Natural Language Processing

Character Encoding

Mustafa Jarrar

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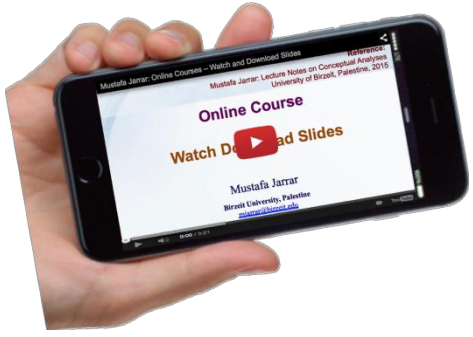

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In this lecture:

- Part 1: **Encoding Schemes**
- Part 2: Locales and Word Order

ASCII

- **American Standard Code for Information Interchange** (published 1963)
- based on the English alphabet, encodes 128 characters into seven-bit integers

- 95 printable chars
  0-9 a-z A-Z …

- 33 non-printing control chars
  return, tab, escape, …
  Most are obsolete - for old typers

- **For example**, lowercase (i):
  1101001 binary
  69 hexadecimal
  105 decimal

b_7 b_6 b_5 → / Bits / b_4 b_3 b_2 b_1 ↓ / Row ↓ / Column →	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	0	1	2	3	4	5	6	7
0 0 0 0	0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1	1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0	2	STX	DC2	"	2	B	R	b	r
0 0 1 1	3	ETX	DC3	#	3	C	S	c	s
0 1 0 0	4	EOT	DC4	$	4	D	T	d	t
0 1 0 1	5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0	6	ACK	SYN	&	6	F	V	f	v
0 1 1 1	7	BEL	ETB	'	7	G	W	g	w
1 0 0 0	8	BS	CAN	(	8	H	X	h	x
1 0 0 1	9	HT	EM	)	9	I	Y	i	y
1 0 1 0	10	LF	SUB	*	:	J	Z	j	z
1 0 1 1	11	VT	ESC	+	;	K	[	k	{
1 1 0 0	12	FF	FS	,	<	L	\	l	|
1 1 0 1	13	CR	GS	-	=	M	]	m	}
1 1 1 0	14	SO	RS	.	>	N	^	n	~
1 1 1 1	15	SI	US	/	?	O	_	o	DEL

Extended ASCII

eight-bit or larger character encodings - includes the 7-bit chars, and more

128	Ç	144	É	160	á	176	▒	192	└	208	╨	224	α	240	≡
129	ü	145	æ	161	í	177	▒	193	┴	209	╤	225	ß	241	±
130	é	146	Æ	162	ó	178	▓	194	┬	210	╥	226	Γ	242	≥
131	â	147	ô	163	ú	179	│	195	├	211	╙	227	π	243	≤
132	ä	148	ö	164	ñ	180	┤	196	─	212	╘	228	Σ	244	⌠
133	à	149	ò	165	Ñ	181	╡	197	┼	213	╒	229	σ	245	⌡
134	å	150	û	166	ª	182	╢	198	╞	214	╓	230	µ	246	÷
135	ç	151	ù	167	º	183	╖	199	╟	215	╫	231	τ	247	≈
136	ê	152	ÿ	168	¿	184	╕	200	╚	216	╪	232	Φ	248	°
137	ë	153	Ö	169	⌐	185	╣	201	╔	217	┘	233	Θ	249	∙
138	è	154	Ü	170	¬	186	║	202	╩	218	┌	234	Ω	250	·
139	ï	155	¢	171	½	187	╗	203	╦	219	█	235	δ	251	√
140	î	156	£	172	¼	188	╝	204	╠	220	▄	236	∞	252	ⁿ
141	ì	157	¥	173	¡	189	╜	205	═	221	▌	237	φ	253	²
142	Ä	158	₧	174	«	190	╛	206	╬	222	▐	238	ε	254	■
143	Å	159	ƒ	175	»	191	┐	207	╧	223	▀	239	∩	255	

For example, lowercase (i):

1101001 binary

69 hexadecimal

105 decimal

Unicode

Universal standard for encoding, representing, and handling text in computers.

