

Handout for the Workshop Abjad-numerals

Istanbul, Second international workshop of the Prof. Dr. Fuat Sezgin Foundation; Friday August 23, 9:00-11:00. Assistants: Wilfred de Graaf and Jan Hogendijk, Department of Mathematics, University of Utrecht, Netherlands.

0. Aim. The aim of this workshop is to enable participants to read Arabic abjad-numerals in medieval manuscripts and on medieval instruments such as astrolabes. No previous knowledge of the Arabic alphabet is assumed - on the contrary, the workshop may be a great way to learn some Arabic letters!

1. The principle. For didactic purposes, we will first explain the principle of the abjad (alphabetic) numeration in the Latin alphabet. We give each letter of the alphabet a numerical values as follows:

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 i = 9
j = 10 k = 20 l = 30 m = 40 n = 50 o = 60 p = 70 q = 80 r = 90
s = 100 t = 200 u = 300

More will not be necessary today.

To write a number such as “11”, we first write the number for 10 and then the number for 1, thus: ja, but not aj; ”123” will be skc, not cks or ksc etc. There is no letter corresponding to zero, so “202” = tb.

Exercise 1: Decipher the numbers: nf, ld, pa, ume, sji, th, tp, tph.

Exercise 2: Write the following numbers in abjad: 24, 258, 307.

This system of alphabetic numeration was first defined for older alphabets, including the Greek, where it was already used before 700 BC. The order of the Greek is not equivalent to the Latin, although there are some similarities: $\alpha = 1$, $\beta=2$, $\delta=4$, $\iota = 10$, $\kappa = 20$, $\lambda=30$, $\mu = 40$, $\nu = 50$.

2. The Arabic alphabet. The same principle was used for Arabic letters and their numerical values:

1 = alif, 2 = ba, 3 = jim, 4 = dal, 5 = ha, 6 = waw, 7 = zay, 8 = ḥa, 9 = ṭa,

10 = ya, 20 = kaf, 30 = lam, 40 = mim, 50 = nun, 60 = sin, 70= ayn, 80 = fa, 90 = ṣad,

100 = qaf, 200 = ra, 300 = shin, etc.

The system is often called “abjad”; this artificial word is a way to memorize ”1, 2, 3, 4”.

Table of the numerals 1-91 in *abjad* notation

		(0)	10	20	30	40	50	60	70	80	90
	name		ya	kaf	lam	mim	nun	sin	ayn	fa	ṣad
			ى	ك	ل	م	ن	س	ع	ف	ص
+1	alif	ا	يا	كا	لا	ما	نا	سا	عا	فا	صا
+2	ba	ب	با	كب	لب	مب	نب	سب	عب	فب	
+3	jim	ج	جا	كج	لج	مج	نج	سج	عج	فج	
+4	dal	د	دا	كد	لد	مد	ند	سد	عد	فد	
+5	ha	ه	ها	كه	له	مه	نه	سه	عه	فه	
+6	waw	و	وا	كو	لو	مو	نو	سو	عو	فو	
+7	zay	ز	زا	كز	لز	مز	نز	سز	عز	فز	
+8	ḥa	ح	حا	كح	لح	مح	نح	سح	عح	فح	
+9	ṭa	ط	طا	كط	لط	مط	نط	سط	عط	فط	

Now have a look at the table of the first 91 numbers in abjad, prepared by Dr. Rob van Gent, and see how the system works. In the table, you see in the second and third columns the letters (names and shapes) for 1, 2, ..., 9, in the second and third rows the letters (names and shapes) for 10, 20, ..., 90, and in the rest of the table the combinations of all the letters. For example, to see the number 58 look in the row for +8 and the column for 50. The system works in exactly the same way as the system for the Latin letters which we have explained earlier; note that Arabic is written from right to left.

Note that each Arabic letter has different shapes: a shape when it is used alone, another shape when it is at the beginning of a group of letters (initial); and possibly also other shapes in the middle of a group of letters (medial); at the end of a group of letters (final).

Exercise 3: In the table on this page, locate the shapes of the following letters, when they are used alone:

1 = alif, 2 = ba, 3 = jim, 4 = dal, 5 = ha, 6 = waw, 7 = zay, 8 = ḥa, 9 = ṭa, 10 = ya, 20 = kaf, 30 = lam, 40 = mim, 50 = nun, 60 = sin, 70 = ayn, 80 = fa, 90 = ṣad.

Exercise 4: Now look at the numbers ‘11’ and ‘12’ in the table. Try to find the initial shape of ya and the final shapes of alif and ba.

