Class 8
Order in nonconcatenative morphology: Root-and-pattern morphology in Arabic

11/16/23

1 Root-and-pattern morphology in Arabic

- We've now seen how "templatic morphology" a.k.a. "morphological templates" pose a problem for cyclic concatenation.

- Another kind of morphology that sometimes gets called "templatic" is the root-and-pattern nonconcatenative morphology in the Semitic languages — sometimes referred to as "prosodic templates".
  → These systems will also be challenging for cyclic concatenation.
  - We can capture them better with parallel models that rely on constraint interaction, especially because that will let us model how the phonology impacts ordering patterns.

- In these languages, morphological word building frequently does not consist of sequential affixation to a fixed base of derivation.
  - Morphemes may be interspersed within other morphemes.
  - Adding new morphemes often significantly alters the segmental order and/or larger prosodic organization of the word.

⋆ Because Baker was thinking about the Mirror Principle in terms of something like cyclic concatenation (Baker 1985:378ff.), he didn't see a clear way to reason about thoroughly nonconcatenative morphological processes/systems with respect to the Mirror Principle (Baker 1985:400–403, LeTourneau 1997).
  → The MAP let's us explain these kinds of root-and-pattern systems in a way that *does* let us reason about the Mirror Principle.
  - We'll see if we can replicate the MAP analysis with a BD-faithfulness analysis.

1.1 A MAP-Based Analysis of the Arabic Reflexive

- Arabic verbs are built around a consonantal root, proto-typically three consonants (see McCarthy 1979).
  - I'll exemplify forms using the root /ktb/ 'write' .

- The verbal system is divided into "Forms", built to these roots.
  - Forms are morphosyntactic categories associated with a particular phonological shape (traditionally described in terms of a CV "template") and a range of morphosemantics (often highly idiomatized).

- Within this system, Reflexive /t/ recurs across multiple Forms:
  - Sometimes as an *"infix"* (Table 1a)
  - Sometimes as a *"prefix"* (Table 1b)

Table 1: Forms with Reflexive /t/ (for example root √*ktb* 'write'; data from McCarthy 1981:384)

Position		Form	Proposed morphosyntax	Example form	Translation
a.	*Infixal*	VIII	Reflexive	***kṯ**ataba*	'write, be registered'
		V	Reflexive of the Causative	***ṯ**a**k**attaba*	(*constructed form*)
b.	*Prefixal*	VI	Reflexive of the Applicative	***ṯ**a**k**aataba*	'write to each other'
		X	Causative of the Reflexive	*s**ṯ**a**k**taba*	'write, make write'

- Recent accounts (Tucker 2010, 2011; cf. Ussishkin 2003) have used alignment constraints to help derive the ordering alternation.
  - However, an alignment-based analysis of the Reflexive leads to the ranking paradox in (1).
  - That these paradoxical rankings properly derive the distribution is confirmed in (2).

(1) **Ranking paradox**

a. Infixal Form (VIII): ALIGN-ROOT-L ≫ ALIGN-REFLEXIVE-L
b. Prefixal Forms (V,VI,X): ALIGN-REFLEXIVE-L ≫ ALIGN-ROOT-L

(2) **Alignment-based derivation of the Reflexive alternation**

(/t/ ⇔ REFL, /μ_c/ ⇔ CAUS, /a/ ⇔ PERF.ACT, /a/ ⇔ 3SG.MASC)

i. Infixal order: Form VIII Reflexive ***kṯ**ataba* [= (1a)]

/t, ktb, a, a/		ALIGN-ROOT-L	ALIGN-REFL-L
a.	**ṯak**taba	*!*	
b. ☞	**kṯ**ataba		*

ii. Prefixal order: Form V Reflexive of Causative ***ṯak**at$_c$taba* [= (1b)]

/t, μ_c, ktb, a, a/		ALIGN-REFL-L	ALIGN-ROOT-L
a. ☞	**ṯak**at$_c$taba		**
b.	**kṯ**at$_c$taba	*!	

- The MAP will let us take advantage of a syntactic generalization (3) to deliver an explanation.

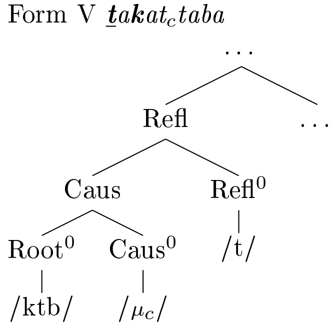
(3) **Syntactic generalization about Reflexive /t/**

a. When Reflexive co-occurs with (and scopes over/c-commands) another verbal derivational morpheme (e.g. Causative or Applicative), its exponent is *prefixal*.
b. When Reflexive is the only verbal derivational morpheme, its exponent is *infixal*.

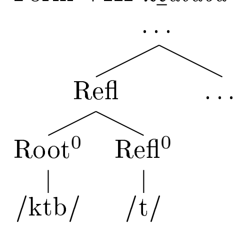
- The difference can be illustrated by comparing the syntactic structures of Form V (the reflexive of the causative) and Form VIII (the simple reflexive), as shown in (4).

(4) **Syntactic structures with Reflexive**

a. Form V ***ṯak**at$_c$taba*



b. Form VIII ***kṯ**ataba*



- In Form V (4a), Refl *asymmetrically c-commands* Root, since it adjoins to the complex head containing Root and Caus.
  → The MAP produces ALIGN-REFL-L ≫ ALIGN-ROOT-L, which generates prefixal /t/ (2.ii).
- In Form VIII (4b), Refl and Root stand in *symmetric c-command*, because Refl is the first head to adjoin with Root. (Here's where head movement gets us a result.)
  → Since the MAP only establishes rankings based on asymmetric c-command, the ranking between ALIGN-REFL-L and ALIGN-ROOT-L is underdetermined.

(5) **MAP-governed rankings with Reflexive**

a. Form VIII (infixal order): ALIGN-ROOT-L, ALIGN-REFLEXIVE-L
b. Form V (prefixal order): ALIGN-REFLEXIVE-L ≫ ALIGN-ROOT-L

- While we've now identified a distinction between the two types of structures' alignment behavior, the MAP itself doesn't explain why Reflexive /t/ is infixal in Form VIII. Now observe one further generalization:

(6) **Root-alignment generalization**
The Root's left edge always surfaces further to the left than (the left edge of the exponent of) the first head which adjoins to it.

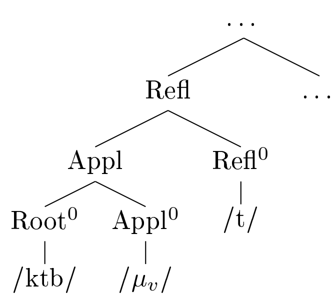
- This holds in all of the following Forms:

(7) **Forms exemplifying (6)**

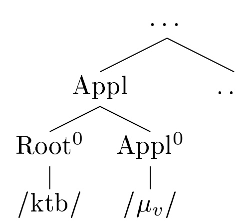
Root and Reflexive:	a.	Form VIII	$\boldsymbol{k\underline{t}}\textit{ataba}$	(4b)
Root and Causative:	b.	Form V	$\textit{ta}\boldsymbol{ka}\underline{\boldsymbol{t}}_c\textit{taba}$	(4a)
	c.	Form II	$\boldsymbol{ka}\underline{\boldsymbol{t}}_c\textit{taba}$	(§1.2)
Root and Applicative:	d.	Form VI	$\textit{ta}\boldsymbol{ka}\underline{\boldsymbol{a}}_v\textit{taba}$	(8a)
	e.	Form III	$\boldsymbol{ka}\underline{\boldsymbol{a}}_v\textit{taba}$	(8b)

(8) **Syntactic structures with Applicative**

a. Form VI *takaa*$_v$*taba*



b. Form III *kaa*$_v$*taba*



- We can understand the generalization in (6) in terms of alignment.
  - In each of the relevant cases, the constraint ALIGN-ROOT-L outranks the left-oriented alignment constraint of the verbal derivational morpheme.
  - Note crucially that these are exactly the cases where the MAP does not establish a ranking, because the two heads stand in symmetric c-command.

- If we assume that there is a language-specific default ranking that emerges in the absence of contradictory instructions from the MAP, we can account for these cases by positing the default ranking in (9):

(9) **Language-specific default ranking for Arabic**
ALIGN-ROOT-L ≫ all the other alignment constraints

- For the infixal Reflexive in Form VIII ***kṯataba*** (4b), the default ranking in (9) steps in to resolve the indeterminacy (cf. (5)) in favor of ALIGN-ROOT-L. This now yields the ranking in (10a).

(10) **MAP-governed rankings supplemented by Arabic default ranking**
  a. Form VIII (infixal order): ALIGN-ROOT-L ≫ ALIGN-REFLEXIVE-L
  b. Form V (prefixal order): ALIGN-REFLEXIVE-L ≫ ALIGN-ROOT-L

- The two distinct rankings in (10) are the paradoxical rankings from (1) above which generate the contrasting prefixal vs. infixal behavior of the Reflexive detailed in Table 1 above.

→ We have found an explanation for the apparent paradox: the dynamic interaction of the MAP and Arabic's default ranking as mediated by the syntactic structure.

