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Buxoro muhandislik – texnologiya instituti, dotsent.

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RYUKZAK MASALASINI DINAMIK DASTURLASH YORDAMIDA SAMARALI YECHISH ALGORITMLARI VA OPTIMAL KO‘YLAK TO‘PLAMINI ANIQLASH

Mamatova Zilolaxon Xabibulloxonovna
Farg‘ona davlat universiteti dotsenti, pedagogika fanlari bo‘yicha falsafa doktori (PhD)
E-mail: mamatova.zilolakhon@gmail.com
Orcid: 0009-0009-9247-3510
Mamasiddiqova Sarvinoz Dilshod qizi
Farg‘ona davlat universiteti talabasi
E-mail: sarvinozmamasiddiqova39@gmail.com

Annotatsiya. Ushbu maqolada kombinatorial optimallashtirish sohasidagi muhim masalalardan biri - ryugzak masalasi ko‘rib chiqiladi. Masala amaliy vaziyat asosida shakllantirilib, cheklangan sig‘im sharoitida maksimal qiymatni aniqlash maqsad qilingan. Har bir elementning og‘irligi va qiymati berilgan holda, optimal tanlovni topish uchun dinamik dasturlash usuli qo‘llanilgan. Rekurrent tenglamalar asosida hisoblash jarayoni bosqichma-bosqich amalga oshirilgan va natijada eng yuqori daromad beruvchi optimal yechim aniqlangan.

Kalit so‘zlar: ryugzak masalasi, dinamik dasturlash, optimallashtirish, rekurrent tenglama, maksimal qiymat, algoritm, kombinatorial masala.

Annotation. This article examines one of the classical problems in combinatorial optimization - the knapsack problem. The problem is formulated based on a practical scenario where the objective is to maximize total value under limited capacity constraints. Given the weights and values of items, the optimal solution is determined using the dynamic programming approach. The solution process is carried out step by step using recursive relations, and the final result identifies the optimal combination that yields the maximum profit.

Keywords: knapsack problem, dynamic programming, optimization, recursive equation, maximum value, algorithm, combinatorial problem.

Аннотация. В данной статье рассматривается одна из классических задач комбинаторной оптимизации - задача о рюкзаке. Задача формулируется на основе практической ситуации, где требуется максимизировать суммарную стоимость при ограниченной вместимости. При заданных значениях веса и стоимости элементов оптимальное решение находится с использованием метода динамического программирования. Процесс решения выполняется поэтапно на основе рекуррентных соотношений, в результате чего определяется оптимальный набор, обеспечивающий максимальную прибыль.

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Ключевые слова: задача о рюкзаке, динамическое программирование, оптимизация, рекуррентное уравнение, максимальное значение, алгоритм, комбинаторная задача.

KIRISH.

Optimallashtirish masalalari zamonaviy iqtisodiyot, logistika va biznesda muhim o‘rin tutadi. Ayniqsa, cheklangan resurslar sharoitida maksimal foyda olish muammosi kundalik hayotda keng uchraydi. Ryugzak masalasi (Knapsack Problem) shunday masalalar sinfiga kiradi: berilgan og‘irlik chegarasi doirasida qiymatlar yig‘indisini maksimallashtirishni talab etadi.

Ushbu maqolada quyidagi amaliy vaziyat ko‘rib chiqiladi: savdogar chet eldan ayollar uchun mo‘ljallangan 10 ta xorijiy brend ko‘ylaklarni tanlashi lozim. Har bir brendning narxi va og‘irligi ma’lum, ryugzakning sig‘imi esa W = 10 kg bilan cheklangan. Masala dinamik dasturlash algoritmidan foydalanib, qadam-baqadam yechish yo‘li ko‘rsatiladi.

Dinamik dasturlash - murakkab masalani kichik qismlarga bo‘lib, har bir qismning yechimini jadvalda saqlash orqali umumiy optimal yechimni topish usulidir. Bu metod 1950-yillarda Richard Bellman tomonidan ishlab chiqilgan bo‘lib, bugungi kunda keng qo‘llaniladi.

