Tutorial-03

1. Let x be the weights of frying chicken.

$x \sim N(500, 100^2)$, pdf of Normal distribution

$$f_X(x) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

$x \sim N(\mu, \sigma^2)$

a) $P(x < 650)$

$= P\left(\frac{x-\mu}{\sigma} < \frac{650-500}{100}\right)$

$= P(Z < 1.5)$

$= 0.9332$.

b) $P(x < 345)$

$= P\left(\frac{x-\mu}{\sigma} < \frac{345-500}{100}\right)$

$= P(Z < \overset{-1.55}{\cancel{0.0069}})$ OR $1 - P(Z < 1.55)$

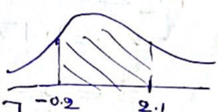
$= 0.0606$ $\qquad 1 - 0.9394$

c) $P(480 < x < 710)$

$= P\left(\frac{480-500}{100} < Z < \frac{710-500}{100}\right)$

$= P(-0.2 < Z < 2.1)$

$= 1 - [P(Z < -0.2) + P(Z > 2.1)]$



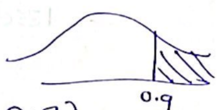
$= 1 - [P(Z < -0.2) + P(Z < -2.1)]$

$= 1 - [0.4207 + 0.0179)$

$= 0.5614$

d) $P(x > 590)$

$= P\left(\frac{x-\mu}{\sigma} > \frac{590-500}{100}\right)$



$= P(Z > 0.9) = 1 - P(Z < 0.9)$

$= P(Z < -0.9) = 0.1841$

2) Let X be the IQ scores.

$X \sim N(125, 10^2)$ $f_X(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$

$X \sim N(\mu, \sigma^2)$.

a) $P(X < 142)$

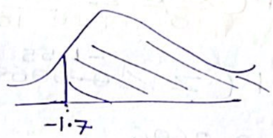
$= P\left(\frac{X-\mu}{\sigma} < \frac{142-125}{10}\right)$

$= P(Z < 1.7)$

$= 0.9554$

b) $P(X > 108)$

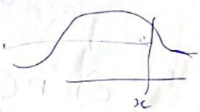
$= P\left(\frac{X-\mu}{\sigma} > \frac{108-125}{10}\right)$



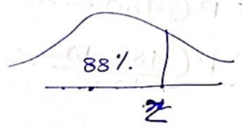
$= P(Z > -1.7)$

$= 1 - P(Z < -1.7)$

$= 1 - 0.0446 = 0.9554$



c) $P(X < x) = 0.88$



$P(Z < z) = 0.88$ $P\frac{X-\mu}{\sigma}$

$Z = 1.175$

$z = \frac{x-\mu}{\sigma}$

$x = \mu + \sigma z$

$= 125 + 10 \times 1.175$

$= 136.75$

d) $P(X < x) = 0.36$

$P(Z < z) = 0.36$

$z = -0.36$

$x = \mu + \sigma z$

$= 125 + 10 \times -0.36$

$= 121.4$

e) $P(X < 100)$

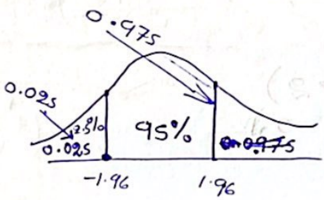
$= P\left(\frac{X-\mu}{\sigma} < \frac{100-125}{10}\right)$

$= P(Z < -2.5)$

$= 0.0062$

Then the no. of applicants will not be admitted is $1500 \times 0.0062 = 9.3 \simeq 9$

f)



$z_{0.025} = -1.96$

$z_{0.975} = 1.96$

$P(x_1 < X < x_2) = 0.95$

$P(-1.96 < Z < 1.96) = 0.95$

$x_1 = \mu + \sigma z$

$= 125 + 10(-1.96)$

$= 105.4$

$x_2 = \mu + \sigma z$

$= 125 + 10(1.96)$

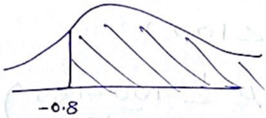
$= 144.6$

3) Let x be the annual rainfall.

$x \sim N(40, 5^2)$.

a) $P(x \geq 36)$

$= P\left(\frac{x-\mu}{\sigma} > \frac{36-40}{5}\right)$



$= P(Z > -0.8)$

$= 1 - P(Z < -0.8)$

$= 1 - 0.2119$

$= 0.7881$

b) $P(x < 38) + P(x > 50)$

$= P\left(\frac{x-\mu}{\sigma} < \frac{38-40}{5}\right) + P\left(\frac{x-\mu}{\sigma} > \frac{50-40}{5}\right)$.