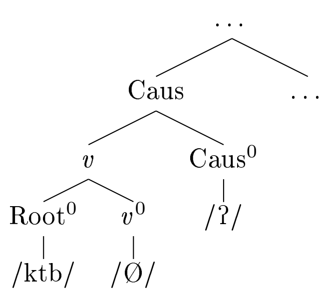
1.2 A MAP-Based Analysis of the Causative

- Arabic has two basic types of morphological causatives (cf. Wright 1896:31–36, Ryding 2005:491, 515, Arbaoui 2010a,b, *a.o.*):
  - Form II, which is marked by an infixal consonantal mora (/μ_c/), as in ***kat**$_c$**taba*** (11b)
  - Form IV, which is marked by a prefixal /ʔ/, as in ***ʔ**aktaba* (11a)

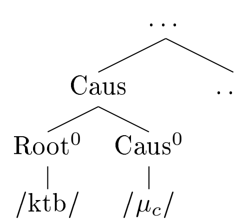
- The analysis of the Reflexive in the previous subsection gives us a roadmap for understanding this infix vs. prefix alternation.
  - An infixal morpheme should be the first head to attach to the Root, such that the default high ranking of ALIGN-ROOT-L can emerge in the absence of a MAP-determined ranking.
  - A prefixal morpheme should be a higher head, such that it asymmetrically c-commands Root, and the MAP can rank its alignment constraint above ALIGN-ROOT-L.

- If we reverse engineer the syntax in this way, we come up with the structures in (11).
  - ∗ Note that we must posit a null *v* head in Form IV (11a) in order to create the necessary structures.

(11) **Syntactic structures with Causative**
  a. Form IV *ʔaktaba*



  b. Form II *kat$_c$taba*



- The MAP-based phonological analysis predicts distinct syntactic structures for the two types of causatives.
  - *Does this supposed syntactic distinction correlate with other observable differences?*
  - → **Yes:** we can observe a difference in the semantics of the two categories.

- Both Forms can contribute causative or factitive semantics (Wright 1896:31–36).
  - Most Form IV forms have a canonically causative or factitive interpretation (ibid.:34).
  - → On the other hand, Form II forms have a substantially wider range of interpretations relating to causation or transitivity, such as (in Wright's parlance): intensive, extensive, iterative/frequentative, declarative, and estimative (ibid.:31–32).

- The root $\sqrt{}$*ʕlm* 'know' provides a minimal pair that illustrates this distinction clearly (ibid.:34):
  - It has a Form II causative *ʕa$\underline{l}_c$lama* which means 'teach' (clearly idiomatic/lexicalized).
  - It also has a Form IV causative *$\underline{ʔ}$aʕlama*, which means 'inform' (≈ 'make someone know').

- Taking this distinction to be general, consider now the nature of the syntactic difference posited in (11).
  - In Form IV, the Causative head selects a *v*P.
  - In Form II, the Causative head directly selects the Root.

- Cross-linguistically, root-selecting heads allow more idiomatic semantics than non-root-selecting heads (Marantz 1997, Arad 2003).

→ This is exactly what we observe in the semantics of these two Forms.
  - The one which selects for Root (Form II) has a wide range of semantics.
  - The one which selects for *v*P has more consistent semantics.

1.3 Interim conclusions

- We therefore have exactly the sort of correlation between ordering, syntactic structure, and semantics that we would expect in the MAP framework.
- Because the MAP generates morpheme order using a feed-forward modular architecture, syntactic differences should lead to ordering differences at PF the same way they lead to interpretative differences at LF.
- Furthermore, the MAP, unlike cyclic concatenation, allows us to use nonconcatenative morphophonological patterning to make falsifiable hypotheses about syntactic structure (and thus semantics), exactly as the Mirror Principle envisions.

- So (I think) these are good arguments that the MAP is a better theory of morpheme order for nonconcatenative morphology than cyclic concatenation or other kinds of theories that are on the market (e.g. McCarthy 1979's prosodic templates).
- For Bantu, we saw that a BD-correspondence analysis was superior to the MAP for templatic morphology.

⋆ Can it also work (better) for Arabic?

1.4 BD-correspondence for Arabic root-and-pattern morphology?

- Here's my big data table (adapted from McCarthy 1981:385), so that we can see all the forms in one place.

Table 2: Arabic verbal system (3SG.M of root $\sqrt{}$ktb 'write'; Zukoff 2023:439)

Form	Perf. Active /a/	Perf. Passive /ui/	Imperf. Active /???/	Imperf. Passive /ua/
I	katab-a	kutib-a	y-aktub-u	y-uktab-u
II	ka$\underline{t}_c$tab-a	ku$\underline{t}_c$tib-a	y-uka$\underline{t}_c$tib-u	y-uka$\underline{t}_c$tab-u
III	ka$\underline{a}_v$tab-a	ku$\underline{u}_v$tib-a	y-uka$\underline{a}_v$tib-u	y-uka$\underline{a}_v$tab-u
IV	$\underline{ʔ}$aktab-a	$\underline{ʔ}$uktib-a	y-u($\underline{ʔ}$a)ktib-u	y-u($\underline{ʔ}$a)ktab-u
V	$\underline{t}$aka$\underline{t}_c$tab-a	$\underline{t}$uku$\underline{t}_c$tib-a	y-a$\underline{t}$aka$\underline{t}_c$tab-u	y-u$\underline{t}$aka$\underline{t}_c$tab-u
VI	$\underline{t}$aka$\underline{a}_v$tab-a	$\underline{t}$uku$\underline{u}_v$tib-a	y-a$\underline{t}$aka$\underline{a}_v$tab-u	y-u$\underline{t}$aka$\underline{a}_v$tab-u
VII	$\underline{n}$katab-a	$\underline{n}$kutib-a	y-a$\underline{n}$katib-u	y-u$\underline{n}$katab-u
VIII	k$\underline{t}$atab-a	k$\underline{t}$utib-a	y-ak$\underline{t}$atib-u	y-uk$\underline{t}$atab-u
X	$\underline{st}$aktab-a	$\underline{st}$uktib-a	y-a$\underline{st}$aktib-u	y-u$\underline{st}$aktab-u

1.4.1 Form I

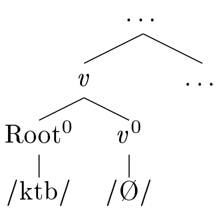
- The basic verb form (Form I) in Arabic consists only of the Root, the Aspect/Voice (AV) morpheme (the "vocalic melody"), and agreement affixes (suffixal in the perfective, "circumfixal" in the imperfective):

(12) **3rd singular masculine of Form I**

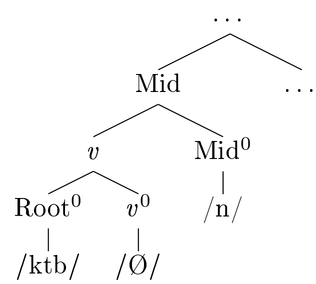
	Perfective	Imperfective
Active	katab-a	y-aktub-u
Passive	kutib-a	y-uktab-u

- I assume that Form I is formed with the same *v* that we find in Form IV (11a), which is also in Form VII (14) (so /n/ can be prefixal) and Form X (reflexive of Form IV causative).

(13) **Structure of Form I**



(14) **Structure of Form VII "Middle"** ***nkataba***



⋆ This *v* is not present in any of the other forms, where the Root combines directly with Caus, Appl, or Refl.
  → Since Form I would not be a morphosyntactic subconstituent of these derivatives, it should not be able to function as a base for them, according to the criteria we used for Bantu.

∗ Though keep in mind that some of these structures are dependent on the MAP analysis, so an alternative analysis might be able to posit different structures that would yield different BD relationships.

1.4.2 Other possible BD relationships

- While Form I isn't necessarily going to be a good base across the board, we do have some containment relationships:

Table 3: Morphosyntactic structure and alignment analysis of verbal Forms (Zukoff 2023:437)

Form	Perf. Act.	Syntactic structure	Alignment Ranking
I	*kataba*	[*v* [Root]]	Align-Root-L ($\gg$ Align-*v*-L)
II	*ka*$\underline{t}_c$*taba*	[Caus [Root]]	Align-Root-L $\gg$ Align-Caus-L
III	*ka*$\underline{a}_v$*taba*	[Appl [Root]]	Align-Root-L $\gg$ Align-Appl-L
IV	*ʔ̲aktaba*	[Caus [*v* [Root]]]	Align-Caus-L $\gg$ Align-Root-L ($\gg$ Align-*v*-L)
V	*t̲aka*$\underline{t}_c$*taba*	[Refl [Caus [Root]]]	Align-Refl-L $\gg$ Align-Root-L $\gg$ Align-Caus-L
VI	*t̲aka*$\underline{a}_v$*taba*	[Refl [Appl [Root]]]	Align-Refl-L $\gg$ Align-Root-L $\gg$ Align-Appl-L
VII	*n̲kataba*	[Mid [*v* [Root]]]	Align-Mid-L $\gg$ Align-Root-L ($\gg$ Align-*v*-L)
VIII	*kt̲ataba*	[Refl [Root]]	Align-Root-L $\gg$ Align-Refl-L
X	*s̲t̲aktaba*	[Caus [Refl [*v* [Root]]]]	Align-Caus-L $\gg$ Align-Refl-L $\gg$ Align-Root-L

(15) **Containment relationships**

a. Form I → Form IV
b. Form I → Form VII
c. Form II → Form V
d. Form III → Form VI

- The relationships between the simple Applicative (II) and Causative (III) and their Reflexivized versions (V/VI) definitely have some BD flavor to them.
  - The Refl /t/ gets infixed in Form VIII where there is no base.
  - The Refl /t/ gets prefixed (and supported by a vowel) when there is a base.