Ryugzak masalasining matematik shakllanishi: n ta buyum berilgan bo‘lib, i-buyumning og‘irligi a_i va qiymati C_i bo‘lsin. Ryugzakning sig‘imi W bilan cheklangan. $x_i \in \{0,1,2,...\}$ buyumning olingan soni bo‘lsa, masala quyidagi ko‘rinishda yoziladi:

$$Z = \Sigma\, C_i \cdot x_i \;\rightarrow\; \max$$

$$\Sigma\, a_i \cdot x_i \le W, \quad x_i \ge 0, \quad x_i \text{ — butun son}$$

Dinamik dasturlash yordamida $\varphi_k(y)$ kiritiladi — k ta buyum ichidan y og‘irlik chegarasida olinadigan maksimal qiymat. Rekurrent tenglama:

$$\varphi_k(y) = \max \{\, \varphi_{k-1}(y) \;;\; \varphi_k(y - a_k) + C_k \,\}, \quad y \ge a_k$$

$$\varphi_k(y) = \varphi_{k-1}(y), \quad y < a_k$$

Boshlang‘ich shart: $\varphi_1(y) = C_1 \cdot \lfloor y / a_1 \rfloor$, $y = 1, 2, \ldots, W$.

Indeks funksiyasi i(k; y) — y og‘irlik va k-qadam uchun qaysi brend tanlanganini ko‘rsatadi:

$$i(k; y) = k, \quad agar\ \varphi_k(y - a_k) + C_k \ge \varphi_{k-1}(y)$$

$$i(k; y) = i(k-1; y),$$

aks holda

Optimal yechimni tiklash: i(n; W) dan boshlab i(k; $y-a_k$) ga o‘tib, i(k;y)=0 bo‘lguncha davom etiladi.

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Masala. Savdogar chet eldan quyidagi 10 ta brend ayollar ko‘ylaklaridan olib kelishi mumkin. Ryugzak sig‘imi W = 10 kg. Maqsad - umumiy qiymatni maksimallashtirish.

1-jadval.

Ko‘ylak brendlari va ularning parametrlari

№	Brend nomi	C_i (narx, $)	a_i (og‘irlik, kg)	Turi
1	Chanel	9,000	8	Ko‘ylak
2	Dior	6,000	6	Ko‘ylak
3	Gucci	5,000	7	Ko‘ylak
4	Valentino	7,000	5	Ko‘ylak
5	Saint Laurent	4,000	4	Ko‘ylak
6	The Row	6,000	3	Ko‘ylak
7	Max Mara	3,000	6	Ko‘ylak
8	Brunello Cucinelli	8,000	2	Ko‘ylak
9	Maje	550	10	Ko‘ylak
10	Sandro	600	15	Ko‘ylak

Yechish. Quyida har bir k = 1, 2, …, 10 qadam uchun $\varphi_k(y)$ va i(k;y) funksiyalari y = 1, 2, …, 10 uchun ketma-ket hisoblanadi. Rekurrent tenglama asosida oldingi qadam qiymatlari ishlatiladi.

[k = 1] bo‘lganda $\varphi_1(y)$ ni hisoblash ($C_1 = 9000, a_1 = 8$)

$\varphi_1(y) = C_1 \cdot [y / a_1] = 9000 \cdot [y / 8]$

$\varphi_1(1) = 9000 \cdot [1/8] = 0$

$\varphi_1(7) = 9000 \cdot [7/8] = 0$

$\varphi_1(8) = 9000 \cdot [8/8] = 9000$

$\varphi_1(9) = 9000 \cdot [9/8] = 9000$

$\varphi_1(10) = 9000 \cdot [10/8] = 9000$

[k = 1] bo‘lganda $i_1(y)$ ni hisoblash

i(1; 1) = 0, i(1; 2) = 0 …

i(1; 8) = 1, i(1; 9) = 1, i(1; 10) = 1

[k = 2] bo‘lganda $\varphi_2(y)$ ni hisoblash ($C_2 = 6000, a_2 = 6$)

$\varphi_2(y) = \max \{ \varphi_1(y) ; \varphi_2(y - 6) + 6000 \}$

$\varphi_2(1) = \max(\varphi_1(1), \varphi_2(1-6)+6000) = 0$

$\varphi_2(2) = \max(\varphi_1(2), \varphi_2(2-6)+6000) = 0$

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$\varphi_2(5) = \max(\varphi_1(5), \varphi_2(5-6)+6000) = 0$

