

**O'ZBEKISTON RESPUBLIKASI OLIY TA'LIM, FAN VA
INNOVATSIYALAR VAZIRLIGI**

**Samarqand davlat veterinariya meditsinasi, chorvachilik va
biotexnologiyalar universiteti**

Axborot texnologiyalar kafedrası

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bosqich 101 guruh talabalari uchun "Amaliy matematika 1,2" fanidan
"Korrelyatsiya koefitsiyentini hisoblash" mavzusidagi

AMALIY MASHG'ULOTI ISHLANMASI

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“Korrelyatsiya koeffitsiyentini hisoblash” mavzusi bo’yicha amaliy mashg’ulotni olib boorish texnologiyasi

<i>Talabalar soni</i> 20	2 soat
<i>Mashg’ulot shakli</i>	Amaliy
<i>Amaliy mashg’ulot rejasi</i>	1. Korrelyatsion bog’lanish. 2. Chiziqli bog’lanishda korrelyatsiya koeffitsiyentini hisoblash. 3. Regressiya tenglamasi.
<i>O’quv mashg’ulotining maqsadi</i>	Mavzu bo’yicha ko’nikmalarini hosil qilish.
<i>Pedagogik vazifalar:</i>	<i>O’quv faoliyati natijalari:</i>
- Korrelyatsion bog’lanishda Excel dasturidan foydalanish; -Chiziqli korrelyatsion bog’lanishda regressiya tenglamasini hisoblash;	- Korrelyatsion bog’lanishda Excel dasturidan foydalanish; -Chiziqli korrelyatsion bog’lanishda regressiya tenglamasini hisoblash;
<i>O’qitish usullari</i>	namoyish, aqliy hujum, insert texnikasi.
<i>O’qitish vositalari</i>	Doska, videoproyektor, topshiriqlar, tarqatma materiallar.
<i>O’qitish shakllari</i>	Frontal, kollektiv, talaba bilan yakka tartibda ishlash.
<i>O’qitish sharoiti</i>	O’quv auditoriyasi
<i>Monitoring va baholash</i>	Kuzatish, og’zaki baholash, savol- javob, test savollari.

27-mavzu. Korrelyatsiya koeffitsiyentini hisoblash

27.1. Korrelyatsion bog'lanish.

27.2. Chiziqli bog'lanishda korrelyatsiya koeffitsiyentini hisoblash.

27.3. Regressiya tenglamasi.

Kalit so'zlar: Korrelyatsion bog'lanish, koeffitsiyent, regressiya tenglamasi, Aproksimatsiya, chiziqli va chiziqsiz korrelyatsion bog'lanishlar, Excel dasturida ishlash.

27.1. Korrelyatsiya koeffitsiyentini hisoblash

Masala: Korxonada ishlayotgan o'nta ishchining kunlik bajargan ish normasi (X)-bilan o'rtacha bir oylik daromadi (U)-orasidagi bog'lanishni tahlil kiling. Ma'lumotlar quyidagi jadvalda keltirilgan.

X	1	0.5	1.3	0.9	2.4	2.8	0.3	3.1	1.7	5.5
y	2.9	1.7	4.6	2.8	6.4	7.4	1.2	8.6	5.7	7.8

Ishning bajarish tartibi.

1. Bog'lanish turini aniklash.
2. Regressiya tenglamasi koeffitsiyenti va korrelyatsiya koeffitsiyenti aniqlash;
3. Korrelyatsiya koeffitsiyentining mohiyatligini baholash;
4. Regressiya tenglamasi koeffitsiyentlarining mohiyatligini baholash.
5. Regressiya tenglamasining mohiyatligini baholash.

Masalani yechish:

1. Bog'lanish turini to'g'ri chiziqli $y = a_0 + a_1x$ tanlaymiz.
2. Chiziqli tenglamalar sistemasining koeffitsiyentlarini jadval yordamida hisoblab chiqamiz.

N	X	Y	X ²	XY	Y ²
1	1	2.9	1	2.9	8.41
2	0.5	1.7	0.25	0.85	2.89
3	1.3	4.6	1.69	5.98	21.16
4	0.9	2.8	0.81	2.52	7.84
5	2.4	6.4	5.76	15.36	40.96
6	2.8	7.4	7.84	20.72	54.76

7	0.3	1.2	0.09	0.36	1.44
8	3.1	8.6	9.61	26.66	73.96
9	1.7	5.7	2.89	9.69	32.49
10	5.5	7.8	30.25	42.9	60.84
$N=10$	$\sum X = 19$	$\sum Y = 49.1$	$\sum X^2 = 60.19$	$\sum XY = 127.9$	$\sum Y^2 = 304.75$

$$\begin{cases} na_0 + a_1 \sum x = \sum y, \\ a_0 \sum x + a_1 \sum x^2 = \sum y \cdot x. \end{cases} \quad \text{tenglamalar sistemasiga jadvaldagini kuyib ushbu normal}$$

tenglamalar sistemasiga ega bo'lamiz.

$$\begin{cases} 10a_0 + a_1 19.5 = 49.1, \\ 19.5a_0 + 60.19a_1 = 127.9. \end{cases}$$

Tenglamalar sistemasining parametrlarini quyidagi formula bo'yicha hisoblaymiz.