- We could also squint at the Form I ones to say that you can't infix because there's a base.
  - It's easier for Form VII, because there isn't any phonology going on.
  - It's harder for Form IV, because you're getting a reordering of the first AV vowel and the first Root consonant.
    - This is driven (in my analysis) by a (morpho)phonological requirement that (this) [ʔ] not be preconsonantal.
    - This same requirement also holds of the Reflexive /t/, which explains why there isn't an initial cluster in Forms V & VI.

1.4.3 An attempt at an analysis

- If we want to pursue a BD analysis of any of these, we have to figure out what the actual faithfulness constraint would be. Here are our options (MAX, DEP, IDENT clearly won't help):

(16) **Complex faithfulness constraints** (McCarthy & Prince 1995)

a. CONTIGUITY-B(→)D (*no intrusion*): Assign a violation for each pair of segments which are adjacent in the base that have non-adjacent correspondents in the derivative.

b. CONTIGUITY-B(←)D (*no skipping*): Assign a violation for each pair of segments which are adjacent in the derivative that have non-adjacent correspondents in the base.

c. ANCHOR-L-BD: Assign one violation if the leftmost segment of the base is not in correspondence with the leftmost segment of the derivative.

d. ANCHOR-R-BD: Assign one violation if the rightmost segment of the base is not in correspondence with the rightmost segment of the derivative.

e. LINEARITY-BD: For each pair of segments in the base x_B, y_B with correspondents in the derivative x_D, y_D, assign one violation if x_b ***precedes*** y_b (at any distance) but x_D ***follows*** y_D (at any distance).

- ANCHOR-L-BD could in principle trigger infixation, in order to keep the leftmost base segment in initial position. (Could have trouble with the imperfective where there is an outermost agreement prefix.)
  → But the infixal cases are exactly the ones which *don't* have bases, if we stick with the structures from the MAP analysis.
  - But maybe these still result from a high(ish)-ranked ALIGN-ROOT-L, independent of the MAP, when they are *not* subject to ANCHOR-L-BD because they don't have a base.

- LINEARITY-BD isn't really going to be relevant if we assume that morphemes are unordered in the input, and therefore infixation vs. prefixation won't affect any precedence relations.
  - Furthermore, the frequent reversals of Root consonants and AV vowels would precisely violate this constraint.

- So what about CONTIGUITY-BD? In Forms V, VI, and VII, it seems like this might do the trick.
  - If CONTIGUITY-BD outranks ALIGN-ROOT-L, then infixation will be worse than prefixation.

(17) **Prefixation in Form VII because it has a base**

Base: [katab-] [[Root]*v*] / Input: /ktb$_{RT}$, Ø$_v$, n$_{MID}$/ [[[Root]*v*]Mid]			Contig-BD	Anchor-L-BD	Align-Root-L
a.	☞	<u>n</u>katab- (Mid < Root)			*
b.		k<u>n</u>atab- (Root < Mid)	*!	*!	

(18) **Infixation in Form VIII because it doesn't have a base**

Base: *none* / Input: /ktb$_{RT}$, t$_{REFL}$/ [[Root]Refl]			Contig-BD	Anchor-L-BD	Align-Root-L
a.		<u>t</u>katab- (Refl < Root)	*n/a*	*n/a*	*!
b.	☞	k<u>t</u>atab- (Root < Refl)			

- But what about Form IV, where you get a reversal of the Root-initial consonant and the AV-initial vowel?
  - Part of the story is (or could be) the phonotactic requirement on /ʔ/.
  - → But that won't fully solve the problem — it predicts infixation as the response:

(19) **Prefixation in Form VII because it has a base**

Base: [katab-] [[Root]*v*] / Input: /ktb$_{RT}$, Ø$_v$, ʔ$_{CAUS}$/ [[[Root]*v*]Caus]			*ʔ$_{caus}$C	Contig-BD	Anch-L-BD	Aln-Rt-L
a.		<u>ʔ</u>**k**atab- (Caus < Rt < AV)	*!			*
b.	💣	**k**<u>ʔ</u>atab- (Rt < Caus < AV)		* (k→a)	*	
c.	☹	<u>ʔ</u>a**k**tab- (Caus < AV < Rt)		*(*!) (k←t,a→t)	*	*(!)*

- Here's the problem with the analysis:
  - We don't have any constraints that *want* the prefix to be at the left edge.
  - So they only end up as prefixes when that option is harmonically *improving* on a constraint ranked above Align-Root-L.

- If we introduce an alignment constraint for *v*-domain morphemes above Align-Root-L, then we revert to prefixation being the default, which would tank our analysis of infixation (18).
  - And also note that the structure of Form IV (vs. Form II) was motivated independently on syntactic/semantic grounds, so we don't want to monkey with that.

- We could also consider giving up on our assumption that the morpheme are not ordered in the input. This would potentially let us use Linearity-**IO** to attack the problem.
  - But that won't work either. The (b) and (c) candidates each do exactly one reordering, so Linearity won't distinguish between them either.

⋆ I don't currently see a way around this problem (but maybe you do!), so I think we probably **still need the MAP** for root-and-pattern morphology.

2 The phonology of Arabic nonconcatenative morphology

2.1 Data Preview

- I make the following, largely traditional assumptions about the morphological composition of Arabic verbs:

(20) **Morphological composition**

a. Roots consist of a string of underlying consonants (usually 3).
My analysis works transparently for 3-consonant roots; more will need to be said for 2- and 4-consonant roots.

b. The "vocalic melodies" expone Aspect and Voice, and consist of a string of 1–3 underlying V's.
I treat them as portmanteaux, but contextual allomorphy may be possible as well.

c. The additional phonological content present in derived "Forms" expones v-domain morphemes: CAUSATIVE, APPLICATIVE, REFLEXIVE, MIDDLE (vel sim.).
Their precise morphosemantic character is not crucial for the phonology, but their structural positions are.

d. Subject agreement affixes are outermost: suffixal in the perfective, simultaneously prefixal and suffixal (→ circumfixal) in the imperfective.
I won't have anything to say about their actual exponence.

- The phonological shapes of the nine productive verb "Forms", in the four aspect/voice categories, are given in Table 4.

Form	Pf. Act. /a/	Pf. Pass /ui/	Impf. Act. /???/	Impf. Pass. /ua/
I	**katab-a**	**kutib-a**	**y-aktub-u**	**y-uktab-u**
II	**kat$_c$tab-a**	**kut$_c$tib-a**	**y-ukat$_c$tib-u**	**y-ukat$_c$tab-u**
III	**kaa$_v$tab-a**	**kuu$_v$tib-a**	**y-ukaa$_v$tib-u**	**y-ukaa$_v$tab-u**
IV	**ʔaktab-a**	**ʔuktib-a**	**y-u(ʔa)ktib-u**	**y-u(ʔa)ktab-u**
V	**takat$_c$tab-a**	**tukut$_c$tib-a**	**y-atakat$_c$tab-u**	**y-utakat$_c$tab-u**
VI	**takaa$_v$tab-a**	**tukuu$_v$tib-a**	**y-atakaa$_v$tab-u**	**y-utakaa$_v$tab-u**
VII	**nkatab-a**	**nkutib-a**	**y-ankatib-u**	**y-unkatab-u**
VIII	**ktatab-a**	**ktutib-a**	**y-aktatib-u**	**y-uktatab-u**
X	**staktab-a**	**stuktib-a**	**y-astaktib-u**	**y-ustaktab-u**

Table 4: Arabic verbal system (3SG.M of root √ktb 'write'; adapted from McCarthy 1981:385)

∗ In the imperfective of Form IV, the /ʔ/ and the following vowel are absent on the surface. It is not clear whether this is due to a deletion process or morphological non-exponence.

- My morphological analysis of the various v-domain morphemes is given in Table 5.

Syntactic Heads		Morphs		Forms
Applicative		/μ_v/		III, VI
Reflexive		/t/		V, VI, VIII, X
Middle		/n/		VII
v		/∅/		I, IV, VII, X
Causative	i.	/μ_c/	(sister to Root)	II, V
	ii.	/ʔ/	(sister to v)	IV
	iii.	/s/	(sister to Refl)	X

Table 5: Morphemes involved in verbal Forms

∗ The precise morphosemantic characterization of the v-domain morphemes is not crucial.

- My analysis of the morphosyntactic structures and MAP rankings is given in Table 6.