$\varphi_2(6) = \max(\varphi_1(6), \varphi_2(6-6)+6000) = 6000$

$\varphi_2(7) = \max(\varphi_1(7), \varphi_2(7-6)+6000) = 6000$

$\varphi_2(8) = \max(\varphi_1(8), \varphi_2(8-6)+6000) = 9000$

$\varphi_2(9) = \max(\varphi_1(9), \varphi_2(9-6)+6000) = 9000$

$\varphi_2(10) = \max(\varphi_1(10), \varphi_2(10-6)+6000) = 9000$

[k = 2] bo‘lganda i(1; y) ni hisoblash

$\varphi_2(1-8)+9000 < \varphi_1(1) \Rightarrow i(1;1) = 0$

$\varphi_2(2-8)+9000 < \varphi_1(2) \Rightarrow i(1;2) = 0$

$\varphi_2(7-8)+9000 < \varphi_1(7) \Rightarrow i(1;7) = 0$

$\varphi_2(8-8)+9000 \geq \varphi_1(8) \Rightarrow i(1;8) = 2$

$\varphi_2(9-8)+9000 \geq \varphi_1(9) \Rightarrow i(1;9) = 2$

$\varphi_2(10-8)+9000 \geq \varphi_1(10) \Rightarrow i(1;10) = 2$

[k = 3] bo‘lganda $\varphi_3(y)$ nihisoblash ($C_3 = 5000, a_3 = 7$)

$\varphi_3(y) = \max \{ \varphi_2(y) ; \varphi_3(y - 7) + 5000 \}$

$\varphi_3(1) = 0, \quad \varphi_3(2) = 0, \quad \varphi_3(3) = 0, \quad \varphi_3(4) = 0$

$\varphi_3(5) = \max(\varphi_2(5), \varphi_3(5-7)+5000) = 6000$

$\varphi_3(6) = \max(\varphi_2(6), \varphi_3(6-7)+5000) = 6000$

$\varphi_3(7) = \max(\varphi_2(7), \varphi_3(7-7)+5000) = 6000$

$\varphi_3(8) = \max(\varphi_2(8), \varphi_3(8-7)+5000) = 9000$

$\varphi_3(9) = \max(\varphi_2(9), \varphi_3(9-7)+5000) = 9000$

$\varphi_3(10) = \max(\varphi_2(10), \varphi_3(10-7)+5000) = 9000$

[k = 3] bo‘lganda i(2; y) ni hisoblash

$\varphi_3(1-7)+5000 < \varphi_2(1) \Rightarrow i(2;1) = 0$

$\varphi_3(2-7)+5000 < \varphi_2(2) \Rightarrow i(2;2) = 0$

$\varphi_3(3-7)+5000 < \varphi_2(3) \Rightarrow i(2;3) = 0$

$\varphi_3(4-7)+5000 < \varphi_2(4) \Rightarrow i(2;4) = 0$

$\varphi_3(5-7)+5000 < \varphi_2(5) \Rightarrow i(2;5) = 0$

$\varphi_3(6-7)+5000 < \varphi_2(6) \Rightarrow i(2;6) = 0$

$\varphi_3(7-7)+5000 < \varphi_2(7) \Rightarrow i(2;7) = 0$

$\varphi_3(8-7)+5000 < \varphi_2(8) \Rightarrow i(2;8) = 2$

$\varphi_3(9-7)+5000 < \varphi_2(9) \Rightarrow i(2;9) = 2$

$\varphi_3(10-7)+5000 < \varphi_2(10) \Rightarrow i(2;10) = 2$

[k = 4] bo‘lganda $\varphi_4(y)$ ni hisoblash ($C_4 = 7000, a_4 = 5$)

$\varphi_4(y) = \max \{ \varphi_3(y) ; \varphi_4(y - 5) + 7000 \}$

$\varphi_4(1)=0, \quad \varphi_4(2)=0, \quad \varphi_4(3)=0, \quad \varphi_4(4)=0$

$\varphi_4(5) = \max(\varphi_3(5), \varphi_4(5-5)+7000) = 7000$

$\varphi_4(6) = \max(\varphi_3(6), \varphi_4(6-5)+7000) = 7000$

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$\varphi_4(7) = \max(\varphi_3(7), \varphi_4(7-5)+7000) = 7000$