$$\begin{cases} a_0 = \frac{(\sum x_i)^2 \cdot (\sum y_i) - (\sum x_i) \cdot (\sum x_i \cdot y_i)}{n \cdot \sum x_i^2 - (\sum x_i)^2} \\ a_1 = \frac{n \cdot \sum x_i \cdot y_i \cdot (\sum y_i) - (\sum x_i) \cdot (\sum y_i)}{n \cdot \sum x_i^2 - (\sum x_i)^2} \end{cases}$$

$$a_0 = 2.078, a_1 = 1.45$$

Shunday qilib quyidagi regressiya tenglamasiga ega bo'lamiz:

$$\bar{y} = 2.078 + 1.45x$$

Yuqoridagi tenglama yordamida x-omilning bir qiymatiga u-natijaviy omilning unga mos qiymatini aniqlaymiz:

$$y_{x_1} = 2.078 + 1.45 * 1 = 3.528$$

$$y_{x_2} = 2.078 + 1.45 * 0.5 = 2.803$$

$$y_{x_3} = 2.078 + 1.45 * 1.3 = 3.963$$

$$y_{x_4} = 2.078 + 1.45 * 0.9 = 3.963$$

$$y_{x_5} = 2.078 + 1.45 * 2.4 = 5.558$$

$$y_{x_6} = 2.078 + 1.45 * 2.6 = 5.848$$

$$y_{x_7} = 2.078 + 1.45 * 0.3 = 2.513$$

$$y_{x_8} = 2.078 + 1.45 * 3.1 = 6.573$$

$$y_{x_9} = 2.078 + 1.45 * 1.7 = 4.543$$

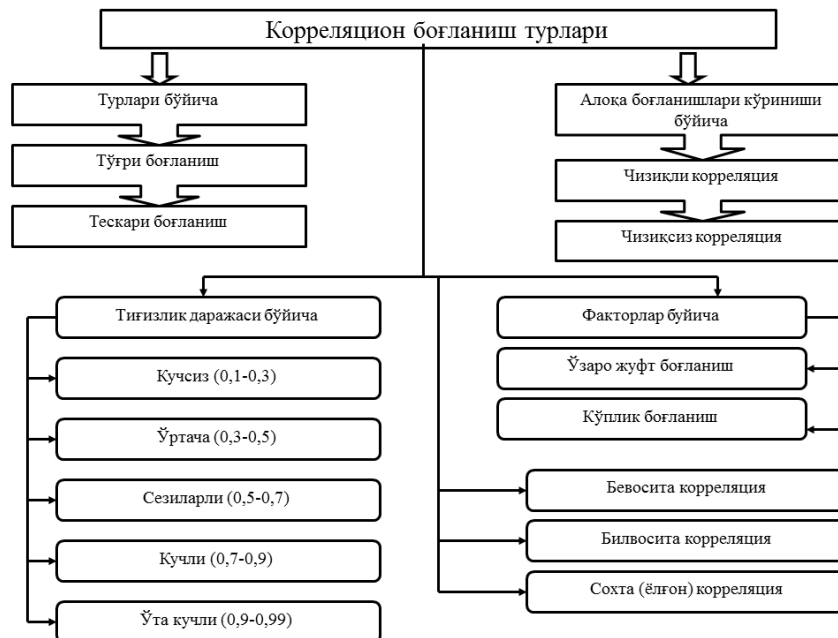
$$y_{x_{10}} = 2.078 + 1.45 * 5.5 = 10.053$$

Demak, ish normasining bir birlikka oshishi o'rtacha bir oylik daromadning 1.45 (ming) sum oshishiga olib keladi. Korrelyasiya koeffitsiyenti (aloka zichligi) quyidagi formula bilan topiladi.

$$r = \frac{N \sum XY - \sum X \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \sqrt{N \sum Y^2 - (\sum Y)^2}}$$

ya'ni, $r = 0.857$

Natijaviy kursatkich U-bilan omil kursatkichi X-urtasidagi boglanishni baxolashda aloka zichligi quyidagi xollarda aniklanadi:



Demak, $r = 0.857$ ekanligidan natijaviy belgi U-bilan omil belgi X-orasidagi bog'lanish kuchliligi bilan aniqlanadi.

Determinasiya koeffitsiyenti $d = r^2$ formula bilan topiladi.

$d = 0.74$ Demak korxonada ishlayotgan o'nta ishchining kunlik bajargan ish normasi o'rtacha bir oylik daromadini oshishiga 74 foizni tashkil qilar ekan.

Korrelyasiya koeffitsiyentining xatoligi

$$G_r = \frac{1-r^2}{\sqrt{N-1}} = 0.087 \text{ kelib chiqadi.}$$

Korrelyasiya koeffitsiyentining ishonchlik ma'nosi

$$E = \frac{r}{G_r} = \frac{0.86}{0.087} = 9.89 \text{ formula bilan topamiz.}$$

$$\text{Ya'ni } E = \frac{0.86}{0.087} = 9.89$$

Agar $E > 2.5$ bo'lsa, u holda ko'rsatkichlar orasidagi aloqa ishonchli bo'ladi. Demak, $E = 9.89 > 2.5$ ekanligidan aloqa ishonchli ekanligi kelib chikadi. Korrelyasiya koeffitsiyentining ishonchligi quyidagi:

$$t_{his} = \frac{r}{\sqrt{1-r}} * \sqrt{N-2} \text{ formula bilan topiladi.}$$

Bu formula St'yudent t -me'zoni deyiladi.