Form	**Perf. Act.**	**Syntactic structure**	**Alignment Ranking**
I	*kataba*	[*v* [Root]]	ALIGN-ROOT-L (≫ ALIGN-*v*-L)
II	*kat$_c$taba*	[Caus [Root]]	ALIGN-ROOT-L ≫ ALIGN-CAUS-L
III	*kaa$_v$taba*	[Appl [Root]]	ALIGN-ROOT-L ≫ ALIGN-APPL-L
IV	***ʔ**aktaba*	[Caus [*v* [Root]]]	ALIGN-CAUS-L ≫ ALIGN-ROOT-L (≫ ALIGN-*v*-L)
V	***t**akat$_c$taba*	[Refl [Caus [Root]]]	ALIGN-REFL-L ≫ ALIGN-ROOT-L ≫ ALIGN-CAUS-L
VI	***t**akaa$_v$taba*	[Refl [Appl [Root]]]	ALIGN-REFL-L ≫ ALIGN-ROOT-L ≫ ALIGN-APPL-L
VII	***n**kataba*	[Mid [*v* [Root]]]	ALIGN-MID-L ≫ ALIGN-ROOT-L (≫ ALIGN-*v*-L)
VIII	*k**t**ataba*	[Refl [Root]]	ALIGN-ROOT-L ≫ ALIGN-REFL-L
X	***st**aktaba*	[Caus [Refl [*v* [Root]]]]	ALIGN-CAUS-L ≫ ALIGN-REFL-L ≫ ALIGN-ROOT-L

Table 6: Morphosyntactic structure and alignment analysis of verbal Forms

⋆ In all Forms, we require the ranking ALIGN-ROOT-L ≫ ALIGN-AV-L.
  - This does not follow from the MAP in any obvious way; in fact, we'd probably expect the opposite.
  - In §3, I'll show that we can use *amalgamation* (Harizanov & Gribanova 2019) to derive a structure that can generate the desired ranking.
  - Until then, I simply take the ranking for granted.

2.2 Explaining the left edge: a lexically-indexed phonotactic constraint

- The MAP-based alignment analysis makes an incorrect prediction about the sequences at the left edge of certain Forms.
  - E.g., in Form V (21), a candidate (21a) where the Root-initial [k] comes immediately after Reflexive /t/ should win based on alignment alone.
  - Desired winner (21b) also splits AV /u/, incurring a violation of INTEGRITY not shared by (21a).

(21) **Form V perfective passive *tukut$_c$tiba*** (alignment only)

/t$_{\text{REFL}}$, $\mu_{C\ \text{CAUS}}$, ktb, ui$_{\text{AV}}$, a$_{\text{AGR}}$/	ALIGN-REFL-L	ALIGN-ROOT-L	ALIGN-AV-L
a. 💣 **tkut$_c$tiba**		*	**
b. ☹ **tukut$_c$tiba**		**!	*
c. **ktut$_c$tiba**	*!		*

- Three (sets of) morphemes have this same property of disrupting alignment to have a following vowel:

(22) **Morphemes requiring a following vowel**

a. Reflexive /t/ [Form V,VI,X]

b. Causative /ʔ/ [Form IV]

c. Imperfective agreement affixes (at least the left-edge morphs): /y,t,ʔ,n/.

- In McCarthy (1979, 1981) and other templatic approaches, these are all morphemes/Forms which have to be associated to a template beginning in CV.

⋆ Rather than building this into the representations, we can implement the generalization using a *lexically-indexed markedness constraint* (following Pater 2000, 2009, Flack 2007, *a.o.*):

(23) ***AFX$_i$/_C:** Assign a violation * if a morpheme(/segment) with the index *i* precedes a consonant in the output.

{ *Alternatively*: AFX$_i$ linked to *CC or AFX$_i$ linked to *C]$_\sigma$ or *C$_i$C }

→ As long as the morphemes in (22) are indexed to $*\text{AFX}_i$/_C, and $*\text{AFX}_i$/_C outranks the alignment constraints, we derive the desired outputs for these cases, as demonstrated for Form V in (24).
- ▷ Exponents indexed to $*\text{AFX}_i$/_C are underlined in candidate outputs.

(24) **Form V perfective passive** *tukut$_c$tiba* (alignment plus $*\text{AFX}_i$/_C)

/t$_{i\ \text{REFL}}$, $\mu_{c\ \text{CAUS}}$, ktb, ui$_{\text{AV}}$, a$_{\text{AGR}}$/	$*\text{AFX}_i$/_C	ALIGN-REFL-L	ALIGN-ROOT-L	ALIGN-AV-L
a. tkut$_c$tiba	*!		*	**
b. ☞ tukut$_c$tiba			**	*
c. ktut$_c$tiba		*!		*

- **N.B.:** $*\text{AFX}_i$/_C is indexed to the /ʔ/ *exponent* of CAUSATIVE, but not the /μ_c/ or /s/ exponents of CAUSATIVE. This indicates that the index is attached to the "morpheme" (in the DM sense).

2.2.1 $*\text{AFX}_i$/_C and the *v*-domain morphemes

- The other *v*-domain morpheme indexed to $*\text{AFX}_i$/_C is the Causative /ʔ/ found in Form IV. The constraint interaction works exactly the same as before, as shown in (25).

(25) **Form IV perfective passive** *ʔuktiba* ($*\text{AFX}_i$/_C active for /ʔ/)

/ʔ$_{i\ \text{CAUS}}$, ktb, ui$_{\text{AV}}$, a$_{\text{AGR}}$/	$*\text{AFX}_i$/_C	ALIGN-CAUS-L	ALIGN-ROOT-L	ALIGN-AV-L
a. ʔkutiba	*!		*	**
b. ☞ ʔuktiba			**	*
c. kʔutiba		*!		**

- In Forms without affixes indexed to $*\text{AFX}_i$/_C — e.g. Form VII with Middle /n/ (26) — alignment can be maximally satisfied, allowing for clusters to surface at the left edge:

(26) **Form VII perfective active** *nkataba* ($*\text{AFX}_i$/_C not active)

/n$_{\text{MID}}$, ktb, a$_{\text{AV}}$, a$_{\text{AGR}}$/	$*\text{AFX}_i$/_C	ALIGN-MID-L	ALIGN-ROOT-L	ALIGN-AV-L
a. ☞ nkataba	n/a		*	**
b. naktaba			**!	*
c. knataba		*!		**

- Initial clustering is also found in Form VIII (reflexive). In this case, both alignment and $*\text{AFX}_i$/_C advocate for Reflexive /t/ to surface in pre-vocalic position (27a).[1]

(27) **Form VIII perfective passive** *ktutiba* ($*\text{AFX}_i$/_C active for /t/, but superfluous)

/t$_{i\ \text{REFL}}$, ktb, ui$_{\text{AV}}$, a$_{\text{AGR}}$/	$*\text{AFX}_i$/_C	ALIGN-ROOT-L	ALIGN-REFL-L	ALIGN-AV-L
a. ☞ ktutiba			*	**
b. kuttiba	*!		**	*
c. tkutiba	*!	*		**

[1] I represent a strict ranking between ALIGN-REFL-L and ALIGN-AV-L. This is not necessary for the candidates considered, but it would be if we considered an additional candidate *[kututiba], with an extra [u]. This ranking does not follow from the MAP or the Default Ranking. A solution is still wanting.

2.2.2 *AFX$_i$/_C and imperfective agreement

- As can be seen in Table 7 below, in the imperfective, a vowel always intervenes between the left-edge agreement morph and the next consonant (whether it belongs to the Root or to a *v*-domain morpheme).

Form	Pf. Act. /a/	Pf. Pass /ui/	Impf. Act. /???/	Impf. Pass. /ua/
I	katab-a	kutib-a	y-aktub-u	y-uktab-u
II	kat$_c$tab-a	kut$_c$tib-a	y-ukat$_c$tib-u	y-ukat$_c$tab-u
III	kaa$_v$tab-a	kuu$_v$tib-a	y-ukaa$_v$tib-u	y-ukaa$_v$tab-u
IV	ʔaktab-a	ʔuktib-a	y-u(ʔa)ktib-u	y-u(ʔa)ktab-u
V	takat$_c$tab-a	tukut$_c$tib-a	y-atakat$_c$tab-u	y-utakat$_c$tab-u
VI	takaa$_v$tab-a	tukuu$_v$tib-a	y-atakaa$_v$tab-u	y-utakaa$_v$tab-u
VII	nkatab-a	nkutib-a	y-ankatib-u	y-unkatab-u
VIII	ktatab-a	ktutib-a	y-aktatib-u	y-uktatab-u
X	staktab-a	stuktib-a	y-astaktib-u	y-ustaktab-u

Table 7: Arabic verbal system (repeated from Table 4 above)

- This vowel varies by voice (and by Form, in the active), but not by person.
  - i.e., the [ya]'s and [yu]'s of the 3rd person singular are matched by [ta]/[tu], [ʔa]/[ʔu], and [na]/[nu].
- This strongly suggests that these vowels are *not* part of the agreement morpheme (cf. McCarthy 1981), but rather part of the AV morpheme (Brame 1970:70, Yip 1988:569).

→ Therefore, just as with the *v*-domain morphemes, we can derive the requirement of a second-position vowel by indexing the imperfective agreement morphs to *AFX$_i$/_C.

- For illustration, consider the Form I imperfective passive *yuktabu* (28), which follows from the same interaction that derived the more complex Forms above.

