Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi
Pamukkale University Journal of Engineering Sciences

Kabul Edilmiş Araştırma Makalesi (Düzenlenmemiş Sürüm)

Accepted Research Article (Uncorrected Version)

Makale Başlığı / Title	Gerçek bir sınav çizelgeleme problemi için iki aşamalı çözüm yaklaşımı A two-phase solution approach for a real-life examination timetabling problem
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Referans No / Reference No	PAJES-96606
DOI	10.5505/pajes.2018.96606

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Pamukkale Univ Muh Bilim Derg, XX(X), XX-XX, 20XX

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Pamukkale University Journal of Engineering Sciences

'ÅÒëÅË ÂÉÒ ÓąÎÁÖ ëÉÚÅÌÇÅÌÅÍÅ ÐÒÏÂÌÅ

! ÔÖ ËÁÓÁ ÓÏÌÕÔÉÏÎ ÁÐÐÒÏÁÃÈ ÆÏÒ ÁÎ ÅØÁÍ ÔÉÍÅÔÁÂÌÉÎÇ ÐÒÏÂÌÅÍ

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Geliş Tarihi/ Received: 16.02.2018, Kabul Tarihi/ Accepted: 04.06.2018 doi: 10.5505/pajes.2018.96606

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vÚ

-ÎÉÖÅÒÓÉÔÅÌÅÒÄÅ ÉÌÇÉÌÉ ÆÁËÕÌÔÅ ÈÁÚąÒÌÁÎÍÁÓą ÏÌÄÕËÇÁ ÕÚÕÎ ÓİÒÅ ëÉÚÅÌÇÅÌÅÒÉ ëÏøÕ ÚÁÍÁÎ ÎÅ ÅøÒÅÎÃÉÌÅÒÉ ÎÅ ÄÅ ÅÎÓÔÒÕËÔÏÒÌÅÒÉ ... dereceleri ...

Anahtar kelimeler: 3ąÎÁÖ ëÉÚÅÌÇÅÌÅÍÅ, Tam sayılı programlama, vøÒÅÎÃÉ/ ÅøÒÅÔÉÍ ÏÙÅÌÅÒÉ ÍÅÍÎÕÎÉÙÅÔÉ

Abstract

In the faculties or departments of universities, preparing th examination timetables takes quite a long time, and often could n satisfy neither the students nor the instructors or managers. In this study, the final exam timetabling problem of a department of university is considered. For the problem, in the first stage, the exa are classified into the groups according to their difficulty levels by a integer programming model. In the second stage, an integ programming model is proposed in order to find an exam timetab which will increase the concentration and study efficiency of th students. In the model, the number of students taking more than one exam on the same day is minimized by weighting the difficulty levels of the relevant exams. The proposed solution approach is applied by us a real data set of a semester. By comparing the exam timetable obtai with the schedule prepared by hand, the advantages of the proposed solution approach are presented.

Keywords: Examination timetabling, Integer programming, Student /instructor satisfaction, Difficulty level

1 'ÉÒÉŞ

-ÎÉÖÅÒÓÉÔÅÌÅÒÄÅ ÖÅ ÉÌÇÉÌÉ ÂÅÌÉÒÌÅÎÍÉŞ ... problemde genellikle ... durumu ... ÇÅÒÅËÌÉ ...

"Õ ëÁÌąŞÍÁÄÁ ÂÉÒ ...

- !ÙÎą ÓąÎąÆÔÁ ÏËÕÙÁÎ ÅøÒÅÎÃÉ ÓąÎÁÖ ÁÔÁÎÍÁÓą ...

alan programlama

2 Programlama

veya otomatik) ve beklentilerin soruldu

Programlama modeli

(International Timetabling Competition ITC-2007, http://www.cs.qub.ac.uk/itc2007/)

McCollum

Programlama modeli

bir 0-1

Aakob ve Sherali

Programlama modelleri

Programlama modeli

veren bir 0-1

Programlama modeli

$x_{i,l}$ — [illegible] i [illegible] l [illegible] halde

D_{max} — [illegible] fark [illegible]

[illegible] $= D_{max}$ [illegible] (2)

[illegible] $i, j \in D$, $l = 1, 2, 3$ (3)

[illegible] $i \in D$ (4)

[illegible] $l = 1, 2, 3$ (5)