Bu formuladan:

$$t_{his} = \frac{0.857}{\sqrt{1-0.857}} * \sqrt{10-2} = 4.706$$

Agar $t_{his} > t_{jad}$ bo'lsa, u holda bu parametr mohiyati hisoblanadi. Ijtimoiy-iqtisodiy tekshirishlarda ko'pincha mohiyatlilik darajasi uchun 0.05 olinadi, ya'ni ko'rsatkichlarning mohiyatli bo'lish extimoli 0.9 ga teng.

Me'zonning nazariy kiymati t_{jad} St'yudent taqsimotining jadvali orkali aniqlanadi. Kuzatishlar soni 10 ta bo'lganda $t_{jad} = 2.306$ ga teng.

Bundan $t_{his} = 4.706 > t_{jad} = 2.306$ bo'ladi.

Ishchining o'rtacha bir oylik daromadi U bilan, uning bajargan ish normasi X orasidagi bog'lanish korrelyasion bog'lanish ekanligi kelib chikadi. Demak: korrelyasiya koeffitsiyenti mohiyatli.

1b. Modelni quyidagi darajali chiziq lashtiriladigan ko'rinishda quramiz.

$$y = a \cdot x^b$$

Masalani chiziqli funksiyaga qo'rinishga keltirish uchun qismlar bo'yicha logarifmik ko'rinishga keltiramiz:

$$lgy = lga + b \cdot lgx,$$

Bu yerdan agar $y = \lg(y), x = \lg(x), c = \lg(a)$ qo'rinishda belgilash olsak regressiya tenglamamiz quyidagi ko'rinishga ega bo'ladi:

$$y = c + b \cdot x$$

Hisoblash natijalari 3-jadvalda keltirilgan.

3-jadval

N	Y	X	XY	X ²	Y ²	Yx	y-yx	Ai
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1	0,909556	1,025306	0,932573	1,051252	0,827292	10,59109	-	30,43213
2	1	1,068186	1,068186	1,141021	1	11,70246	-	17,02461
3	0,924796	1,093422	1,011192	1,195571	0,855248	12,4097	-3,9997	47,55884
4	1,082785	1,139879	1,234244	1,299324	1,172424	13,82417	-	14,24936
5	1,093422	1,164353	1,273129	1,355718	1,195571	14,63244	-	18,00358
6	1,056905	1,209515	1,278342	1,462927	1,117048	16,24899	-	42,53496
7	1,10721	1,240549	1,373548	1,538962	1,225914	17,46139	-	36,41713
8	1,143015	1,274158	1,456381	1,623478	1,306483	18,87587	-	35,7976
9	1,238046	1,305351	1,616085	1,703942	1,532758	20,29034	-	17,28521
10	1,243038	1,340444	1,666223	1,79679	1,545144	22,00792	-	25,75952
Jami	10,79877	11,86116	12,9099	14,16899	11,77788	0		285,0629
O'rta	1,079877	1,186116	1,29099	1,416899	1,177788	0		28,50629
□□□	0,011653	0,010027						
□□	0,10795	0,100134						

$$b = \frac{cov(x, y)}{\sigma_x^2} = \frac{\bar{y}x - \bar{y} \cdot \bar{x}}{\bar{x}^2 - \bar{x}^2} = \frac{1,28791 - 1,079877 \cdot 1,183201}{1,416899 - 1,183201^2} = 1,004$$

$$s = \bar{y} - b \cdot \bar{x} = 1,079877 - 1,004 \cdot 1,183201 = -0,10806$$

Bundan regressiya tenglamasi quyidagi ko'rinishga ega bo'ladi:

$$y_x = -0,10806 + 1,004 \cdot x$$

Potensiallab quyidagiga ega bo'lamiz:

$$y_x = 10^{-0,10806} \cdot x^{1,004} = 0,779722 \cdot x^{1,004}$$

$$r_{xy} = \sqrt{1 - \frac{\sum(y - y_x)^2}{\sum(y - \bar{y})^2}} = \sqrt{1 - \frac{10,31902}{93,51801}} = 0,943217$$

$$A = \frac{1}{n} \sum \left| \frac{y - \bar{y}}{y} \right| \cdot 100\% = 7,8$$

1c. Tenglamani ko'rsatkichli funksiya ko'rinishida olamiz.

$$y = a \cdot b^x$$

$$\lg y = \lg a + x \cdot \lg b,$$

$$y = c + b \cdot x$$

4-jadval

N	X	Y	XY	X ²	Y ²	Y _x	Y-Y _x	(Y-Y _x) ²	Ai
1	10,5	0,90955 6	9,55033 8	110,25	0,82729 2	8,60349 6	-0,4835	0,23376 9	5,95438 8
2	11,6	1	11,6	134,56	1	9,23908 5	0,76091 5	0,57899 1	7,60914 8
3	12,3	0,92479 6	11,3749 9	151,29	0,85524 8	9,66778 5	- 1,25778	1,58202 2	14,9558 2
4	13,7	1,08278 5	14,8341 6	187,69	1,17242 4	10,5857 8	1,51421 8	2,29285 5	12,5141 9
5	14,5	1,09342 2	15,8546 1	210,25	1,19557 1	11,1489 8	1,25102 4	1,56506 2	10,0889 1
6	16,1	1,05690 5	17,0161 7	259,21	1,11704 8	12,3668 5	- 0,96685	0,93479 2	8,48110 7
7	17,3	1,10721	19,1547 3	299,29	1,22591 4	13,3667 8	- 0,56678	0,32124 5	4,42800 6
8	18,7	1,14301 5	21,3743 8	349,69	1,30648 3	14,6360 2	- 0,73602	0,54172 3	5,29509 8
9	20,1	1,23804 6	24,8847 3	404,01	1,53275 8	16,0257 7	1,27422 8	1,62365 8	7,36548 2
10	21,8	1,24303 8	27,0982 3	475,24	1,54514 4	17,8919 2	- 0,39192	0,15360 1	2,23954 2

