Week-8 Questions

Prof . Prathosh AP and Chandan J

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1. The co-variance matrix of the parameters of the latent encoders vary over time in such a way that the distribution of the latent at the final time step is Gaussian. The determinant of this co-variance matrix is

   (A) 1
   (B) $\sqrt{0.5}$
   (C) $\sqrt{0.9}$
   (D) 0.99

   Answer: (A)

2. Consider the forward transition at time step t, defined by

$$q(x_t \mid x_{t-1}) \; = \; \mathcal{N}\big(\sqrt{\alpha_t}\, x_{t-1},\; 1 - \alpha_t\big).$$

   If $\alpha_t = 0.3$ and $x_{t-1} = 4$, what is the mean of $q(x_t \mid x_{t-1})$? give the answer to two decimal places without rounding.

   (A) $\sqrt{2.19}$
   (B) $2.19 * \sqrt{2.19}$
   (C) 2.19
   (D) 2.19^2

   Answer: (C)

3. Consider the forward transition at time step t, defined by

$$q(x_t \mid x_{t-1}) \; = \; \mathcal{N}\big(\sqrt{\alpha_t}\, x_{t-1},\; 1 - \alpha_t\big).$$

   If $\alpha_t = 0.3$ and $x_{t-1} = 4$, what is the variance of $q(x_t \mid x_{t-1})$? Enter the answer to two decimal places without rounding.

   (A) 0.7
   (B) $\sqrt{0.7}$

(C) 0.7^2

(D) $0.7 * 0.69$

Answer: (A)

4. The DDPM posterior mean is

$$\mu_t = \frac{1}{\sqrt{\alpha_t}}\Big(x_t - \frac{\beta_t}{\sqrt{1-\bar{\alpha}_t}}\,\epsilon\Big).$$

Given $x_t = 2$, $\beta_t = 0.04$, $\alpha_t = 0.96$, $\bar{\alpha}_t = 0.9216$, and $\epsilon = 1$, compute μ_t. (Two decimals, no rounding.)

(A) 1.81

(B) 1.89

(C) $\sqrt{1.89}$

(D) 1.89^2

Answer: (B)

5. In the reverse sampling step you add noise with standard deviation $\sqrt{\beta_t}$. If $\beta_t = 0.02$, what is $\sqrt{\beta_t}$? (Two decimals, no rounding.)

(A) $0.14 * 0.138$

(B) $\sqrt{1.4}$

(C) 0.14

(D) 0.28

Answer: (C)

6. The forward diffusion step in the q_sample method is implemented as

$$x_t = \sqrt{\bar{\alpha}_t}\,x_0 \;+\; \sqrt{1-\bar{\alpha}_t}\,\epsilon.$$

In the code, $\bar{\alpha}_t$ is stored as $alpha\_cumprod[t]$. Which option matches the actual expression used?

(A) $\sqrt{\alpha_t}\,x_0 + \sqrt{1-\alpha_t}\,\epsilon$

(B) $\sqrt{\bar{\alpha}_t}\,x_0 + \sqrt{1-\bar{\alpha}_t}\,\epsilon$

(C) $\alpha_t\,x_0 + \beta_t\,\epsilon$

(D) $\sqrt{\alpha_t}\,x_{t-1} + \sqrt{\beta_t}\,\epsilon$

Answer: (B)

7. In the ‘UNet2ch‘ class definition, the very first convolutional block is constructed with $in\_c = 2$. What do these 2 input channels correspond to?

(A) The original image and its grayscale copy

(B) The noisy image x_t and timestep channel t

(C) The clean image x_0 and the predicted noise ϵ

(D) The image gradient in x and y directions

Answer: (B)

8. After computing

`t_chan = t.view(-1,1,1,1).expand(-1,1,H,W); inp = torch.cat([x_t, t_chan], dim=1)`,

what is the shape of `inp` if x_t has shape $[B, 1, H, W]$?

(A) $[B, 1, H, W]$

(B) $[B, 2, H, W]$

(C) $[B, 3, H, W]$

(D) $[B, 4, H, W]$

Answer: (B)

9. During sampling, the code computes:

```
mean = math.sqrt(acp_prev) * x0_hat
x = mean + math.sqrt(1 - acp_prev) * torch.randn_like(x).
```

What does the term $\sqrt{1 - \bar{\alpha}_{t-1}}$ represent?

(A) The forward noise variance at step t.

(B) The standard deviation of the posterior $q(x_{t-1} \mid x_t, x_0)$.

(C) The cumulative product $\prod_{s=1}^{t-1} \alpha_s$.

(D) The learning rate for the reverse process.

Answer: (B)

10. Consider the DDPM

If $\bar{\alpha}_{t-1} = 0.70$, $\bar{\alpha}_t = 0.50$, $\beta_t = 0.20$, $x_0 = 2$, and $x_t = 3$, what is $\mu_t(x_t, x_0)$? (Compute to two decimal places by truncating, no rounding.)

(a) 2.25

(b) 2.27

(c) 2.29

(d) 2.31

Answer: (B)