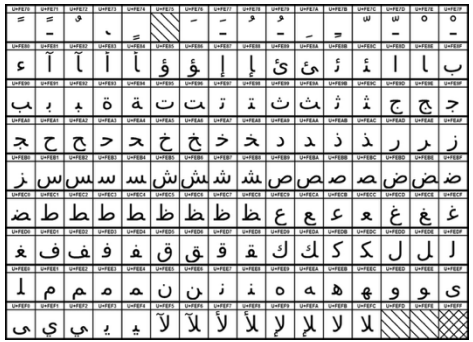
To ensure every character from every writing system has a unique code, no matter the platform, program, or language.

- Unique number for each character (e.g., U+0627 = Arabic letter “ا”)
- Covers 150+ scripts (Latin, Arabic, Chinese, Emoji, etc.).
- Enables global text processing and exchange across systems.

Without Unicode → text may appear garbled or inconsistent.
With Unicode → seamless communication across languages and platforms.

Examples

U+0041 → A (Latin)
U+0627 → ا (Arabic)
U+4E2D → 中 (Chinese)
U+1F600 → 😀 (Emoji)



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In this lecture:

- Part 1: Encoding Schemes
- Part 2: **Locales and Word Order**

Locales and Word Order
(الترتيب الأبجدي)

A locale defines regional & cultural preferences for software:

- Language & script (Arabic, English, Chinese…)
- Date, time, and number formats
- Collation rules (how words are sorted and compared)

Different languages sort words differently:

- English: alphabetical order (A → Z)
- Swedish: å, ä, ö are separate letters at the end of the alphabet
- Arabic: (أ ب ت...) or (أ ب ج د..)
- Chinese/Japanese: sorted by radicals, stroke count, or phonetics
- Case sensitivity, accents, and diacritics **change order**:
- resume ≠ résumé in some locales, but treated the same in others

Unicode Collation

Collation = rules for comparing and ordering text.
Determines how strings are **sorted, matched, or searched** in different languages.
Without collation → “alphabetical order” varies and may confuse users.

Unicode Collation Algorithm (UCA)
A **standard method** for comparing Unicode strings across languages.
Provides a **default order** for all characters.
Allows **locale-specific tailoring** (e.g., Arabic, Swedish, Chinese).

Examples
English: resume < résumé < resumé
Swedish: z < å < ä < ö
Arabic: Sorts by base letters, ignoring diacritics ا = أ
Chinese: Sorted by **pinyin** or **radical + stroke order**.

Letter ordering systems in Arabic

1. Alphabetical Order (الألفبائي/الترتيب الهجائي)

أ، ب، ت، ث، ج، ح، خ، د، ذ، ر، ز، س، ش، ص، ض، ط، ظ، ع، غ، ف، ق، ك، ل، م، ن، هـ، و، ي

- Widely used today, especially in dictionaries, indexes, and reference works.
- Based on the similarity of letters in shape and sound
- By the linguist Naṣr ibn Asim al-Laythī (نصر بن عاصم الليثي), order of al-Ḥajjāj, to distinguish it from the Abjad order.

2. Abjad Order (الترتيب الأبجدي)

أ، ب، ج، د، هـ، و، ز، ح، ط، ي، ك، ل، م، ن، س، ع، ف، ص، ق، ر، ش، ت، ث، خ، ذ، ض، ظ، غ

- Oldest ordering of the Arabic script
- Primarily used in Abjad numerals (ḥisāb al-jummal), where each letter is assigned a numerical value - historically used in other Semitic languages.

3. Phonetic Order (المخرجي/الترتيب الصوتي)

ع، ح، هـ، خ، ق، ج، ش، ض، ص، س، ز، ط، د، ت، ظ، ث، ذ، ر، ل، ن، ف، ب، م، و، ي، أ، ء

- Less common than the other two systems. It is based on the articulation points of letters in the speech organs, beginning from the throat and moving outward [1, 4].
- by al-Khalīl ibn Aḥmad al-Farāhīdī (الخليل بن زحمد)

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