Jami	156,6	10,7987 7	172,742 3	2581,4 8	11,7778 8	123,532 5		9,82771 8	78,9316 9
O'rtacha	15,66	1,07987 7	17,2742 3	258,14 8	1,17778 8			0,98277 2	7,89316 9
σ	3,59338 3	0,10795							
σ^2	12,9124	0,01165 3							

$$b = \frac{cov(x, y)}{\sigma_x^2} = \frac{\bar{y}x - \bar{y} \cdot \bar{x}}{\bar{x}^2 - \bar{x}^2} = \frac{17,27423 - 15,66 \cdot 1,079877}{258,148 - 15,66^2} = 0,02814$$

$$s = \bar{y} - b \cdot \bar{x} = 1,079877 - 0,02814 \cdot 15,66 = 0,639205$$

Bundan regressiya tenglamasi quyidagi ko'rinishga ega bo'ladi:

$$y_x = 0,639205 + 0,02814 \cdot x$$

Potensiallab quyidagiga ega bo'lamiz:

$$y_x = 10^{0,639205} \cdot 10^{0,2814x} = 4,357175 \cdot 1,06694^x$$

$$r_{xy} = \sqrt{1 - \frac{\sum(y - y_x)^2}{\sum(y - \bar{y})^2}} = \sqrt{1 - \frac{9,827718}{93,51801}} = 0,945997$$

$$A = \frac{1}{n} \sum \left| \frac{y - \bar{y}}{y} \right| \cdot 100\% = 7,9$$

1d. Tenglamani giperbola ko'rinishida olamiz.

$$y = a + b \cdot \frac{1}{x}$$

Bu regressiya tenglamasini chiziqli tenglama ko'rinishiga keltirish uchun quydagicha bulgilash olamiz:

$$z = \frac{1}{x}$$

U holda tenglama $y = a + b \cdot z$ ko'rinishga keladi.

N	Z	Y	ZY	Z2	Y2	Yz	Y-Yz	(Y-Yz) ²	Ai
1	0,09523 8	8,12		0,00907	65,9344	7,62767 4	0,49232 6	0,24238 5	6,06313

2	0,08620 7	10	0,86206 9	0,00743 2	100	9,17208 1	0,82791 9	0,68545	8,27919
3	0,08130 1	8,41	0,68374	0,00661	70,7281	10,0110 6	- 1,60106	2,56339 5	19,0375 8
4	0,07299 3	12,1	0,88321 2	0,00532 8	146,41	11,4318 1	0,66818 6	0,44647 2	5,52219 6
5	0,06896 6	12,4	0,85517 2	0,00475 6	153,76	12,1204 9	0,27950 5	0,07812 3	2,25407 4
6	0,06211 2	11,4	0,70807 5	0,00385 8	129,96	13,2925 4	- 1,89254	3,58168 9	16,6011 9
7	0,05780 3	12,8	0,73988 4	0,00334 1	163,84	14,0292 9	- 1,22929	1,51116 5	9,60386 3
8	0,05347 6	13,9	0,74331 6	0,00286	193,21	14,7693 4	- 0,86934	0,75574 7	6,25422 4
9	0,04975 1	17,3	0,86069 7	0,00247 5	299,29	15,4062 9	1,89371 1	3,58614	10,9463
10	0,04587 2	17,5	0,80275 2	0,00210 4	306,25	16,0697 5	1,43025 4	2,04562 6	8,17287 8
Jami	0,67371 8	123,93	7,13891 6	0,04783 4	1629,38 3	123,930 3	0	15,4961 9	92,7346 3
O'rtacha	0,06737 2	12,393	0,79321 3	0,00478 3	162,938 3			1,54961 9	9,27346 3
σ	0,01563 5	3,05807 1							
σ^2	0,00024 4	9,35180 1							

$$b = \frac{cov(z, y)}{\sigma_z^2} = \frac{\bar{y}\bar{z} - \bar{y} \cdot \bar{z}}{\bar{z}^2 - z^2} = \frac{0,793213 - 12,393 \cdot 0,067372}{0,004783 - 0,067372^2} = -171,008$$