$\varphi_4(8) = \max(\varphi_3(8), \varphi_4(8-5)+7000) = 9000$

$\varphi_4(9) = \max(\varphi_3(9), \varphi_4(9-5)+7000) = 9000$

$\varphi_4(10) = \max(\varphi_3(10), \varphi_4(10-5)+7000) = 14000$

[k = 4] bo‘lganda i(3; y) ni hisoblash

$\varphi_4(1-5)+7000 < \varphi_3(1) \implies i(3;1) = 0$

$\varphi_4(2-5)+7000 < \varphi_3(2) \implies i(3;2) = 0$

$\varphi_4(3-5)+7000 < \varphi_3(3) \implies i(3;3) = 0$

$\varphi_4(4-5)+7000 < \varphi_3(4) \implies i(3;4) = 0$

$\varphi_4(5-5)+7000 \geq \varphi_3(5) \implies i(3;5) = 3$

$\varphi_4(6-5)+7000 \geq \varphi_3(6) \implies i(3;6) = 3$

$\varphi_4(7-5)+7000 \geq \varphi_3(7) \implies i(3;7) = 3$

$\varphi_4(8-5)+7000 < \varphi_3(8) \implies i(3;8) = 2$

$\varphi_4(9-5)+7000 < \varphi_3(9) \implies i(3;9) = 2$

$\varphi_4(10-5)+7000 \geq \varphi_3(10) \implies i(3;10) = 3$

[k = 5] bo‘lganda $\varphi_5(y)$ ni hisoblash ($C_5 = 4000$, $a_5 = 4$)

$\varphi_5(y) = \max \{ \varphi_4(y) ; \varphi_5(y-4) + 4000 \}$

$\varphi_5(1)=0, \varphi_5(2)=0, \varphi_5(3)=0$

$\varphi_5(4) = \max(\varphi_4(4), \varphi_5(4-4)+4000) = 4000$

$\varphi_5(5) = \max(\varphi_4(5), \varphi_5(5-4)+4000) = 7000$

$\varphi_5(6) = \max(\varphi_4(6), \varphi_5(6-4)+4000) = 7000$

$\varphi_5(7) = \max(\varphi_4(7), \varphi_5(7-4)+4000) = 7000$

$\varphi_5(8) = \max(\varphi_4(8), \varphi_5(8-4)+4000) = 9000$

$\varphi_5(9) = \max(\varphi_4(9), \varphi_5(9-4)+4000) = 11000$

$\varphi_5(10) = \max(\varphi_4(10), \varphi_5(10-4)+4000) = 14000$

[k = 5] bo‘lganda i(4; y) ni hisoblash

$\varphi_5(1-4)+4000 < \varphi_4(1) \implies i(4;1) = 0$

$\varphi_5(2-4)+4000 < \varphi_4(2) \implies i(4;2) = 0$

$\varphi_5(3-4)+4000 < \varphi_4(3) \implies i(4;3) = 0$

$\varphi_5(4-4)+4000 \geq \varphi_4(4) \implies i(4;4) = 5$

$\varphi_5(5-4)+4000 < \varphi_4(5) \implies i(4;5) = 3$

$\varphi_5(6-4)+4000 < \varphi_4(6) \implies i(4;6) = 3$

$\varphi_5(7-4)+4000 < \varphi_4(7) \implies i(4;7) = 3$

$\varphi_5(8-4)+4000 < \varphi_4(8) \implies i(4;8) = 2$

$\varphi_5(9-4)+4000 \geq \varphi_4(9) \implies i(4;9) = 5$

$\varphi_5(10-4)+4000 < \varphi_4(10) \implies i(4;10) = 3$

[k = 6] bo‘lganda $\varphi_6(y)$ ni hisoblash ($C_6 = 6000$, $a_6 = 3$)

$\varphi_6(y) = \max \{ \varphi_5(y) ; \varphi_6(y-3) + 6000 \}$

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$\varphi_6(1)=0,\ \varphi_6(2)=0$