(28) **Form I imperfective passive** *yuktabu* (*AFX$_i$/_C active for /y/)

/ktb, ua$_{AV}$, y$_i$(-)u$_{AGR}$/	*AFX$_i$/_C	ALIGN-AGR-L	ALIGN-ROOT-L	ALIGN-AV-L
a. ykutabu	*!		*	**
b. ☞ yuktabu			**	*
c. kyutabu		*!		**

2.3 Explaining the vocalic melodies: INTEGRITY and *CCC

- The interaction between alignment and *AFX$_i$/_C explains the behavior at the left edge of all the forms.

⋆ The largest remaining piece of the puzzle is the position and number of the vowels of the AV vocalic melody in the various Forms.

→ My jumping off point is the (somewhat novel) generalizations in (29), confirmed by Table 8.
  - See McCarthy (1981:400), Yip (1988:565) for similar observations.

(29) **Phonological conditions on vowel splitting**

a. No Form has multiple instances of multiple AV vowels (only one vowel splits).

b. Assuming the sonority scale $a \succ u \succ i$, whenever additional vowels are required in order to create well-formed structures, the most sonorous vowel splits.

  - These generalizations clearly hold in the Perfective Active, Perfective Passive, and Imperfective Passive, where the same combination of vowels in the same order appears across the different Forms.
  - They hold also in the Imperfective Active, even though the set of vowels differs by Form.

Form	Pf. Act. /a/	Pf. Pass /ui/	Impf. Act. /???/	Impf. Pass. /ua/
I	katab-a	kutib-a	y-aktub-u	y-uktab-u
II	$\text{kat}_c\text{tab-a}$	$\text{kut}_c\text{tib-a}$	$\text{y-ukat}_c\text{tib-u}$	$\text{y-ukat}_c\text{tab-u}$
III	$\text{kaa}_v\text{tab-a}$	$\text{kuu}_v\text{tib-a}$	$\text{y-ukaa}_v\text{tib-u}$	$\text{y-ukaa}_v\text{tab-u}$
IV	ʔaktab-a	ʔuktib-a	y-u(ʔa)ktib-u	y-u(ʔa)ktab-u
V	$\text{takat}_c\text{tab-a}$	$\text{tukut}_c\text{tib-a}$	$\text{y-atakat}_c\text{tab-u}$	$\text{y-utakat}_c\text{tab-u}$
VI	$\text{takaa}_v\text{tab-a}$	$\text{tukuu}_v\text{tib-a}$	$\text{y-atakaa}_v\text{tab-u}$	$\text{y-utakaa}_v\text{tab-u}$
VII	nkatab-a	nkutib-a	y-ankatib-u	y-unkatab-u
VIII	ktatab-a	ktutib-a	y-aktatib-u	y-uktatab-u
X	staktab-a	stuktib-a	y-astaktib-u	y-ustaktab-u

Table 8: Arabic verbal system (repeated from Table 4 above)

> ∗ Note that this cannot be recast in directional terms (Yip 1988):
> - In the Perfective Passive (/ui/) and Forms VII, VIII, X in the Imperfective Active (/ai/), the *lefthand* vowel splits.
> - But in the Imperfective Passive (/ua/), the *rigthand* vowel splits.
>
> → This is problematic for directional autosegmental association accounts:
> - In order to maintain *left-to-right* association, McCarthy (1981:401) had to stipulate a prior rule that associates /i/ to the right edge first.

⋆ We can use this phonological conditioning to generate the range of surface patterns from compact UR's.

- I implement this with the faithfulness constraint Integrity (McCarthy & Prince 1995), relativized to individual vowel qualities, ranked (inversely) according to their sonority value (30).
  - Not clear whether this ranking is substantive or accidental.

(30) **Definition and ranking of Integrity (sub-)constraints**

a. *Definition* of Integrity[x]-IO: For each input segment of type x, assign one violation * for each pair of corresponding segments in the output.

b. *Ranking*: Integrity[i]-IO ≫ Integrity[u]-IO ≫ Integrity[a]-IO

- This approach yields three desiderata:

(31) **Splitting desiderata**

a. It correctly selects *which* vowel splits when splitting occurs.

b. It correctly predicts that only one underlying vowel is ever split in a given form.

c. It predicts that splitting will be minimal (since more splitting incurs more violations), subject to the needs of higher-ranked constraints.

- The primary drivers of Integrity violation are *Afx_i/_C and *CCC (32), modulated by alignment.

(32) ***CCC:** Assign a violation * for each three-consonant sequence in the output.

⋆ One Form where splitting occurs is the Form X imperfective active *yastaktibu*, where there are *two* instances of [a] in the output.

2.3.1 Relative order via alignment

- The order of consonantal morphemes is determined purely by alignment ranking (cf. Table 6), as in (33):

(33) **Ordering via alignment**

Align-Agr-L	≫	Align-Caus-L	≫	Align-Refl-L	≫	Align-Root-L
y	>	s	>	t	>	k

- As long as INTEGRITY ranks *below* these alignment constraints, splitting AV vowels will always be better than reordering the consonantal morphemes as a repair for *AFX$_i$/_C.
  - → A candidate like **syaktitbu* (34c), which satisfies *AFX$_i$/_C by swapping the order of the exponents, excessively violates high-ranked alignment constraints (here, ALIGN-AGR-L and ALIGN-REFL-L).
  - ∗ *Italicized* vowels in the output are split vowels, incurring INTEGRITY violations.

(34) **Form X imperfective active** *yastaktibu*: ordering via alignment

/s$_{CAUS}$, t$_{i\ REFL}$, ktb, ai$_{AV}$, y$_i$(-)u$_{AGR}$/	*AFX$_i$/_C	ALIGN-AGR-L	INTEGRITY[a]
a. ystkatibu	*!*		
b. ☞ y*a*st*a*ktibu			*
c. syaktitbu		*!	

2.3.2 Splitting driven by *AFX$_i$/_C and *CCC

⋆ Holding the ordering of the consonantal morphemes constant, we can now see the full interaction between *AFX$_i$/_C, *CCC, and INTEGRITY. This is demonstrated in (35) below.

- Perfect alignment (35a) produces a long string of consonants at the beginning of the word, violating both *AFX$_i$/_C and *CCC.

(35) **Form X Imperfective Active** *yastaktibu*: motivating splitting

/s$_{CAUS}$, t$_{i\ REFL}$, ktb, ai$_{AV}$, y$_i$(-)u$_{AGR}$/	*AFX$_i$/_C	*CCC	INTEGRITY[a]
a. ystkatibu	*!*	*!*	
b. ysatkitbu	*!*		
c. yastiktbu		*!	
d. ☞ y*a*st*a*ktibu			*

- There is no way to fully repair both markedness problems by simply moving around the AV vowels (i.e. without splitting). Candidates (35b) and (35c) can each solve one problem, but no candidate can solve both:

  1. Place the two AV vowels after every second consonant from the left (35b).
     - This satisfies *CCC, but doesn't alleviate the *AFX$_i$/_C violations.[2]
     - ↪ Therefore, *AFX$_i$/_C ≫ INTEGRITY.
  2. Place the two AV vowels after the two exponents indexed to *AFX$_i$/_C (35c).
     - This satisfies *AFX$_i$/_C, but creates a *CCC-violating cluster towards the right.
     - ↪ Therefore, *CCC ≫ INTEGRITY.

→ Only by splitting one of the vowels (35d) can both markedness constraints be satisfied simultaneously.

2.3.3 Splitting governed by INTEGRITY

⋆ Once splitting is motivated by *AFX$_i$/_C and *CCC, INTEGRITY does the rest, as shown in (36).

- INTEG[i] ≫ INTEG[a] ensures that underlying /a/ is split (36b) rather than underlying /i/ (36a).
- The ranking of the INTEGRITY constraints over other markedness constraints, e.g. NOCODA or *CC, ensures that additional splitting does not occur: (36b) ≻ (36c,d).[3]

[2] Note that there are consonant-initial agreement suffixes, which would trigger a *CCC violation at the right edge of the stem.
[3] I have defined INTEGRITY to assign violations to all pairs of corresponding output segments, so the number of violations will increase exponentially as splitting increases. This has no effect on the evaluation as long as we are operating with constraint ranking rather than weighting.

(36) **Form X Imperfective Active** *yastaktibu*: governing splitting

/s_{CAUS}, $t_{i\ REFL}$, ktb, ai_{AV}, y_i(-)u_{AGR}/		Integrity[i]	Integrity[a]	NoCoda/*CC
a.	yastiktibu	*!		**
b. ☞	yastaktibu		*	**
c.	yastakatibu		**!*	*
d.	yasatakatibu		**!****	

∗ (36d) would actually be ruled out by alignment, because the extra [a] (the second one) intervenes between the left word-edge and the left edge of several left-oriented morphemes.

→ (36c), though, does have the same alignment profile as (36b), because the extra vowel surfaces inside the root, after all the left edges. So the ranking arguments still hold.

2.4 Explaining the right edge: *both-edge* alignment

- The last issue that I'll tackle is the relative positions of exponents towards the *right* edge of the stem.

- Nothing about the current analysis distinguishes, e.g., the two candidates outputs for a Form X imperfective active in (37):

(37) **Form X imperfective active**

a. *yastak[ti]bu* (stem-final **CVC**)
b. **yastak[it]bu* (stem-final **VCC**)

- In both forms, left-alignment of all the morphemes is maximized (subject to markedness and Integrity), and there are the same number of codas and consonant clusters.