$$a = \bar{y} - b \cdot \bar{z} = 12,393 + 171,008 \cdot 0,067372 = 23,91415$$

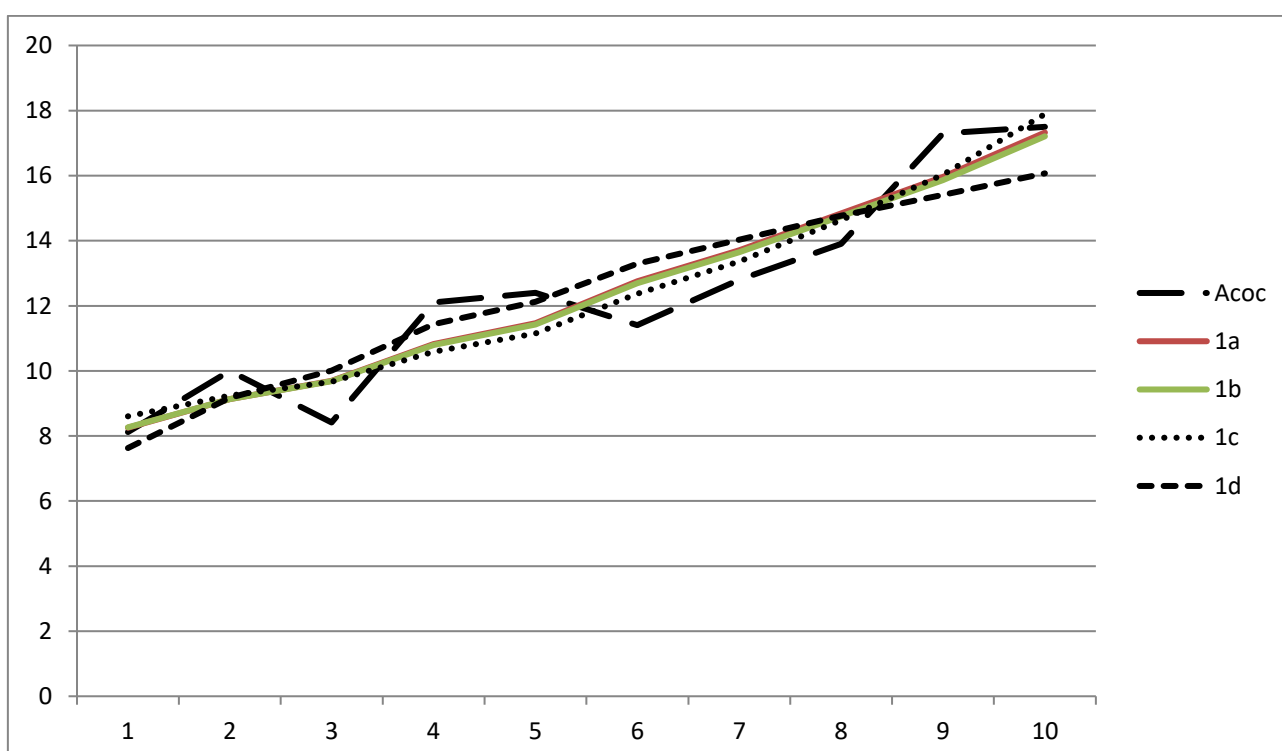
Bundan regressiya tenglamasi quyidagi ko'rinishga ega bo'ladi:

$$y_x = 23,91415 - 171,008 \cdot \frac{1}{x}$$

$$r_{xy} = \sqrt{1 - \frac{\sum(y - y_z)^2}{\sum(y - \bar{y})^2}} = \sqrt{1 - \frac{15,49619}{93,51801}} = 0,913399$$

$$A = \frac{1}{n} \sum \left| \frac{y - \bar{y}}{y} \right| \cdot 100\% = 9,3$$

№	Regressiya tenglamasi	Korrelyasiya koeffitsiyenti	O'rtacha aproksimasiya xatosini
1a	$y_x = -0,180 + 0,803 \cdot x$	$r_{xy} = 0,94517$	$A = 7,8$
1b	$y_x = 0,779722 \cdot x^{1,004}$	$r_{xy} = 0,943217$	$A = 7,8$
1c	$y_x = 4,357175 \cdot 1,06694^x$	$r_{xy} = 0,945997$	$A = 7,9$
1d	$y_x = 23,91415 - 171,008 \cdot \frac{1}{x}$	$r_{xy} = 0,913399$	$A = 9,3$



Regression tahlil bog'liq o'zgaruvchini bog'liqmas bilan bog'laydigan va tenglama koeffitsiyentlaridan iborat noma'lum parametrlarni o'z ichiga olgan regressiya tenglamasi ko'rinishidagi model tuzishdan iborat. Agar tenglama parametrlarga nisbatan chiziq bo'lsa, u holda regressiya chiziq, aks holda chiziqmas hisoblanadi. Bunda 2 masala yechiladi:

- o'zgaruvchilar orasida sabab-oqibat bog'lanishlar borligi tekshiriladi ;
- bog'liqmas o'zgaruvchilar qiymatlaridan bog'liq o'zgaruvchilar qiymatlarini bashoratlash

Agar x va y orasidagi bogliqlik chiziq deb taxmin qilinsa, u holda $y = b_0 + b_1x$ orqali ifodalinishi mumkin, bu yerda b_0, b_1 – tenglama parametrlari.

Bu holda regression tahlil maqsadi b_0, b_1 – tenglama parametrlari uchun statistik ma'nodagi eng yaxshi baholarni qidirishdan iborat.

Ularning qiymatlari $x=x_i$ da y ning bashorat qilinayotgan yechimini topish imkonini beradi.

b_0, b_1 – tenglama parametrlarini topish uchun eng kichik kvadratlar usuli qo'llaniladi, Masala. x va y o'zgaruvchilarning tajriba natijasida olgan qiymatlari quyidagi jadvalda keltirilgan

Xi	0	1	2	4	5
Yi	2,1	2,4	2,6	2,8	3,0

Eng kichik kvadratlar usulini qo'llab bu qiymatlarga yaqinlashuvchi $y=ax+b$ chiziqli bog'lanish (a va b parametrlar)ni toping.