$\varphi_6(3) = \max(\varphi_5(3), \varphi_6(3-3)+6000) = 6000$

$\varphi_6(4) = \max(\varphi_5(4), \varphi_6(4-3)+6000) = 6000$

$\varphi_6(5) = \max(\varphi_5(5), \varphi_6(5-3)+6000) = 7000$

$\varphi_6(6) = \max(\varphi_5(6), \varphi_6(6-3)+6000) = 12000$

$\varphi_6(7) = \max(\varphi_5(7), \varphi_6(7-3)+6000) = 12000$

$\varphi_6(8) = \max(\varphi_5(8), \varphi_6(8-3)+6000) = 13000$

$\varphi_6(9) = \max(\varphi_5(9), \varphi_6(9-3)+6000) = 18000$

$\varphi_6(10) = \max(\varphi_5(10), \varphi_6(10-3)+6000) = 18000$

[k = 6] bo‘lganda i(5; y) ni hisoblash

$\varphi_6(1-3)+6000 < \varphi_5(1) \implies i(5;1) = 0$

$\varphi_6(2-3)+6000 < \varphi_5(2) \implies i(5;2) = 0$

$\varphi_6(3-3)+6000 \geq \varphi_5(3) \implies i(5;3) = 6$

$\varphi_6(4-3)+6000 \geq \varphi_5(4) \implies i(5;4) = 6$

$\varphi_6(5-3)+6000 < \varphi_5(5) \implies i(5;5) = 3$

$\varphi_6(6-3)+6000 \geq \varphi_5(6) \implies i(5;6) = 6$

$\varphi_6(7-3)+6000 \geq \varphi_5(7) \implies i(5;7) = 6$

$\varphi_6(8-3)+6000 \geq \varphi_5(8) \implies i(5;8) = 6$

$\varphi_6(9-3)+6000 \geq \varphi_5(9) \implies i(5;9) = 6$

$\varphi_6(10-3)+6000 \geq \varphi_5(10) \implies i(5;10) = 6$

[k = 7] bo‘lganda $\varphi_7(y)$ ni hisoblash ($C_7 = 3000, a_7 = 6$)

$\varphi_7(y) = \max \{ \varphi_6(y) ;\ \varphi_7(y - 6) + 3000 \}$

$\varphi_7(1)=0,\ \varphi_7(2)=0$

$\varphi_7(3) = \max(\varphi_6(3), \varphi_7(3-6)+3000) = 6000$

$\varphi_7(4) = \max(\varphi_6(4), \varphi_7(4-6)+3000) = 6000$

$\varphi_7(5) = \max(\varphi_6(5), \varphi_7(5-6)+3000) = 7000$

$\varphi_7(6) = \max(\varphi_6(6), \varphi_7(6-6)+3000) = 12000$

$\varphi_7(7) = \max(\varphi_6(7), \varphi_7(7-6)+3000) = 12000$

$\varphi_7(8) = \max(\varphi_6(8), \varphi_7(8-6)+3000) = 13000$

$\varphi_7(9) = \max(\varphi_6(9), \varphi_7(9-6)+3000) = 18000$

$\varphi_7(10) = \max(\varphi_6(10), \varphi_7(10-6)+3000) = 18000$

[k = 7] bo‘lganda i(6; y) ni hisoblash

$\varphi_7(1-6)+3000 < \varphi_6(1) \implies i(6;1) = 0$

$\varphi_7(2-6)+3000 < \varphi_6(2) \implies i(6;2) = 0$

$\varphi_7(3-6)+3000 < \varphi_6(3) \implies i(6;3) = 6$

$\varphi_7(4-6)+3000 < \varphi_6(4) \implies i(6;4) = 6$

$\varphi_7(5-6)+3000 < \varphi_6(5) \implies i(6;5) = 3$

$\varphi_7(6-6)+3000 < \varphi_6(6) \implies i(6;6) = 6$

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$\varphi_7(7-6)+3000 < \varphi_6(7) \implies i(6;7) = 6$

$\varphi_7(8-6)+3000 < \varphi_6(8) \implies i(6;8) = 6$

$\varphi_7(9-6)+3000 < \varphi_6(9) \implies i(6;9) = 6$

$\varphi_7(10-6)+3000 < \varphi_6(10) \implies i(6;10) = 6$

[k = 8] bo‘lganda $\varphi_8(y)$ ni hisoblash ($C_8 = 8000$, $a_8 = 2$)