- The answer seems to lie in the longstanding generalization that all verbal stems (i.e. the material preceding the agreement suffixes) must *end in a VC sequence* (McCarthy 1979, McCarthy & Prince 1990, *a.o.*).
  - ⋆ If something actively enforces this generalization, it will prefer *yastak[ti]bu* (37a) over **yastak[it]bu* (37b).

→ The current alignment-based analysis presents a new explanation.

Other possible explanations

- We could simply hardwire this into the analysis with some expanded version of the constraint Final-C (cf. McCarthy & Prince 1990, McCarthy 1993, 2005a, Kiparsky 2003, Farwaneh 2009, *a.o.*).
  - ◦ But this would not provide much explanatory value without further contextualization.
- We could alternatively appeal to paradigm uniformity using McCarthy's (2005b) "Optimal Paradigms" (OP) approach, which he shows can derive similar facts through paradigmatic overapplication.
  - ◦ Since there are consonant-initial verbal agreement suffixes, and three-consonant clusters are not allowed (*CCC), some inflected forms will not tolerate a VCC-final stem.
  - ◦ These instead require a VC-final stem, and this is transferred through OP-correspondence (perhaps Linearity, or something relating to syllable weight) to the rest of the paradigm, resulting in consistently VC-final stems.

2.4.1 Alignment and the right edge

- Consider the following two facts:
  (i) The stem-final VC sequence is always composed of the last AV vowel followed by the last Root C.
  (ii) Based on the behavior of the left edge of the stem: Align-Root ≫ Align-AV.

→ If these alignment constraints **also regulate the right edge**, then alignment derives the distribution.

- ◦ Furthermore, the right-side agreement morph always *follows* this VC sequence, just like the left-side agreement morph always *precedes* the Root and the AV morpheme at the left edge (cf., e.g., (28)).

⋆ A right-oriented version of the alignment ranking that is independently needed for the left edge (38) generates the correct order in full (for agreement suffixes of any shape), as shown in (39) below.

(38) **Ranking** (to be refined): ALIGN-AGR-R ≫ ALIGN-ROOT-R ≫ ALIGN-AV-R

(39) **Form X imperfective active** *yastaktibu*: explaining the right edge

/s_{CAUS}, $t_{i\ REFL}$, kt**b**, **ai**$_{AV}$, y_i(-)**u**$_{AGR}$/	ALIGN-AGR-R	ALIGN-ROOT-R	ALIGN-AV-R	INTEG
a. ☞ y*a*st*a*kt**ibu**		*	**	*
b. y*a*st*a*k**i**t**bu**		*	***!	*
c. yast**i**kt*u***b***u*		*	***!**	*
d. yast**i**kt**u**b	*!		****	

- Because ALIGN-AGR-R is highest ranked, agreement must be rightmost, ruling out (39d), which solves the markedness problems without splitting by moving the Agr /u/ inside the Root.
  - This means there must be a violation of ALIGN-ROOT-R, and ensures the word-final sequence [bu].
- Beyond that, the only constraint that cares which segment comes next is ALIGN-AV-R.
  - This ensures that the rightmost AV vowel comes next (39a).
- ⋆ Having the Root-medial /t/ surface next (39b) confers no benefit, nor does splitting the agreement affix and having it come next (39c); in fact, both worsen AV-alignment.

- As long as ALIGN-AV-R dominates the INTEGRITY constraints, this approach also explains why agreement suffixes don't split even when they provide the most sonorous (and thus most splittable) vowel:
  → **Doing so would worsen AV-alignment**.
- We can see this in the Form V perfective passive 3SG.MASC, w/ AV morph /ui/ and agreement morph /a/.
  ▷ All candidates in (40) have the same CV shape, differing only in which vowel splits.

- The ranking INTEG[i] ≫ INTEG[u] ≫ INTEG[a] prefers splitting the agreement morph /a/ (40a).
  - But, this displaces the AV-final /i/ further left than the other splitting options, incurring extra ALIGN-AV-R violations.

→ To ensure that the AV-final /i/ is as far right as possible, the AV-initial /u/ gets split instead (40b).
  - Still, (40b) ≻ (40c) because it splits the more sonorous vowel without any consequences for alignment.

(40) **Form V perfective passive** *tukuttiba*

/$t_{i\ REFL}$, $\mu_{c\ CAUS}$, ktb, ui$_{AV}$, a$_{AGR}$/	ALIGN-AV-R	INTEG[i]	INTEG[u]	INTEG[a]
a. tukit$_c$t*a*b*a*	***!**			*
b. ☞ t*u*k*u*t$_c$tiba	**		*	
c. tukit$_c$t*i*ba	**	*!		

2.4.2 *Both-edge* alignment

- We now see that we need **both** *left*-alignment and *right*-alignment for:

(41) a. The Root
b. The AV morpheme
c. The (imperfective) agreement morphemes

- This may have been obvious on its face for the imperfective agreement markers, which can (superficially, at least) be categorized as circumfixes.[4]

[4] Perfective agreement is aligned only to the right. Therefore, the direction of alignment must differ for the different agreement categories. Conceptually, we might relate this to the idea that the lexical index for *AFX$_i$/_C must apply to morphs not morphemes (see above). More thought about how this fits into the alignment system broadly is required.

⋆ I implement this by enriching Generalized Alignment (McCarthy & Prince 1993, Hyde 2012) as follows:

→ **Alignment constraints can select *both edge* ("E") as their direction of alignment**.

- Adopting this approach, the alignment constraint for, e.g., the AV morpheme would be defined as in (42):

(42) **ALIGN-AV-E:** Assign one violation * for:

a. each segment which intervenes in the output between the *left* edge of the exponent of the AV morpheme and the *left* edge of the word, **and**

b. each segment which intervenes in the output between the *right* edge of the exponent of the AV morpheme and the *right* edge of the word.

∗ This to some extent recapitulates Yip's (1988) notion of "Edge-In Association", which was motivated by the same facts.

- One other place where we can see the effects of E-alignment is the perfective active AV morpheme /a/.

→ If we assume a unisegmental UR /a/ (rather than OCP-violating /aa/), we can view E-alignment as the driver of splitting in Form I, where one vowel would suffice for phonotactics (43).

(43) **Form I perfective active** 3SG.MASC *katab*a

/ktb, a$_{\text{AV}}$, a$_{\text{AGR}}$/	ALIGN-AV-E	INTEG[a]
a. katb-a	4! (*|***)	
b. ktab-a	4! (**|**)	
c. ☞ k*a*t*a*b-a	3 (*|**)	*

▹ For E-alignment constraints, violations for the left edge are indicated to the left of the " | ", violations for the right edge to its right.

- This holds equally well for consonant-initial agreement suffixes, e.g. the perfective 3PL.FEM /-na/ (44).

(44) **Form I perfective active** 3PL.FEM *katab*na

/ktb, a$_{\text{AV}}$, na$_{\text{AGR}}$/	*CCC	ALIGN-ROOT-E	ALIGN-AV-E	INTEG[a]
a. katb-na	*!	2 (|**)	5 (*|****)	
b. ktab-na		2 (|**)	5! (**|***)	
c. ☞ k*a*t*a*b-na		2 (|**)	4 (*|***)	*
d. k*a*tb*a*-na		3! (|***)	3 (*|**)	*

∗ There is an outstanding problem regarding a candidate like *[k*a*t-n-*a*b-a], where the Root and the AV morph intrude into the multisegmental agreement suffix.

- This may be solvable by introducing a high-ranked CONTIGUITY-AFX-IO constraint.
- However, this will require further scrutiny about the representation of the imperfective agreement markers, which are definitionally discontiguous, and also potentially the AV morpheme.

3 Amalgamation and the relationship between Root & Aspect/Voice

- There is one place where naive assumptions about asymmetric c-command vis-à-vis the MAP are not met:
  → The interaction between **Root and Aspect/Voice** (i.e. the vocalic melodies).

- We would expect Aspect and Voice to asymmetrically c-command Root given their higher position on the clausal spine. However, an alignment-based ordering analysis requires the reverse ranking:

(45) **Ranking:** ALIGN-ROOT-L ≫ ALIGN-AV-L (instead of expected ALIGN-AV-L ≫ ALIGN-ROOT-L)

⋆ In this section, I will first motivate this ranking, then propose a solution based on *amalgamation* (Harizanov & Gribanova 2019) that can derive it in a way that is consistent with the MAP.

3.1 Alignment ranking

- Tableau (46) shows the basic interaction from a Form I (basic form) perfective passive.
  → Assuming that alignment is all that is in play, we would need the ranking ALIGN-ROOT-L ≫ ALIGN-AV-L.

(46) **Form I perfective passive *kutiba***

/ktb, ui$_{AV}$, a$_{AGR}$/	ALIGN-ROOT-L	ALIGN-AV-L
a. ☞ kutiba		*
b. uktiba	*!	

- Tableau (47) shows an additional case, the Form VII ("middle") perfective active, where the output is clearly not otherwise phonotactically optimizing (the winner will require [ʔi] epenthesis (phrase-initially)).
  → This ensures that it is alignment which is driving the derivation, not markedness considerations.