[illegible] $i \in D$, $l = 1, 2, 3$ (6)

[illegible] $l = 1, 2, 3$ (7)

[illegible] (8)

[illegible] zor ders grubu [illegible] (i, j) ders ikilisine ait [illegible] $E_{i,j}$ [illegible] D_{max} olarak [illegible] (6)-(8) [illegible]

Bu [illegible] belirlenirken, [illegible] programlama modelinin girdisi olarak [illegible] optimize edilebilir ve [illegible] programlama [illegible]

3.4 [illegible] programlama modeli 2 (TPM2)

[illegible]

3.5 İndisler

D	[illegible]
i, j	[illegible] $i, j \in D$, [illegible]
G	[illegible]
g	[illegible] $g \in G$, [illegible]
T	[illegible]
t	Zaman dilimlerine ait indis, $t \in T$,
OU	[illegible]
o	[illegible] $o \in OU$, [illegible]
S	[illegible]
s	[illegible] $s \in S$, [illegible]
ODL_o	o [illegible]
DL_s	s [illegible] (s = 1, 2, 3, 4),
TDL_s	s [illegible] (s = 3, 4), [illegible]
SDL	3. ve 4. [illegible]
ZDL_s	s [illegible]

3.6 Parametreler

[illegible] z_i [illegible] $z_i \in \{1, 2, 3\}$ [illegible] ks_i [illegible] ts_i [illegible]

3.7 [illegible]

x_{igt} — 1, [illegible] g. [illegible] t. zaman dilimine [illegible]
0, aksi halde.

$y12_{ij}$ — 1, [illegible] i [illegible] j dersine ait [illegible]
0, aksi halde.

$y23_{ij}$ — 1, [illegible] j [illegible]
0, aksi halde.

$y34_{ij}$ — 1, [illegible] i [illegible] j [illegible]
0, aksi halde.

$y3S_j$ — 1, [illegible] i [illegible] j [illegible]
0, aksi halde.

$y4S_j$ — 1, [illegible] j [illegible]
0, aksi halde.

ySS_j — 1, [illegible] j [illegible]
0, aksi halde.

[illegible] fonksiyonu (9) [illegible] (10)-(15) [illegible] i [illegible] $y12_{ij} = 1$ [illegible] ks_i ile dersin [illegible]

ikilisinin toplam zorluk derecelerinin ($z_i + z_j$) ëÁÒÐąÍą ÓÏÎÕÃÕ ÂÕÌÕÎÁÎ ÁøąÒÌąË ÄÅøÅÒÉ ÉÌÅ ÃÅÚÁÌÁÎÄąÒÌÁËÔÁÄąÒ8 vÒÎÅøÉÎh ÂÉÒ ÂÉÒÉÎÃÉ Óą i ąÆÁÄÌÁÎÓ (ks_i = 10); ilgili ÓÁÙąÓą ρπ ǂ

i ÄÅÒÓÉÎÉÎ ÚÏÒÌÕ (z_i ÈÁÇ / ÖÔąÍąÆÁ ÁÉÔ ÂÉÒ ÄÅÒÓÉÎÉÎ ÚÏÒÌÕË (z_j) ÄÅÒÅÃÅÓÉÎ ÓÏÎÕÃ8 ÆÏÎËÓÉÙÏÎÕÎÄÁh ÂÕ ÉËÉ ÄÅÒÓÅ ÁÉÔ ÓąÎÁÖÌÁÒąÎ ÁÙÎą ÇÌÎÅ ÁÔÁÎÍÁÓą

($y12_{ij}$ = 1) durumu; ks_i ($z_i + z_j$) È ρπρǂς CσϤ È υπ ÄÅøÅÒÉ ÉÌÅ ÃÅÚÁÌÁÎÄąÒąÌÁÃÁËÔąÒ8 ÉËÉÎÃÉ ÉÆÁÄÅÌÅÒ ... ÄÅÒÓÌÅÒÉÎ ÂÅÎÚÅÒ ĥÅËÉÌÄÅ ÃÅÚÁÌÁÎÄąÒÍÁËÔÁÄąÒ8 ... ÄÅÒÓÅ ÁÉÔ ÓąÎÁÖÌÁÒ ÁÙÎą ÇÌÎÅ ÁÔÁÎÍÁÓą