$\varphi_8(y) = \max \{ \varphi_7(y) ; \varphi_8(y-2) + 8000 \}$

$\varphi_8(1) = \max(\varphi_7(1), \varphi_8(1-2)+8000) = 0$

$\varphi_8(2) = \max(\varphi_7(2), \varphi_8(2-2)+8000) = 8000$

$\varphi_8(3) = \max(\varphi_7(3), \varphi_8(3-2)+8000) = 8000$

$\varphi_8(4) = \max(\varphi_7(4), \varphi_8(4-2)+8000) = 16000$

$\varphi_8(5) = \max(\varphi_7(5), \varphi_8(5-2)+8000) = 16000$

$\varphi_8(6) = \max(\varphi_7(6), \varphi_8(6-2)+8000) = 24000$

$\varphi_8(7) = \max(\varphi_7(7), \varphi_8(7-2)+8000) = 24000$

$\varphi_8(8) = \max(\varphi_7(8), \varphi_8(8-2)+8000) = 32000$

$\varphi_8(9) = \max(\varphi_7(9), \varphi_8(9-2)+8000) = 32000$

$\varphi_8(10) = \max(\varphi_7(10), \varphi_8(10-2)+8000) = 40000$

[k = 8] bo‘lganda i(7; y) ni hisoblash

$\varphi_8(1-2)+8000 < \varphi_7(1) \implies i(7;1) = 0$

$\varphi_8(2-2)+8000 \geq \varphi_7(2) \implies i(7;2) = 8$

$\varphi_8(3-2)+8000 \geq \varphi_7(3) \implies i(7;3) = 8$

$\varphi_8(4-2)+8000 \geq \varphi_7(4) \implies i(7;4) = 8$

$\varphi_8(5-2)+8000 \geq \varphi_7(5) \implies i(7;5) = 8$

$\varphi_8(6-2)+8000 \geq \varphi_7(6) \implies i(7;6) = 8$

$\varphi_8(7-2)+8000 \geq \varphi_7(7) \implies i(7;7) = 8$

$\varphi_8(8-2)+8000 \geq \varphi_7(8) \implies i(7;8) = 8$

$\varphi_8(9-2)+8000 \geq \varphi_7(9) \implies i(7;9) = 8$

$\varphi_8(10-2)+8000 \geq \varphi_7(10) \implies i(7;10) = 8$

[k = 9] bo‘lganda $\varphi_9(y)$ ni hisoblash ($C_9 = 550$, $a_9 = 10$)

$\varphi_9(y) = \max \{ \varphi_8(y) ; \varphi_9(y-10) + 550 \}$

$\varphi_9(1) = 0$, $\varphi_9(2) = 8000$, $\varphi_9(3) = 8000$

$\varphi_9(4) = 16000$, $\varphi_9(5) = 16000$, $\varphi_9(6) = 24000$

$\varphi_9(7) = 24000$, $\varphi_9(8) = 32000$, $\varphi_9(9) = 32000$

$\varphi_9(10) = \max(\varphi_8(10), \varphi_9(10-10)+550) = 40000$ ✓

[k = 9] bo‘lganda i(8; y) ni hisoblash

$\varphi_9(1-10)+550 < \varphi_8(1) \implies i(8;1) = 0$

$\varphi_9(2-10)+550 < \varphi_8(2) \implies i(8;2) = 8$

$i(8;3) = 8$, $i(8;4) = 8$, $i(8;5) = 8$

$i(8;6) = 8$, $i(8;7) = 8$, $i(8;8) = 8$

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i(8;9) = 8, i(8;10) = 8 (Maje $\varphi_9(0)+550 \le \varphi_8(10)$)

[k = 10] bo‘lganda $\varphi_{10}(y)$ ni hisoblash ($C_{10} = 600, a_{10} = 15$)

$\varphi_{10}(y) = \max \{ \varphi_9(y) ; \varphi_{10}(y - 15) + 600 \}$

$a_{10} = 15 > W = 10$ bo‘lgani uchun Sandro hech qachon tanlanmaydi

$\varphi_{10}(y) = \varphi_9(y)$ barcha y uchun

$\varphi_{10}(1)=0$, $\varphi_{10}(2)=8000$, $\varphi_{10}(3)=8000$, $\varphi_{10}(4)=16000$

$\varphi_{10}(5)=16000$, $\varphi_{10}(6)=24000$, $\varphi_{10}(7)=24000$

$\varphi_{10}(8)=32000$, $\varphi_{10}(9)=32000$, $\varphi_{10}(10)=40000$

[k = 10] bo‘lganda i(9; y) ni hisoblash

$\varphi_{10}(1-15)+600 < \varphi_9(1) \implies i(9;1) = 0$

$\varphi_{10}(2-15)+600 < \varphi_9(2) \implies i(9;2) = 8$

$\varphi_{10}(3-15)+600 < \varphi_9(3) \implies i(9;3) = 8$

i(9;4) = 8, i(9;5) = 8, i(9;6) = 8

i(9;7) = 8, i(9;8) = 8, i(9;9) = 8, i(9;10) = 8

Optimal yechimni tiklash (Backtracking)