Funksiyadan a va b parametrlar bo'yicha hususiy hosila olamiz

$$F(a,b) = \sum_{i=1}^n (y_i - (ax_i + b))^2$$

$$\left\{ \begin{array}{l} \frac{\partial F(a,b)}{\partial a} = 0 \\ \frac{\partial F(a,b)}{\partial b} = 0 \end{array} \right\} \Leftrightarrow \left\{ \begin{array}{l} -2 \sum_{i=1}^n (y_i - (ax_i + b))x_i = 0 \\ -2 \sum_{i=1}^n (y_i - (ax_i + b)) = 0 \end{array} \right\} \left\{ \begin{array}{l} a \sum_{i=1}^n x_i^2 + b \sum_{i=1}^n x_i = \sum_{i=1}^n x_i y_i \\ a \sum_{i=1}^n x_i + nb = \sum_{i=1}^n y_i \end{array} \right\}$$

hosil bo'lgan ikki noma'lumli ikkita tenglamalar sistemasini yechamiz

$$a = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i \right)^2}$$

$$b = \frac{\sum_{i=1}^n y_i - a \sum_{i=1}^n x_i}{n}$$

Topilgan a va b qiymatlarda

$$F(a,b) = \sum_{i=1}^n (y_i - (ax_i + b))^2$$

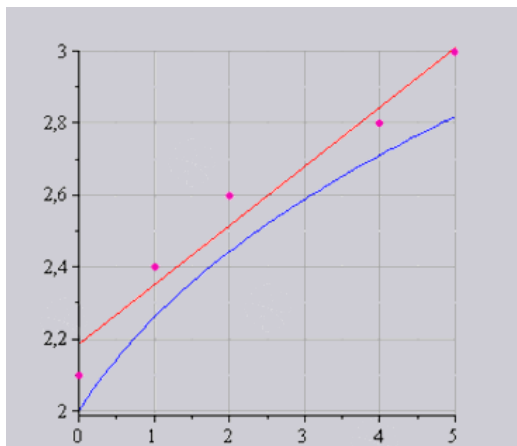
Funksiya eng kichik qiymatga erishadi.

	i=1	i=2	i=3	i=4	i=5	
Xi	0	1	2	4	5	12
Yi	2,1	2,4	2,6	2,8	3,0	12,9
Xi * Yi	0	2,4	5,2	11,2	15,0	33,8

$X_i \cdot X_i$	0	1	4	16	25	46
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$$\begin{cases} a = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i \right)^2} \\ b = \frac{\sum_{i=1}^n y_i - a \sum_{i=1}^n x_i}{n} \end{cases} \Rightarrow \begin{cases} a = \frac{5 \cdot 33,8 - 12 \cdot 12,9}{5 \cdot 46 - 12^2} \\ b = \frac{12,9 - a \cdot 12}{5} \end{cases} \Rightarrow \begin{cases} a \approx 0,165 \\ b \approx 2,184 \end{cases}$$

a va b o'rniga qiymatlarini qo'yib, $y = 0.165x + 2.184$ – yaqinlashuvchi chiziqqa ega bo'lamiz.



Yuqoridagi chiziq –EKKU bilan topilgan $y = ax + b$ chiziq, pastki chiziq– berilgan funksiya grafigi.

Masala: Firma mahsulotlarni shahar ichidagi yaqin masofalarga tarqatadi. Bunday xizmatlarni tashishga ketadigan vaqtga bog'liq holda baholang. Tashish vaqtiga eng ko'p ta'sir qiladigan omil sifatida o'tilgan masofa belgilangan.

Masofa km	3,5	2,4	4,9	4,2	3,0	1,3	1,0	3,0	1,5	4,1
Vaqt, min	16	13	19	18	12	11	8	14	9	16

x_i	3,5	2,4	4,9	4,2	3,0	1,3	1,0	3,0	1,5	4,1	Σ
y_i	16	13	19	18	12	11	8	14	9	16	136
$x_i \cdot x_i$	12	5,8	24	18	9	1,7	1	9	2	17	99
$y_i \cdot x_i$	56	31	93	76	36	14	8	42	14	66	435

$$\bar{y} = \frac{\sum y_i}{n} = \frac{16+13+19+18+12+11+8+14+9+16}{10} = 13,6$$

$$a_1 = \frac{n(\sum y_i x_i) - \sum y_i \sum x_i}{n(\sum x_i^2) - (\sum x_i)^2}; \quad a_0 = \frac{1}{n}(\sum y_i - a_1 \sum x_i)$$

$$a_1 = \frac{10 \cdot 435,30 - 136 \cdot 28,9}{10 \cdot 99,41 - 835,21} = 2,660; \quad a_0 = 0,1 \cdot (136 - 2,660 \cdot 28,9) = 5,913.$$

Qidirilayotgan regression bog'liqlik quyidagicha bo'ladi

$$y^p = 5,913 + 2,660x.$$

Regressiya chizig'ining qiyaligi 2,66 min/km, bu 1 km masofaga ketadigan vaqt. To'g'ri chiziqning Y o'qi bilan kesishgan nuqtasi 5,913 минут – bu o'tilgan masofaga bog'liq bo'lmagan vaqt

Vazifalar:

№	1	2	3	4	5	6	7	8	9	10
X	10,5+0,	11,6+0,	12,3+0,	13,7+0,	14,5+0,	16,1+0,	17,3+0,	18,7+0,	20,1+0,	21,8+0,
	n	n	n	n	n	n	n	n	n	n
Y	8,12	10	8,41	12,1	12,4	11,4	12,8	13,9	17,3	17,5

n-talabning tartib raqami

Iqtisodiy-ijtimoiy muammolarni korrelyasion-regression tahlil usullari bilan samarali modellashtirishda qaralayotgan omillar o'rtasidagi eng yaxshi bog'lanish shakllarini tanlash katta rol o'ynaydi. Biz ushbu bo'limda ko'pchilik hollarda foydalaniladigan regressiya funksiyalarining matematik modellarini va mo-dellardagi noma'lum parametrlarni aniqlash uchun eng kichik kvad-ratlar usuli bilan hosil qilingan normal tenglamalar tizimini keltiramiz.

