = 0.019 = 0.019$

## Sampling Token K

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,3} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$
- $p(z_{2,3} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{4+5.000}\right) = 0.167 \times 0.111 = 0.019 = 0.019$

## Sampling Token K

### Assignments

Doc<sub>0</sub> : z<sub>0</sub> = 2, z<sub>1</sub> = 2, z<sub>2</sub> = 2, z<sub>3</sub> = 2

Doc<sub>1</sub> : z<sub>0</sub> = 0, z<sub>1</sub> = 0, z<sub>2</sub> = 0

Doc<sub>2</sub> : z<sub>0</sub> = 1, z<sub>1</sub> = 1, z<sub>2</sub> = 1, z<sub>3</sub> = 1

### Topics

**Topic 0** :hamburger  
hamburger dog

**Topic 1** :pig iron iron iron

**Topic 2** :pig dog cat cat

- $p(z_{2,3} = 0) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{3+5.000}\right) = 0.167 \times 0.125 = 0.021 = 0.021$
- $p(z_{2,3} = 1) = \left(\frac{3+1.000}{3+3.000}\right) \times \left(\frac{2+1.000}{3+5.000}\right) = 0.667 \times 0.375 = 0.250 = 0.250$
- $p(z_{2,3} = 2) = \left(\frac{0+1.000}{3+3.000}\right) \times \left(\frac{0+1.000}{4+5.000}\right) = 0.167 \times 0.111 = 0.019 = 0.019$

New assignment for (2, 3): 1