veya $y4S_{ij}$ = 1); ilgili j ÓÅëÍÅÌÉ ÄÅÒÓÉÎÅ ... ÓÁÙąÓą (ts_j) ders ikilisinin toplam zorluk derecesi ($z_i + z_j$) ile ëÁÒÐąÍą ÓÏÎÕÃÕ ÂÕÌÕÎÁÎ ÁøąÒÌąË ÄÅøÅÒÉ ÉÌÅ ÃÅÚÁÌÁÎÄąÒ8 !ÍÁë ÆÏÎËÓÉÙÏÎÕÎÄÁËÉ ÓÏÎ ÉÆÁÄÅ ÉÓÅ ÂÅÎÚÅÒ ĥÅËÉÌÄÅ ÉËÉ ÓÅëÍÅÌÉ derse ÁÉÔ ÓąÎÁÖÌÁÒąÎ ÁÙÎą ($y5S_{ij}$ = 1), ... ts_i ... ts_j ... ($z_i + z_j$) ile ëÁÒÐąÌÍÁÓą ÓÏÎÕÃÕ ÂÕÌÕÎÁÎ ÁøąÒÌąË ÄÅøÅÒÉ ÉÌÅ ÃÅÚÁÌÁÎÄąÒ8 ... ikililerinin toplam zorluk derecelerini bir arada dikkate alarak, ĘøÒÅÎÃÉÌÅÒ edekleri ÙÁĥÁÍÁ ÁÉÔ ... ÄÕÙÁÙÁÃÁË ... ËÉëÉËÌÅÍÅÙÅ ëÁÌąĥÍÁËÔÁÄąÒ8

$$\ldots \tag{11}$$

$$\ldots \tag{12}$$

$$\ldots \tag{13}$$

$$\ldots \tag{14}$$

$$\ldots \tag{15}$$

$$\ldots \tag{16}$$

3.8 !ÍÁç fonksiyonu

%Î +ÌëÌËÌÅ

$$\ldots \tag{9}$$

+ąÓąÔ ... ĘøÒÅÎÃÉÌÅÒÉÎ ÓąÎÁÖ ëÁËÉÎÄÅ ... gereksinimi de en ÁÌÔ ÄÌÚÅÙÅ ÉÎÍÅËÔÅĥ ... ÅÓÎÅËÌÉøÉ ÓÁøÌÁÎÍÁËÔÁÄąÒ8

$$\ldots \tag{17}$$

%ÌÅ ÁÌąÎÁÎ ÐÒÏÂÌÅÍÄÅ ÂÅĥÅÒ ÇÌÎÄÅ ... #ÕÍÁÒÔÅÓÉ ... φ8 ÖÅ χ8 ... ÁÔÁÎÍÁÍÁÓąĥ ... ÓÁøÌÁÎÍÁËÔÁÄąÒ

$$\ldots \tag{18}$$

+ąÓąÔ (9) ĥÅÓÉÎ ... fazla ÓąÎÁÖą ÏÌÍÁÓąÎą ĘÎÌÅÍÅËÔÅÄÉÒ8

$$\ldots \tag{19}$$

3.9 +ąÓąÔÌÁÒ

+ąÓąÔ (10) ĥÅËÌÉÎÄÅ ... dersine ait i ÓąÎÁÖą ... j ÓąÎÁÖą ... ($y12_{ij}$) ... ÓÁøÌÁÍÁËÔÁÄąÒ8 (11) ve (12) ise, ikinci ... (i ve j) ÁÙÎą ÇÌÎÅ ÁÔÁÎÍÁÓą ($y23_{ij}$ ve $y34_{ij}$) ... ËÁÒÁÒ ÄÅøÉĥËÅÎÌÅÒÉÎÉÎ ǂρϤ ÄÅøÅÒÉ ... 3ąÎÁÖ ÐÅÒÉÙÏÄÕÎÄÁh ... (20) ve (21) ile ifade edilen ... ÓÁøÌÁÍÁËÔÁÄąÒ8

$$\ldots \tag{10}$$

$$\ldots \tag{20}$$

$$\ldots \tag{21}$$

(22)

(23)

(24)

(25)

(26)

7) ile benzer bir durumu

(27)

(28)

(30)

(31)

(32)

(33)

(34)

(35)

(36)

edilmesidir. TPM2 modeli, IBM ILOG CPLEX Optimization

Tablo 1:

$ÅÒÓ	3ąÎ	vøÒÅ(-ÙÅÓ	vøÒÅ(-ÙÅÓ	vÎÃÅËÉ 9ąÌ vøÒ8 (k_{si}) 3ÁÙą	"ÁĥÁÒą /ÒÁÎÒą (b_i)	$ÅÒÓÉ !ÌÁÎ ($ts_i$)	Zorluk $İÚÅÙ ($z_i$)
BBT	1	!8 9 8	3 8 d 8	5	0,104	167	1
IF	1	C.M.A.		27	0,395	162	2
ISWRE	1	C.E.		2	0,258	154	2
KG	1	T.N.	A.A.	11	0,303	175	2
IM	1	U.E.		20	0,445	150	3
RTDB	1	K.M.		3	0,056	74	1
IDT	1	!8 + 8	E.A.	3	0,125	158	1
ITIIA	2	A.M.		3	0,218	107	2
TE	2	E.H.		13	0,414	124	2
SITP	2	- 8 v 8		16	0,298	121	2
IRO	2	E.E.	A.C.	20	0,490	128	3
PCA	2	A.Y.A.	E.E.	12	0,509	119	3
DD	2	D.D.		29	0,630	192	3
MM	2	D.E.		15	0,573	123	3
IIIRO	3	A.C.		9	0,242	70	2
IMSSP	3	S.E.R.		20	0,341	86	2
ASW	3	%8 v 8		21	0,422	80	2
EM	3	I.M.A.		10	0,198	67	1
AS	3	A.H.		14	0,255	70	2
OUBB	4	%8 v 8		1	0,143	117	1
KPK	4	D.F.M.	A.H.	1	0,185	118	1
SE	4	A.H.		1	0,045	115	1
CU	S	- 8 v 8		1	0,085	26	1
YS	S	# 8 d 8		0	0,040	50	1
6 + + K	S	I.M.A.		0	0,052	71	1
UY	S	U.E.G.		0	0,067	57	1
ER	S	D.F.M.		0	0,129	54	1
YF	S	K.F.		0	0,227	19	2
UTE	S	S.E.R.		0	0,527	49	3

$ÁÈÁ ĘÎÃÅ ÄÅ ÂÁÈÓÅÄÉÌÄÉøÉ İÚÅÒÅ [illegible]
ÇÉÒÍÅ ÄÕÒÕÍÕÎÄÁ ÏÌÁÎ ĘøÒÅÎÃ [illegible] ÄÅÒÓÉÎÄÅÎ Ë
ÚÏÒÌÕËÌÁÒąÎą ÔÏÐÌÁÍą ÄÅ [illegible] ÏÎ ÄÅÒÓÌÅÒÉ
ÔÏÐÌÁÍąÎąÎ ÅÎ ËİëİËÌÅÎÍÅÓÉ [illegible] ÆÏÎËÓÉÙ
ÂÅÌÉÒÌÅÎÍÉĥÔÉÒ8 -ÅÖÃÕÔ ÓąÎÁÖ [illegible] ÙÅÒÌ
ÄÅøÅÒÉ ÈÅÓÁÐÌÁÎÄąøąÎÄÁ ρτσχ [illegible] ÄÅÒÓÉÎ
ÐÒÏÇÒÁÍÄÁ ÂÕ ÄÅøÅÒ ÂİÙİË ĘÌ [illegible] ÁÙą
ÄİĥÍİĥÔİÒ8 -ÅÖÃÕÔ [illegible] ÁÒÔÍÁËÔÁÄąÒ8 "ÅÎ
ÏÌÄÕËëÁ ÙİËÓÅË ëąËÍÁÓąÎą ÎÅÄÅÎ [illegible] ÉÌ ÔÏÐ
ÍÅÖÃÕÔ ÙąÌÓÏÎÕ ÓąÎÁÖ ÐÒÏÇÒÁÍą [illegible] Ę
ÇİÎİ ÉÎÃÅÌÅÎÅÂÉÌÉÒ8 "ÉÒÉÎÃÉ Ó [illegible] zorluk derecesi kolay grup & o [illegible]
ÉËÉÎÃÉ ÓąÎąÆÌÁÒÁ ÁÉÔ [illegible] ÇĘÚÌÅÎÍÅËÔ
ÄÉÌÉÍÌÅÒÉÎÅ ËÏÎÕÌÍÕĥÔÕÒ8)& [illegible] ÌąĥİË
ÚÁÍÁÎÄÁ $$ ÄÅÒÓÉÎÉ ÄÅ ÁÌÍÁËÔÁ [illegible] ÓąÎÁÖÁ ÇÉÒÍÅË
ÚÏÒÕÎÄÁ ËÁÌÍÁËÔÁÄąÒ8)& ÄÅÒÓÉÎÉÎ ÚÏÒÌÕË ÄÅÒÅÃÅÓÉ ς ǰÏÒÔÁ ħ $$
ÄÅÒÓÉÎÉÎ ÚÏÒÌÕË ÄÅÒÅÃÅÓÉ ǰÚÏÒ ÏÌÄÕøÕ ÉëÉÎ ÂÕ ÔÅÒÃÉÈ ÅÄÉÌÍÅ
ÂÉÒ ÄÕÒÕÍÄÕÒ ÖÅ ÂÕ ÉËÉ ÄÅÒÓÅ ÁÉÔ ÓąÎÁÖÌÁÒą ÁÙÎą ÇİÎÅ
ÁÔÁÎÍÁÓąÎą ÁÍÁë ÆÏÎËÓÉÙÏÎÕÎÁ ÅÔËÉÓÉ ςχɕǰςCσɊÈρσυõÄÉÒ8