(47) **Form VII perfective active *nkataba***

/n$_{MID}$, ktb, a$_{AV}$, a$_{AGR}$/	ALIGN-MID-L	ALIGN-ROOT-L	ALIGN-AV-L
a. ☞ nkataba		*	**
b. naktaba		**!	*
c. knataba	*!		**
d. ankataba	*!	**	

⋆ **Question:** Why does ALIGN-ROOT-L outrank ALIGN-AV-L?

3.2 Towards a solution: the Default Ranking Principle and portmanteau exponence

⋆ The Default Ranking Principle in (48) will produce an unexpectedly-high ranking of ALIGN-ROOT-L *in the absence of asymmetric c-command.*

(48) **DRP for Arabic:** When the MAP does not prescribe a ranking between ALIGN-ROOT-L and another alignment constraint, rank ALIGN-ROOT-L higher.

→ If we can derive a structure where **Aspect and Voice no longer asymmetrically c-command Root**, we can use (48) to generate the necessary ranking.

- Now, recall that I have assumed that Aspect and Voice are *always* exponed together as a portmanteau morpheme in the language, as can be seen in Table 9.

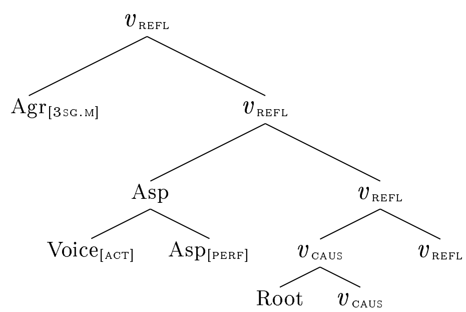
Form	Pf. Act. /a/	Pf. Pass /ui/	Impf. Act. /???/	Impf. Pass. /ua/
I	katab-a	kutib-a	y-aktub-u	y-uktab-u
II	kat$_c$tab-a	kut$_c$tib-a	y-ukat$_c$tib-u	y-ukat$_c$tab-u
III	kaa$_v$tab-a	kuu$_v$tib-a	y-ukaa$_v$tib-u	y-ukaa$_v$tab-u
IV	ʔaktab-a	ʔuktib-a	y-u(ʔa)ktib-u	y-u(ʔa)ktab-u
V	takat$_c$tab-a	tukut$_c$tib-a	y-atakat$_c$tab-u	y-utakat$_c$tab-u
VI	takaa$_v$tab-a	tukuu$_v$tib-a	y-atakaa$_v$tab-u	y-utakaa$_v$tab-u
VII	nkatab-a	nkutib-a	y-ankatib-u	y-unkatab-u
VIII	ktatab-a	ktutib-a	y-aktatib-u	y-uktatab-u
X	staktab-a	stuktib-a	y-astaktib-u	y-ustaktab-u

Table 9: Arabic verbal system (repeated from Table 4 above)

- Systematic facts like these ought to be captured through the application of syntactic and/or morphological processes of the language, rather than through accidents of Vocabulary Insertion.
  → i.e., there should be something special about the structural relationship between Aspect and Voice.

- I propose that the final structure of the complex head is that in (49), where the lowest segments of Aspect and Voice are displaced from the root of the head by a segment of Asp.[5]
  → For this section, I will explicitly be assuming that the "*v*-domain morphemes" are flavors of *v*.

(49) **Proposed morphological structure of the verb word** (Form V perfective active *takat*$_c$*taba*)



⋆ This structure can be derived with Harizanov & Gribanova's (2019) post-syntactic *amalgamation* operation.
  ◦ Its "counter-cyclic" appearance is derived by an odd, but permissible, configuration of feature values of the morphological feature driving amalgamation.

∗ One might also be able to derive this (or an equivalent) structure by positing that Voice moves to Aspect prior to roll-up head movement, as long as roll-up head movement operates over the higher segment of Asp.

⇒ This structure will generate the desired ranking ALIGN-ROOT-L ≫ ALIGN-AV-L because the lowest segments of Aspect and Voice no longer c-command Root.
  ◦ This bleeds the MAP and allows the DRP to rank ALIGN-ROOT-L higher.

3.3 Amalgamation (an overview)

- Harizanov & Gribanova (2019) propose "almagamation" as the morphological process by which heads generated by the syntax are combined to form morphological words (complex head-adjunction structures).
  ◦ In their view, amalgamation is the post-syntactic counterpart of *bona fide* head movement, which takes place in the syntax and exhibits the same behavior/restrictions as Internal Merge.

- Amalgamation adjoins one head to a structurally local head. Adjunction is driven by a binary morphological feature [M] (which can be un(der)specified), present on individual heads:

(50) **Amalgamation and [M]**
  a. Heads specified for [M:−] undergo *lowering* (Embick & Noyer 2001).
  b. Heads specified for [M:+] undergo *raising* (the mirror-image of lowering).
  c. Heads unspecified for this feature ([M:]) don't undergo raising or lowering, but they can still host it for other local heads.

- Amalgamation proceeds cyclically from the lowest head upwards, and the head which the mover adjoins to is the one that projects (just as in traditional head movement).

⋆ When multiple heads with specified values for [M] are present in the same domain, amalgamation (typically) leads to "roll-up head movement", which lands on whichever head is unspecified.

[5] Wallace (2013:4) assumes a similar structure.

3.4 Amalgamation and Aspect/Voice

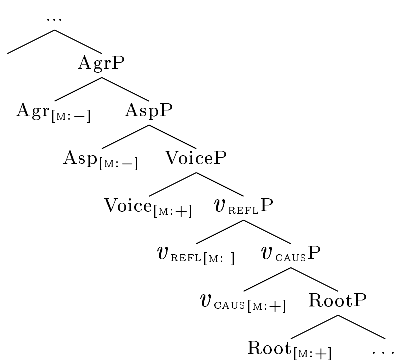
- We can derive the "counter-cyclic" structure in (49) by intermingling *different values of* [M] among the heads comprising the verbal domain, as follows:

(51) **M values in the Arabic verb** (from lowest to highest)

a. Root ⇒ [M:+]
b. All v heads ⇒ [M:+], *except*
c. The highest v head ⇒ [M:] (derived by impoverishment; §3.5.2)
d. Voice ⇒ [M:+] ← ***this is the crucial part***
e. Aspect ⇒ [M:−]
f. Agr ⇒ [M:−]

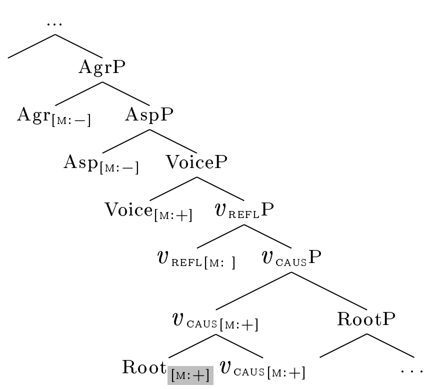
⋆ The trees in (52–57) track the cyclic application of amalgamation applied to the underlying syntactic structure of a perfective active Form V form (reflexive of the causative) (52) *takat*$_c$*taba*.

(52) **Syntactic structure underlying Form V**

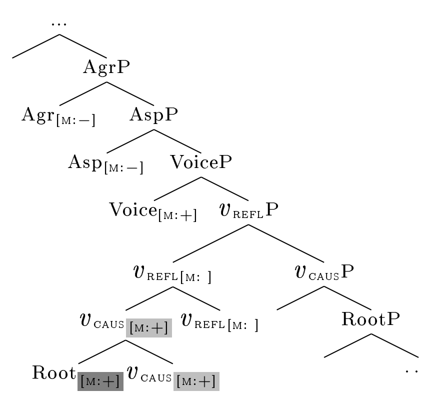


- Since Root and all non-highest v heads (here, Caus) are specified for [M:+]:
  (i) First, Root raises to adjoin to Caus (53).
  (ii) Then, Caus (which is now itself a complex head) raises to adjoin to Refl (54).

(53) **First amalgamation step: Root raises to Caus**



(54) **Second amalgamation step: Caus raises to Refl**

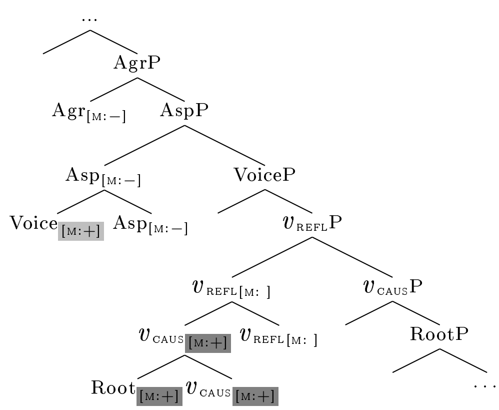


∗ Features which are discharged by the current step of amalgamation are notated with light gray.
∗ Features which have been discharged by an earlier step of amalgamation are notated with dark gray.

- Since the highest v head (here, Refl) is unspecified for [M:], it does not undergo movement.