$= P(Z < -0.4) + P(Z > 2)$

$= P(Z < -0.4) + P(Z < -2)$

$= 0.3446 + 0.0228$

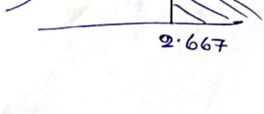
$= 0.3674$.

4) a) Let x be the length of pregnancies

$x \sim N(268, 15^2)$.

a) $P(x > 308)$

$= P\left(\frac{x-\mu}{\sigma} > \frac{308-268}{15}\right)$



$= P(Z > 2.667)$

$= P(Z < -2.667)$

$= 0.0038$

b) $P(X < x_1) = 0.04$

$P(Z < z) = 0.04$

$z = -1.75$

$x_1 = \mu + \sigma z$

$= 268 + 15(-1.75)$

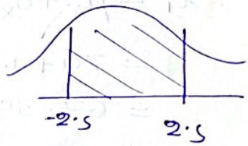
$= 241.75$

5) Let X be ages of the residents.

$X \sim N(70, 4^2)$

a) $P(60 < X < 80)$

$= P\left(\frac{60-70}{4} < Z < \frac{80-70}{4}\right)$



$= P(-2.5 < Z < 2.5)$

$= \cancel{P}\ 1 - 2 \times P(Z < -2.5)$

$= 1 - 2 \times 0.0062$

$= 0.9876$.

b) $n = 9$

~~Sample~~ mean of the means of the sample $= 70$

$\mu_{\bar{x}} = 70$

c) $S.D_{\sigma_{\bar{x}}} = \sigma/\sqrt{n} = 4/\sqrt{9} = 1.333$

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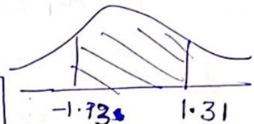
d) $P(68.5 < \bar{X} < 71.75)$

$= P\left(\dfrac{68.5-70}{4/\sqrt{9}} < Z < \dfrac{71.75-70}{4/\sqrt{9}}\right)$

$= P(-1.125 < Z < 1.3125)$



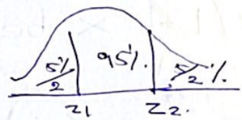
$= 1 - [P(Z < -1.13) + P(Z < -1.31)]$

$= 1 - [0.1292 + 0.0951]$

$= \cancel{}\ 0.7757$

e)

$P(\bar{x}_1 < \bar{X} < \bar{x}_2) = 0.95$



$P(Z < z_1) = 0.025$

$z_1 = -1.96$

$P(-1.96 < Z < 1.96) = 0.95$

$\bar{x}_1 = \mu_{\bar{x}} + \sigma_{\bar{x}} Z$

$= 70 + 1.33(-1.96)$

$= 67.39$

$\bar{x}_2 = \mu_{\bar{x}} + \sigma_{\bar{x}} Z$

$= 70 + 1.33(1.96)$

$= 72.61$

Q6)

Let X be the daily cost of photo copies.

$\Rightarrow P($mean daily cost for 25 days $< 11.85)$

$X \sim N(\mu = 250 \times 0.05, \sigma^2 = 50^2 \times 0.05)$.

$\Rightarrow X \sim N(\mu = 12.5, \sigma^2 = 125)$

$\bar{X} \sim N(\mu = 12.5, \sigma^2 = 125/25)$

$\bar{X} \sim N(\mu = 12.5, \sigma^2 = 5)$

$$P(\bar{X} < 11.85) = P\left(\frac{\bar{X} - 12.5}{\sqrt{5}} < \frac{11.85 - 12.5}{\sqrt{5}}\right)$$

$$= P\left(Z < \frac{11.85 - 12.5}{\sqrt{5}}\right)$$

$$= P\left(Z < \frac{-0.65}{2.2361}\right)$$

$$= P(Z < -0.2907)$$

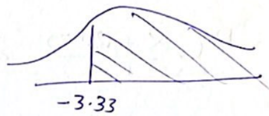
$$= 0.3859$$

7) Let X be the net weights of boxes filled from the machine.