Tablo 2: d ÌÇÉÌÅÉ ÅÄÉÉÔ ÍÅÖÃÕÔ ÓąÎÁÖ ëÉÚÅÌÇÅÓÉ8

' İ Î	Periyot	I. Są Î ąÆ	II. Są Î ąÆ	III. Są Î ąÆ	IV. Są Î ąÆ
Pazartesi	1				KP (D.F.M-A.H.) (z:1, ks:1, ts:118)
	2			EM (I.M.A.) (z:1, ks:10, ts:67)	
	3				
3 Á Ì ą	1	RTDB (K.M.) (z:1 ks:3, ts:74)		UY (U.E.G.) (z:1, ks:0, ts:57)	UY (U.E.G.) (z:1, ks:0, ts:57)
	2		3) 4 0 j - 8 (z:2, ks:16, ts:121)		
	3				
K Á Ò ĥ Á	1		DD (D.D.) (z:3, ks:29, ts:192)		
	2	IF (C.M.A.) (z:2, ks:27, ts:162)		6 + + K (I.M.A.)	6 + + K j) 8 - (z:1, ks:0, ts:71)
	3			AS (A.H.) (z:2, ks:14, ts:70)	
0 Å Ò ĥ Å	1		PCA(A.Y.A-E.E.) (z:3, ks:12, ts:119)		
	2				
	3				
Cuma	1			! 3 7 j % 8 (z:2, ks:21, ts:80)	
	2				
	3				
Pazartesi	1		TE (E.H.) (z:2, ks:13, ts:124)		
	2	" " 4 j-3 8 9 8 (z:1, ks:5, ts:167)		UTE (S.E.R.) (z:3, ks:0, ts:49)	UTE (S.E.R.) (z:3, ks:0, ts:49)
	3				
3 Á Ì ą	1				
	2	ISWRE (C.E.) (z:2, ks:2, ts:154)		IIIRO (A.C.) (z:2, ks:9, ts:70)	
	3				
K Á Ò ĥ Á	1	) $ 4 j-E.A8 + (z:1, ks:3, ts:158)		ER (D.F.M.) (z:1, ks:0, ts:54)	ER (D.F.M.) (z:1, ks:0, ts:54)
	2		IRO(E.E-A.C.) (z:3, ks:20, ts:128)	9 3 j # 8 (z:1, ks:0, ts:50)	9 3 j # 8 d 8 (z:1, ks:0, ts:50)
	3				
0 Å Ò ĥ Å	1	IM (U.E.) (z:3, ks:20, ts:150)	ITIIA (A.M.) (z:2, ks:3, ts:107)	YF (K.F.) (z:2, ks:0, ts:19) # 5 j - 8 v (z:1, ks:1, ts:26)	YF (K.F.) (z:2, ks:0, ts:19) # 5 j - 8 v 8 (z:1, ks:1, ts:26)
	2			IMSSP (S.E.R.) (z:2, ks:20, ts:86)	
	3				
Cuma	1		MM (D.E.) (z:3, ks:15, ts:123)		SE (A.H.) (z:1, ks:1, ts:115)
	2	KG (T.N-A.A.) (z:2, ks:11, ts:175)			/ 5 " " j % 8 v 8 (z:1, ks:1, ts:117)
	3				