1. Chiziqli funksiya $y = a_0 + a_1 x$

$$\begin{cases} na_0 + a_1 \sum x = \sum y, \\ a_0 \sum x + a_1 \sum x^2 = \sum y \cdot x. \end{cases} \quad (1.1)$$

2. Ikkinchi darajali parabola $y = a_0 + a_1 x + a_2 x^2$

$$\begin{cases} na_0 + a_1 \sum x + a_2 \sum x^2 = \sum y, \\ a_0 \sum x + a_1 \sum x^2 + a_2 \sum x^3 = \sum y \cdot x, \\ a_0 \sum x^2 + a_1 \sum x^3 + a_2 \sum x^4 = \sum y \cdot x^2. \end{cases} \quad (1.2)$$

3. Kubik parabola $y = a_0 + a_1 x + a_2 x^2 + a_3 x^3$

$$\begin{cases} na_0 + a_1 \sum x + a_2 \sum x^2 + a_3 \sum x^3 = \sum y, \\ a_0 \sum x + a_1 \sum x^2 + a_2 \sum x^3 + a_3 \sum x^4 = \sum y \cdot x, \\ a_0 \sum x^2 + a_1 \sum x^3 + a_2 \sum x^4 + a_3 \sum x^5 = \sum y \cdot x^2, \\ a_0 \sum x^3 + a_1 \sum x^4 + a_2 \sum x^5 + a_3 \sum x^6 = \sum y \cdot x^3. \end{cases} \quad (1.3)$$

4. k – darajali polinom $y = a_0 + a_1x + a_2x^2 + \dots + a_nx^k$

$$\begin{cases} na_0 + a_1 \sum x + a_2 \sum x^2 + \dots + a_n \sum x^k = \sum y, \\ a_0 \sum x + a_1 \sum x^2 + a_2 \sum x^3 + \dots + a_n \sum x^{k+1} = \sum y \cdot x, \\ \dots \\ a_0 \sum x^k + a_1 \sum x^{k+1} + a_2 \sum x^{k+2} + \dots + a_n \sum x^{2k} = \sum y \cdot x^k. \end{cases} \quad (1.4)$$

5. Giperbola $y = a_0 + \frac{a_1}{x}$

$$\begin{cases} na_0 + a_1 \sum \frac{1}{x} = \sum y, \\ a_0 \sum \frac{1}{x} + a_1 \sum \frac{1}{x^2} = \sum \frac{y}{x}. \end{cases} \quad (1.5)$$

6. k – darajali giperbola $y = a_0 + \frac{a_1}{x^k}$

$$\begin{cases} na_0 + a_1 \sum \frac{1}{x^k} = \sum y, \\ a_0 \sum \frac{1}{x^k} + a_1 \sum \frac{1}{x^{2k}} = \sum \frac{y}{x^k}. \end{cases} \quad (1.6)$$

7. Ko'rsatkichli funksiya $y = a_0 \cdot a_1^x$

$$\begin{cases} n \ln a_0 + \ln a_1 \sum x = \sum \ln y, \\ \ln a_0 \sum x + \ln a_1 \sum x^2 = \sum x \cdot \ln y. \end{cases} \quad (1.7)$$

8. Darajali (bir resursli ishlab chiqarish) funksiya $y = a_0 x^{a_1}$

$$\begin{cases} n \ln a_0 + a_1 \sum \ln x = \sum \ln y, \\ \ln a_0 \sum \ln x + a_1 \sum \ln^2 x = \sum \ln y \cdot \ln x. \end{cases} \quad (1.8)$$

9. Logarifmik funksiya $\ln y = a_0 + a_1x$

$$\begin{cases} na_0 + a_1 \sum x = \sum \ln y, \\ a_0 \sum x + a_1 \sum x^2 = \sum x \cdot \ln y. \end{cases} \quad (1.9)$$

10. Yarim logarifmik funksiya $y = a_0 + a_1 \ln x$

$$\begin{cases} na_0 + a_1 \sum \ln x = \sum y, \\ a_0 \sum \ln x + a_1 \sum \ln^2 x = \sum y \cdot \ln x. \end{cases} \quad (1.10)$$

11. Logistik funksiya $y = \frac{a_0}{1 + a_1 \cdot e^{-bx}}$

Eng avvalo berilgan funktsiyani $\frac{a_0}{y} = 1 + a_1 e^{-bx}$ ko'rinishga keltiramiz, so'ngra eng kichik kvadratlar usuli bilan quyidagi tenglamalar tizimini hosil qilamiz:

$$\begin{cases} a_0 \sum \frac{1}{y^2} + a_1 \cdot \left(- \sum \frac{e^{-bx}}{y} \right) = \sum \frac{1}{y}, \\ a_0 \cdot \left(- \sum \frac{e^{-bx}}{y} \right) + a_1 \cdot \sum e^{-2bx} = \sum e^{-bx}. \end{cases} \quad (1.11)$$