$$X \sim N(16, 0.3^2)$$

a) $P(X > 15)$

$$= P\left(\frac{X-\mu}{\sigma} > \frac{15-16}{0.3}\right)$$



$$= P(Z > -3.333)$$

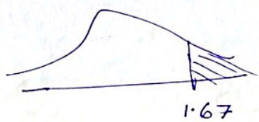
$$= 1 - P(Z < -3.33)$$

$$= 1 - 0.0005$$

$$= 0.9995$$

b) $P(X > 16.5)$

$$= P\left(\frac{X-\mu}{\sigma} > \frac{16.5-16}{0.3}\right)$$



$$= P(Z > 1.6667)$$

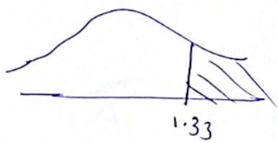
$$= \cancel{P(Z} \; 1 - P(Z < 1.67)$$

$$= 1 - 0.9525$$

$$= 0.0475$$

c) $P(X > 16.4)$

$$= P\left(\frac{X-\mu}{\sigma} > \frac{16.4-16}{0.3}\right)$$



$$= P(Z > 1.3333)$$

$$= P(Z < -1.333)$$

$$= 0.0918$$

8) $P(X \leq 90) \simeq P(X < 90.5)$, a continuity correction is needed as the responses are binary & the counts have a binomial distribution with $n = 400$, $p = 0.20$

$\mu = np$

$= 400 \times 0.2$

$= 80$

$\sigma = \sqrt{npq}$

$= \sqrt{400 \times 0.2 \times 0.8}$

$= 8$

$np \geq 5$, $nq \geq 5$

we can use normal approximation.

$P(X \leq 90) \simeq P(X < 90.5)$

~~By continuity correction~~

$= P\left(\frac{X-\mu}{\sigma} < \frac{90.5-80}{8}\right)$

$= P(Z < 1.31)$

$= 0.9049$

The sample event is not unlikely assuming the claimed percentage of 20%, hence the claim is not unreasonable.

d) $n = 32$

$P(\overline{x} > 16.3)$

$= P\left(\dfrac{\overline{x}-\mu}{\sigma/\sqrt{n}} > \dfrac{16.3-16}{\frac{0.3}{\sqrt{32}}}\right)$

$= P(Z > 5.6568)$

$= 0.0$

#.

e) $n = 32$

$P(\overline{x} < 15.8)$

$= P\left(\dfrac{\overline{x}-\mu}{\sigma/\sqrt{n}} < \dfrac{15.8-16}{\frac{0.3}{\sqrt{32}}}\right)$

$= P(Z < -3.7712)$

$= 0.0001$

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9)

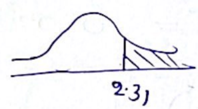
$np = 45 \geq 5$ & $nq > 5$ So we can use normal approximation.

$P(X \geq 57) \doteqdot P(X > 56.5)$, a continuity correction is needed as the response are binary & the counts have a Binomial dist^{n} with $n = 100$, $p = 0.45$.

$\mu = np$
$= 100 \times 0.45$
$= 45$

$\sigma = \sqrt{npq}$
$= \sqrt{100 \times 0.45 \times 0.55}$
$= 4.9749$.

$$P(X \geq 57) \doteqdot P(X > 56.5)$$
$$= P\left(\frac{X-45}{4.9749} > \frac{56.5-45}{4.9749}\right)$$
$$= P(Z > 2.31)$$
$$= P(Z < -2.31)$$
$$= 0.0104$$



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10) Let X be the length of the pea pods for its olive-green pea crop.

$$X \sim N(11.5, 1.6^2)$$

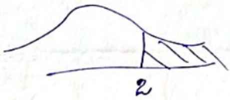
$n = 16$

a) $\sigma_{\bar{x}} = \sigma/\sqrt{n} = \frac{1.6}{\sqrt{16}} = 0.4$

b) $P(\bar{X} > 12.3)$

$= P\left(\frac{\bar{X} - 11.5}{0.4} > \frac{12.3 - 11.5}{0.4}\right)$

$= P(Z > 2)$

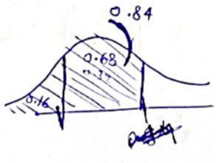


$= 1 - P(Z < 2)$

$= 1 - 0.9772$

$= 0.0228$

c) $P(\bar{x}_1 < \bar{X} < \bar{x}_2) = 0.68$



$P(z_1 < Z < z_2) = 0.68$

$\cancel{Z_1 = -2.145}$ $\cancel{Z_2 = 0.99}$

$z = \frac{\bar{x} - \mu_x}{\sigma_x}$

$P(Z < z_1) = 0.16$ $\quad$ $P(Z < Z_2) = 0.84$

$z_1 = -1.0$ $\quad$ $Z_2 = 1$

$\bar{x}_1 = \mu_x + Z\sigma_x$
$= 11.5 + (-1)0.4$
$= 11.1$

$\bar{x}_2 = \mu_x + Z\sigma_x$
$= 11.5 + 1(0.4)$
$= 11.9$

11)

a) Mean $= np$

$= 1500 \times 0.7$

$= 1050$

standard deviation $= \sqrt{np(1-p)}$

$= \sqrt{1500 \times 0.7 \times 0.3}$

$= 17.7482$

b) $np \geq 5$, $nq \geq 5$

So, we can use normal approximation.