Tablo σ ą v Î Å Ò É Ì Å Î ë Ę Ú İ Í Ù Á Ë Ì Á ĥ ą.Í ą É Ì Å Ï Ì Õ ĥ Ô Õ Ò Õ Ì Á Î

' İ Î	Periyot	I. Są Î ąÆ	II. Są Î ąÆ	III. Są Î ąÆ	IV. Są Î ąÆ

Pazartesi	1				KP (D.F.M-A.H.) (z:1, ks:1 ts:118)
	2			IIIRO (A.C.) (z:2, ks:9, ts:70)	
	3		PCA (A.Y.A-E.E.) (z:3, ks:12,ts:119)		
3 Á Ì ą	1	" " 4 ǰ 3 8 Ø 9 (z:1, ks:5, ts:167)			
	2			UTE (S.E.R.) (z:3, ks:0, ts:49)	UTE (S.E.R.) (z:3, ks:0, ts:49)
	3		ITIIA (A.M.) (z:2, ks:3, ts:107)		
K Á Ò ñ Á	1	KG (T.N-A.A.) (z:2, ks:11, ts:175)			
	2			6 + + K ǰ (z:1, ks:0, ts:71)	6 + + K ǰ) 8 - 8 ! ts:71)
	3			# 5 ǰ - 8 v (z:1, ks:1, ts:26)	# 5 ǰ - 8 v 8 (z:1, ks:1, ts:26)
0 Å Ò ñ Å	1	ISWRE (C.E.) (z:2, ks:2, ts:154)			
	2		MM (D.E.) (z:3, ks:15, ts:123)		
	3			AS (A.H.) (z:2, ks:14,ts:70)	
Cuma	1		TE (E.H.) (z:2, ks:13, ts:124)		
	2	RTDB (K.M.) (z:1, ks:3, ts:74)			
	3			! 3 7 ǰ % 8 v (z:2, ks:21,ts:80)	
Pazartesi	1				SE (A.H.) (z:1, ks:1, ts:115)
	2			EM (I.M.A.) (z:1, ks:10, ts:67)	
	3		IRO (E.E-A.C.) (z:3, ks:20, ts:128)		
3 Á Ì ą	1			YF (K.F.) (z:2, ks:0, ts:19)	YF (K.F.) (z:2, ks:0, ts:19)
	2	IM (U.E.) (z:3, ks:20,ts:150)			
	3			IMSSP (S.E.R.) (z:2 ks:20, ts:86)	
K Á Ò ñ Á	1	) $ 4 ǰ E.A.8 + (z:1, ks:3,ts:158)			
	2		3) 4 0 ǰ - 8 (z:2, ks:16, ts:121)		
	3			UY (U.E.G.) (z:1, ks:0, ts:57)	UY (U.E.G.) (z:1, ks:0, ts:57)
0 Å Ò ñ Å	1				
	2		DD (D.D.) (z:3, ks:29, ts:192)		
	3				/ 5 " " ǰ % 8 v (z:1, ks:1, ts:117)
Cuma	1	IF (C.M.A.) (z:2,ks:27, ts:162)			
	2			ER (D.F.M.) (z:1, ks:0, ts:54)	ER (D.F.M.) (z:1, ks:0, ts:54)
	3			9 3 ǰ # 8 (z:1, ks:0, ts:50)	9 3 ǰ # 8 d (z:1, ks:0, ts:50)

v Î Å Ò É Ì Å Î ÙÁ Ë Ì Á ñ ą Í Áñ Î Á ø Á Ä Å ø Å Ò Ó ą Ò Á Ì Î Í Ä [1] Å Ö Ã Õ Ô Ð Ò Ï Ç Ò Á Í ą Î Ó Á ø Ì Á Ù Á Í Á Ä Ë Á Ò Ë Á Î Ç É É Ë É Ó ą Î Á Ö ą Î Á Ù Î ą Ç

[illegible]

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