Exercise 5: Same question for the other numbers - what are the initial forms of kaf, lam, mim, nun, sin, ayn, fa, ṣad? What are the final shapes of jim, dal, ha, waw, zay, ḥa, ṭa?

Exercise 6: Locate the Arabic letters for “100”, “200” and “300” in the table on p. 4 (you need to use the column for abjad “East”. There is another abjad system, indicated as NWA, which was used in the Maghreb, and which we will not discuss today)

Exercise 7: Your first exercise in writing Arabic: As you see, the places for the numbers “92” through ”99” are empty in the table on p. 2. Try to write these numbers in the table, in Arabic, in the abjad system!

Exercise 8: Your first exercise in reading a medieval Arabic manuscript: Try to read the left column in the photocopy of the page of the astronomical manuscript no. 1442 in Utrecht (Netherlands) which we will give you. Then try to find other columns which you can read. What other numbers can you read in this manuscript? In case you know the subject already, try to locate two zero’s on this page.

3. Degrees, minutes, seconds

Islamic astronomers used the abjad-system in order to do their astronomical computations. Often they computed in the sexagesimal system. This is the same system that we still use in our computation of time (minutes, seconds) and angles (degrees, minutes, seconds). In such a system, one only needs the numbers from 1 to 59 for the minutes and seconds, plus a special sign for zero, usually a dot connected to an overbar. (We will discuss this in class).

4. Reading an astrolabe

If time permits, we will try to read as many numbers as possible on the following astrolabes:

a. The back side of the astrolabe of Sultan al-Ashraf, now in the Metropolitan Museum of Art in New York, and dated 690 Hijra (1291 CE). The maker of this astrolabe, sultan Ashraf of Yemen, also wrote a manuscript which is extant, and in which he made a drawing of the astrolabe. We will use a photo of the astrolabe and the drawing in the manuscript.

b. The front side of this astrolabe.

c. The front and a plate of an undated Abbasid astrolabe, now in the History of Science museum in Florence (no. 1113).

Note: if you want to go ahead and learn the Arabic letters, you should bear in mind that in the abjad numbers, scribes usually omitted some symbols which they would normally write. For example, the letter ya in its initial

form usually has two dots, the ba has one dot, the jim have one dot but is written differently when alone, etc. See the table below.

The Arabic alphabet (table by Dr. Rob van Gent)

Arabic letter	letter form				abjad value		translit.		ArabTeX code
	alone	initial	medial	final	East	NWA	Eng.	Ger.	
'alif	ا	—	—	ا	1	1	, ā	, ā	A
bā'	ب	ب	ب	ب	2	2	b	b	b
tā'	ت	ت	ت	ت	400	400	t	t	t
thā'	ث	ث	ث	ث	500	500	th [th]	ṭ	_t
jīm	ج	ج	ج	ج	3	3	j [dj]	ğ	j / ^g
hā'	ح	ح	ح	ح	8	8	ḥ	ḥ	.h
khā'	خ	خ	خ	خ	600	600	kh [kh]	ḫ	x / _h
dāl	د	—	—	د	4	4	d	d	d
dhāl	ذ	—	—	ذ	700	700	dh [dh]	ḏ	_d
rā'	ر	—	—	ر	200	200	r	r	r
zāy	ز	—	—	ز	7	7	z	z	z
sīn	س	س	س	س	60	300	s	s	s
shīn	ش	ش	ش	ش	300	1000	sh [sh]	š	^s
ṣād	ص	ص	ص	ص	90	60	ṣ	ṣ	.s
dād	ض	ض	ض	ض	800	90	ḍ	ḍ	.d
ṭā'	ط	ط	ط	ط	9	9	ṭ	ṭ	.t
ẓā'	ظ	ظ	ظ	ظ	900	800	ẓ	ẓ	.z
'ayn	ع	ع	ع	ع	70	70	‘	‘	‘
ghayn	غ	غ	غ	غ	1000	900	gh [gh]	ğ	.g
fā'	ف	ف	ف	ف	80	80	f	f	f
qāf	ق	ق	ق	ق	100	100	q [k]	q	q
kāf	ك	ك	ك	ك	20	20	k	k	k
lām	ل	ل	ل	ل	30	30	l	l	l
mīm	م	م	م	م	40	40	m	m	m
nūn	ن	ن	ن	ن	50	50	n	n	n
hā'	ه	ه	ه	ه	5	5	h	h	h
wāw	و	—	—	و	6	6	w, ū	w, ū	w / U
yā'	ي	ي	ي	ي	10	10	y, ī	y, ī	y / I