$X \sim N(1050, 17.7482^2)$

$P(X \geq 1000) = P\left(\frac{X-\mu}{\sigma} \geq \frac{\overset{999.5}{1000} - 1050}{17.7482}\right)$

$\triangleq P(X > 999.5)$

$= P(Z \geq \overset{-2.8453}{\cancel{-2.8171}})$

$= 1 - P(Z \ngtr -2.85)$

$= 1 - 0.0022)$

$= 0.9978$

c) $P(X > 1200) = P\left(\frac{X-\mu}{\sigma} > \frac{1200.5 - 1050}{17.7482}\right)$

$\triangleq P(X > 1200.5)$

$= P(Z > \overset{8.4797}{\cancel{8.4516}})$

$= 0$

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d) $N = 1700$

$\text{mean} = 1700 \times 0.7$

$= 1190$

$S.D = \sqrt{1700 \times 0.7 \times 0.3}$

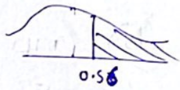
$= 18.8944$

$P(x > 1200)$

$\approx P(x > 1200.5) = P\left(\frac{X-\mu}{\sigma} > \frac{1200.5 - 1190}{18.8944}\right)$

$= P(Z > \cancel{0.5293}\ 0.5557)$

$= 1 - P(Z < 0.56)$



$= 1 - \cancel{0.7019}\ 0.7123$

$\neq \cancel{0.2981}$

$= 0.2877$

12) *

$f_X(x) = \lambda e^{-\lambda x} \quad x > 0$

$\lambda = 1/5 = 0.2/\text{year}$

$14/12 = 1.167 \text{ years}$

$P(T < 14/12) = \int_0^{14/12} 0.2 e^{-0.2 x} dx$

$= -e^{-0.2x} \Big|_0^{14/12}$

$= -e^{-0.2 \times \frac{14}{12}} + 1$

$= -0.7919 + 1 \quad = 0.2081$

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13>

Let X be the lifetime of a particular fan.

$X \sim \exp(\lambda = 0.0003)$

p.d.f $= \lambda e^{-\lambda x}$ $x > 0$

$$P(X > 10000) = \int_{10,000}^{\infty} \lambda e^{-\lambda x} dx$$

$$= -e^{-\lambda x} \Big|_{10,000}^{\infty}$$

$$= 0 + e^{-0.0003 \times 10,000}$$

$$= e^{-3}$$

$$= 0.04978$$

$$= 0.0498$$

$\lambda = 0.00035$

$$P(X > 10,000) = \int_{10,000}^{\infty} \lambda e^{-\lambda x} dx$$

$$= -e^{-\lambda x} \Big|_{10,000}^{\infty}$$

$$= 0 + e^{-0.00035 \times 10,000}$$

$$= e^{-3.5}$$

$$= 0.030197$$

$$= 0.0302.$$

It will fewer fans compare with earlya one.

14) Let X be the time interval between successive barges.

$$\text{mean} = 8$$

$$\frac{1}{\lambda} = 8$$

$$\lambda = \frac{1}{8} = 0.125$$

$$X \sim \exp\left(\frac{1}{8}\right)$$

$$f_x(x) = \lambda e^{-\lambda x} \quad x > 0$$

a) $$P(X < 5) = \int_0^5 \lambda e^{-\lambda x} dx$$

$$= -e^{-\lambda x}\Big|_0^5$$

$$= -e^{-\frac{1}{8}\cdot 5} + 1$$

$$= 0.4647$$

b) $$P(T > t) = \int_t^\infty 0.125 e^{-0.125t} \cdot dt$$

$$= -e^{-0.125t}\Big|_t^\infty$$

$$= e^{-0.125t}$$

$$e^{-0.125t} = 0.95$$

$$e^{-\frac{t}{8}} = 0.95$$

$$-\frac{t}{8} = \ln 0.95$$

$$t = -8 \ln 0.95$$

$$= 0.4103$$