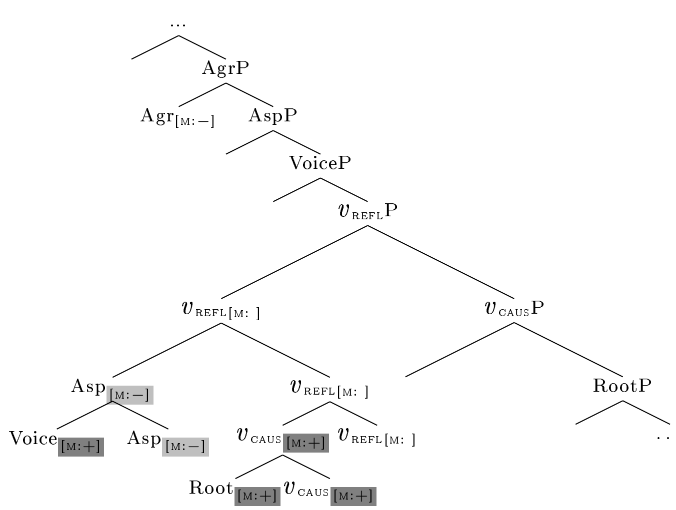
- The derivation proceeds upwards to the next highest head, Voice.
  → Since it is specified for [M:+], it raises to Asp (55).
- ⋆ But because Refl did not undergo amalgamation, this raising step applies *only to the Voice head*.
  - ∘ i.e., *it leaves the complex Refl head behind* (for now).
- This yields the structure in (55), where there are now two separate complex heads within the verbal domain.

(55) **Third amalgamation step: Voice raises to Asp**



- While we might expect this to result in two separate morphological words, the presence of the [M:−] values on the higher heads counters this expectation:
  → As long as Asp is specified for [M:−], this will trigger *lowering* of the complex Asp head down to the complex Refl head (56).
  ∗ Harizanov & Gribanova (2019:488) explicitly state that this configuration is sufficiently local to permit amalgamation to proceed unabated.

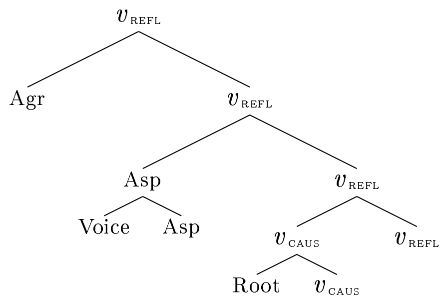
(56) **Fourth amalgamation step: Asp *lowers* to Refl**



- ⋆ This lowering results in two distinct complex heads being joined into one single complex head, but one that does not look like "roll-up head movement".

- Lastly, the [M:−] value on Agr leads to one more lowering step, completing the morphological word, shown in its final form in (57) (= (49)).

(57) **Complete morphological word**



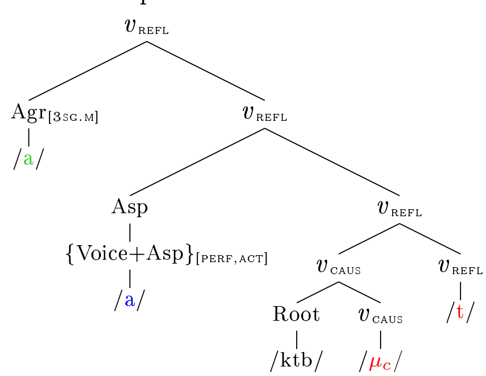
3.5 Morphological prerequisites/consequences

3.5.1 Aspect/Voice and Vocabulary Insertion: Fusion or contextual allomorphy

- In (58), I show that the structure derived by amalgamation can appropriately feed Vocabulary Insertion if we adopt either *fusion* (58a) or *contextual allomorphy* (58b) for Aspect/Voice:

(58) **Vocabulary Insertion** (Form V perfective active $takat_c taba$)

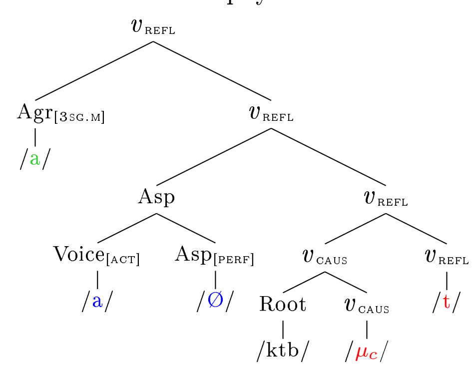
a. Fusion of Aspect & Voice



Vocabulary Items		
[PERF,ACT]	⇔	/**a**/
[IMPF,ACT]	⇔	/???/
[PERF,PASS]	⇔	/ui/
[IMPF,PASS]	⇔	/ua/

∗ VI's are maximally specific, and can be simplified.

b. Contextual allomorphy



Vocabulary Items				
[ACT]	⇔	/**a**/	/	**_PERF**
[ACT]	⇔	/???/	/	_IMPF
[PASS]	⇔	/ui/	/	_PERF
[PASS]	⇔	/ua/	/	_IMPF
[PERF/IMPF]	⇔	/Ø/		

→ Fusion (Halle & Marantz 1993) directly captures the consistent portmanteau exponence of Aspect and Voice (assuming insertion into terminal nodes via the subset principle; Halle & Marantz 1993, Halle 1997).
  - But fusion must leave the intermediate segment of Asp intact (or else c-command would be reinstated), ruling out operations like *M-Merger* (Matushansky 2006) or *Coalescence* (Hsu 2021).
  - If the MAP is calculated *before* fusion, then we could use these operations.

→ The same result can be obtained by assuming that either Aspect or Voice consistently has vocabulary entries conditioned by the other's feature, and the other consistently has a null exponent.
  - But Aspect and Voice's "portmanteau" exponence would be epiphenomenal, since it follows only from the structure of the vocabulary entries.
  - (Some people think that /u/ realizes PASSIVE, but keep in mind that Arabic only has three vowels.)

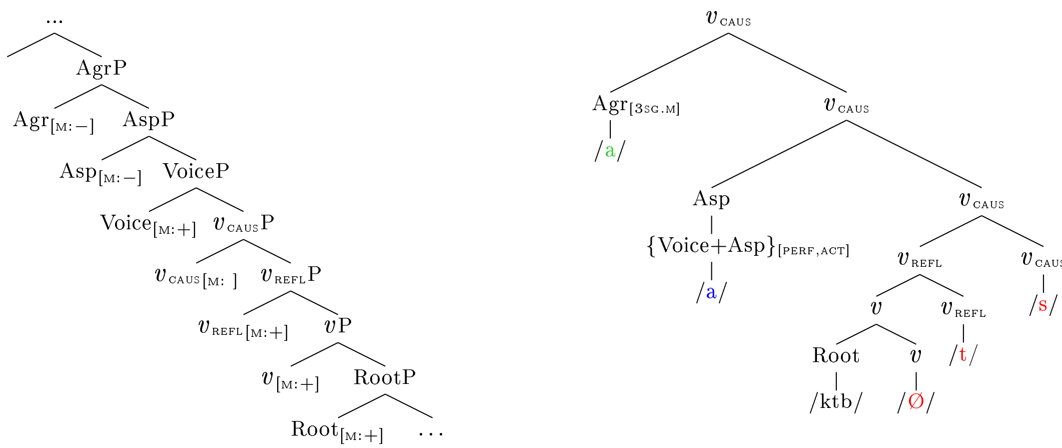
3.5.2 The distribution of M features and Impoverishment

- Under the present analysis, the distribution of M features seems to be (at least in part) grammatically-controlled:
  → In all Forms, the highest *v* head needs to be / end up unspecified ([M:]), while all other *v* heads need to be [M:+].

- For example, based on the behavior of Form X, we know that:
  (i) Refl can't always be unspecified [M:], and
  (ii) Caus can't always be specified as [M:+]

- In Form X (59), the structural order of these two are reversed, and it is now crucial that Refl be specified as [M:+] and that Caus be unspecified [M:], the opposite of Form V.

(59) **Form X (causative of reflexive) perfective active** *staktaba* (cf. Table 6)
a. Underlying syntactic structure ⇒ b. Amalgamated head



- The predictability of this distribution can be generated as follows:
  (i) All *v* morphemes are specified as [M:+] in the lexicon (or are assigned [M:+] by some morphological process).
  (ii) They lose that specification via *impoverishment* (Bonet 1991, Noyer 1992; et seq.) when they are selected by Voice:

(60) **[M]-impoverishment rule:** [M:+] → [M:] / _Voice

- This impoverishment rule must *precede* amalgamation.

3.6 Local summary

- In order to generate the necessary ranking ALIGN-ROOT-L ≫ ALIGN-AV-L, I have proposed a complex-head structure where Aspect and Voice do not c-command Root.
  - This prevents the MAP from generating any ranking (namely, the reverse ranking), which allows the Default Ranking Principle to rank ALIGN-ROOT-L higher.
- I derived the structure via amalgamation. It's counter-cyclic appearance is due to the sequencing of M feature-values: **[M:+] → [M:] → [M:+] → [M:−]**
  - This creates two separate complex heads before joining them together.
- This structure is (to some extent) independently motivated by the consistent portmanteau exponence of Aspect and Voice, under the view that morphological generalizations should be captured by morphological processes rather than accidents of vocabulary entries.

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