12. Neoklassik foydalilik Kobba-Duglas ishlab chiqarish funktsiyasi

$$y = a_0 \cdot x_1^{a_1} \cdot x_2^{a_2} \quad (a_1 + a_2 \leq 1).$$

Model darajasidagi parametrlarni aniqlash uchun, avvalo modelni logarifmik-chiziqli ko'rinishga o'zgartirish lozim:

$$\ln y = \ln a_0 + a_1 \ln x_1 + a_2 \ln x_2.$$

Shundan so'ng normal tenglamalar tizimini tuzishda loga-rifmlardan foydalanamiz:

$$\begin{cases} n \ln a_0 + a_1 \sum \ln x_1 + a_2 \sum \ln x_2 = \sum \ln y, \\ \ln a_0 \sum \ln x_1 + a_1 \sum \ln^2 x_1 + a_2 \sum \ln x_1 \cdot \ln x_2 = \sum \ln x_1 \cdot \ln y, \\ \ln a_0 \sum \ln x_2 + a_1 \sum \ln x_1 \cdot \ln x_2 + a_2 \sum \ln^2 x_2 = \sum \ln x_2 \cdot \ln y. \end{cases} \quad (1.12)$$

Regressiya tenglamasining shaklini tanlashda quyidagilarga e'tibor qilish lozim:

1. Bog'lanishni umumiy shakli, bog'lanishning tabiati va xusu-siyatiga nisbatan professional tushuncha mos kelishi kerak.

2. Imkoni boricha interpretasiya va amaliy qo'llashda oson bo'l-gan tenglamalarning eng sodda shakllaridan foydalanish kerak. Boshlang'ich ma'lumotlarning grafik tasviri - tarqoqlik diagram-masi va regressiyaning empirik chiziqlari regressiyalarini teng-lama shakllarini tanlashda yordam beradi.

Endi ikki omilli chiziqli modelni qaraylik:

$$y = a_0 + a_1x_1 + a_2x_2 \quad (2.16)$$

a_0, a_1, a_2 parametrlar quyidagi tenglamalar tizimini yechish orqali topiladi:

$$\begin{cases} na_0 + a_1 \sum x_1 + a_2 \sum x_2 = \sum y, \\ a_0 \sum x_1 + a_1 \sum x_1^2 + a_2 \sum x_1x_2 = \sum yx_1, \\ a_0 \sum x_2 + a_1 \sum x_1x_2 + a_2 \sum x_2^2 = \sum yx_2. \end{cases} \quad (2.17)$$

Bunda to'plamli korrelyatsiya koeffitsiyenti quyidagicha topiladi:

$$R_{yx_1x_2} = \sqrt{\frac{r_{yx_1}^2 + r_{yx_2}^2 - 2r_{yx_1}r_{yx_2}r_{x_1x_2}}{1 - r_{x_1x_2}^2}} \quad (2.18)$$

$r_{yx_1}, r_{yx_2}, r_{x_1x_2}$ - korrelyatsiya koeffitsiyentlari (2.15) formulaga o'xshash formulalar orqali hisoblanadi:

$$\begin{cases} r_{yx_k} = \frac{\overline{x_k \cdot y} - \bar{x}_k \cdot \bar{y}}{\sigma_{x_k} \cdot \sigma_y}, \\ r_{x_1x_2} = \frac{\overline{x_1 \cdot x_2} - \bar{x}_1 \cdot \bar{x}_2}{\sigma_{x_1} \cdot \sigma_{x_2}}, \end{cases} \quad (k=1; 2) \quad (2.19)$$

$$\begin{cases} \sigma_{x_k} = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_k^{(i)} - \bar{x}_k)^2} = \sqrt{\bar{x}_k^2 - (\bar{x}_k)^2}, \\ \sigma_y = \sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2} = \sqrt{\bar{y}^2 - (\bar{y})^2}. \end{cases} \quad (k=1; 2) \quad (2.20)$$

Mavzuni mustahkamlash uchun savollar.

1. Ishlab chiqarish funksiyasini ta'rifini ayting.
2. Korrelyatsion taxlil va uning vazifasini ayting.
3. Regressiya koefitsiyentlari va uning iqtisodiy mazmuni nima?
4. Chiziqli bog'langan ishlab chiqarish funksiyalarining korrelyasion modellari va ularning parametrlarini aniqlashni tushuntiring.
5. Bir omilli bog'lanishni umumiy ko'rinishini yozing va mohiyatini tushuntiring. Ularning parametrlari qanday aniqlanadi?
6. Ikki omilli bog'lanishni umumiy ko'rinishini yozing va mohiyatini tushuntiring. Ularning parametrlari qanday aniqlanadi.
7. Uch omilli bog'lanishni umumiy ko'rinishini yozing va mohiyatini tushuntiring. Ularning parametrlari qanday aniqlanadi.
8. Parabolik bog'lanishni mohiyatini tushuntiring. Parametrlari qanday aniqlanadi?
9. Giperbolik bog'lanishni mohiyatini tushuntiring. Parametrlari qanday aniqlanadi?
10. Murakkab bog'lanishli korrelyasion modellari va ularning parametrlarini aniqlash qanday amalga oshiriladi ?
11. Korelyasiya koeffitsiyenti nima va mazmunini ayting.

Adabiyotlar ruyxati

Asosiy va qo'shimcha o'quv adabiyotlari va hamda axborot manbalari

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