$\varphi_{10}(10) = 40\,000 \implies i(10;10) = 8 \implies x_8 = 1$ (Brunello Cucinelli)

$i(10; 10-a_8) = i(10; 8) = 8 \implies x_8 = 2$

$i(10; 8-2) = i(10; 6) = 8 \implies x_8 = 3$

$i(10; 6-2) = i(10; 4) = 8 \implies x_8 = 4$

$i(10; 4-2) = i(10; 2) = 8 \implies x_8 = 5$

$i(10; 2-2) = i(1; 0) = 0 \implies$ to‘xtash

$Z_{max} = C_8 \cdot x_8 = 8000 \cdot 5 = 40\,000$ $

2-jadval.

$\varphi_k(y)$ — maksimal qiymat funksiyasi jadvali ($)

k \ y	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	9,000	9,000	9,000
2	0	0	0	0	0	6,000	6,000	9,000	9,000	9,000
3	0	0	0	0	0	6,000	6,000	9,000	9,000	9,000
4	0	0	0	0	7,000	7,000	7,000	9,000	9,000	14,000
5	0	0	0	4,000	7,000	7,000	7,000	9,000	11,000	14,000
6	0	0	6,000	6,000	7,000	12,000	12,000	13,000	18,000	18,000
7	0	0	6,000	6,000	7,000	12,000	12,000	13,000	18,000	18,000
8	0	8,000	8,000	16,000	16,000	24,000	24,000	32,000	32,000	40,000

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9	0	8,000	8,000	16,000	16,000	24,000	24,000	32,000	32,000	40,000
10	0	8,000	8,000	16,000	16,000	24,000	24,000	32,000	32,000	40,000

3-jadval.

i(k;y) — indeks funksiyasi jadvali

k \ y	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0	0	0	0	0	0	0	1	1	1
2	0	0	0	0	0	0	0	2	2	2
3	0	0	0	0	0	0	0	2	2	2
4	0	0	0	0	3	3	3	2	2	3
5	0	0	0	5	3	3	3	2	5	3
6	0	0	6	6	3	6	6	6	6	6
7	0	0	6	6	3	6	6	6	6	6
8	0	8	8	8	8	8	8	8	8	8
9	0	8	8	8	8	8	8	8	8	8
10	0	8	8	8	8	8	8	8	8	8

OPTIMAL YECHIM.$\varphi_{10}(10)$ = 40 000 $ -bu maksimal daromad. i(10;10) = 8, demak Brunello Cucinelli brendi tanlangan.

Yechimni tiklash ketma-ketligi:

i(10;10)=8 → x_8=1; i(10;8)=8 → x_8=2; i(10;6)=8 → x_8=3; i(10;4)=8 → x_8=4;
i(10;2)=8 → x_8=5; i(1;0)=0 → to‘xtash.

$Z_{max} = C_8 \cdot x_8 = 8000 \cdot 5 = 40\,000$ so‘m

XULOSA. Ryugzak sig‘imi 10 kg bo‘lganda, eng optimal variant — Brunello Cucinelli brendidan 5 ta ko‘ylak olish (har biri 2 kg, jami 10 kg, umumiy narxi 40 000 $). Boshqa brendlarning narx/og‘irlik nisbati bu ko‘rsatkichga yetisha olmaydi.

Ushbu maqolada ryugzak masalasi amaliy ko‘ylak savdosi misolida dinamik dasturlash usuli yordamida yechildi. Asosiy natijalar:

1) Rekurrent tenglama asosida 10 qadam davomida $\varphi_k(y)$ va i(k;y) funksiyalari to‘liq hisoblab chiqildi.

2) Optimal yechim — Brunello Cucinelli brendidan 5 ta ko‘ylak (a_8=2 kg, C_8=8000 $).

3) Maksimal umumiy qiymat Z_{max} = 40 000 $, ryugzak to‘liq to‘ldiriladi (10 kg).

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4) Dinamik dasturlash metodi murakkab kombinatorial masalalarni samarali yechishga imkon beradi.

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