Vowel Sandhi

Amba Kulkarni

Fellow IIAS, Shimla

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Juncture euphony and its discretization

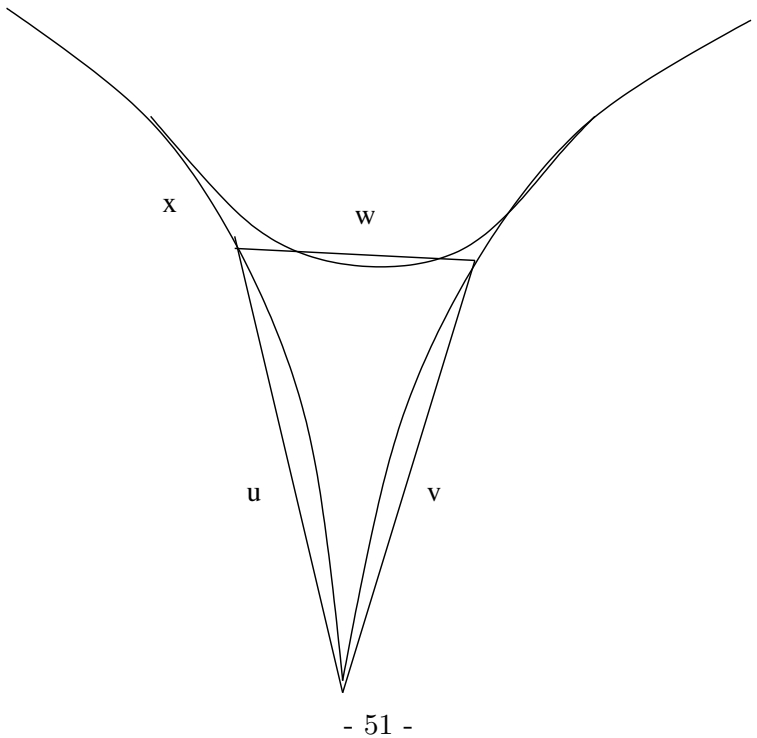
When successive words are uttered, the minimization of the energy necessary to reconfigurate the vocal organs at the juncture of the words provoques a euphony transformation, discretized at the level of phonemes by a contextual rewrite rule of the form:

$$[x]u|v \rightarrow w$$

This juncture euphony, or *external sandhi*, is actually recorded in sanskrit in the written rendering of the sentence. The first linguistic processing is therefore segmentation, which generalises unglueing into sandhi analysis.

Source: Gerard Huet: Tutorial on Zen Toolkit

Sandhi



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Data for sandhi in Sanskrit

Some examples:

- atra + api ⇒ atrāpi
  अत्र + अपि ⇒ अत्रापि
- rāma + ālayam ⇒ rāmālayam
  राम + आलयम् ⇒ रामालयम्
- deva + indraḥ ⇒ devendraḥ
  देव + इन्द्रः ⇒ देवेन्द्रः
- sapta + ṛṣayaḥ ⇒ saptarṣayaḥ
  सप्त + ऋषयः ⇒ सप्तर्षयः
- mahā + indraḥ ⇒ mahendraḥ
  महा +इन्द्रः ⇒ महेन्द्रः
- nadī + ākṛtiḥ ⇒ nadyākṛtiḥ
  नदी + आकृतिः ⇒ नद्याकृतिः
- manu + antaram⇒ manvāntaram
  मनु + अन्तरम्⇒ मन्वान्तरम्
- anu + eṣaṇam ⇒ anveṣaṇam
  अनु + एषणम् ⇒ अन्वेषणम्

Data for sandhi in Sanskrit

L/R	a	A	i	I	u	U	ṛ	ṛṛ	ḷ	e	E	o	O
a	A	A	e	e	o	o	ar	ar	al	E	E	O	O
A	A	A	e	e	o	o	ar	ar	al	E	E	O	O
i	ya	yA	I	I	yu	yU	yṛ	yṛr	yḷ	ye	yE	yo	yO
I	ya	yA	I	I	yu	yU	yṛ	yṛr	yḷ	ye	yE	yo	yO
u	va	vA	vi	vI	U	U	vṛ	vṛr	vḷ	ve	vE	vo	vO
U	va	vA	vi	vI	U	U	vṛ	vṛr	vḷ	ve	vE	vo	vO
ṛ	ra	rA	ri	rI	ru	rU	ṛr	ṛr	ḷ	re	rE	ro	rO
ṛṛ	ra	rA	ri	rI	ru	rU	ṛr	ṛr	ḷ	re	rE	ro	rO
ḷ	la	lA	li	lI	lu	lU	ṛ	ṛr	ḷ	le	lE	lo	lO
e	eZ	ayA	ayi	ayI	ayu	ayU	ayṛ	ayṛr	ayḷ	aye	ayE	ayo	ayO
E	Aya	AyA	Ayi	AyI	Ayu	AyU	Ayṛ	Ayṛr	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avA	avi	avI	avu	avU	avṛ	avṛr	avḷ	ave	avE	avo	avO
O	Ava	AvA	Avi	AvI	Avu	AvU	Avṛ	Avṛr	Avḷ	Ave	AvE	Avo	AvO

A,I,U stand for the long vowels.

Z is the 'avagraha' ऽ symbol used to represent elided (vanished) 'a', as in शिवोऽहम् for शिवः अहम् .

Data for sandhi in Sanskrit

L/R	a	A	i	I	u	U	ṛ	ṝ	ḷ	e	E	o	O
a	A	A	e	e	o	o	ar	ar	al	E	E	O	O
A	A	A	e	e	o	o	ar	ar	al	E	E	O	O
i	ya	yA	I	I	yu	yU	yṛ	yṝ	yḷ	ye	yE	yo	yO
I	ya	yA	I	I	yu	yU	yṛ	yṝ	yḷ	ye	yE	yo	yO
u	va	vA	vi	vI	U	U	vṛ	vṝ	vḷ	ve	vE	vo	vO
U	va	vA	vi	vI	U	U	vṛ	vṝ	vḷ	ve	vE	vo	vO
ṛ	ra	rA	ri	rI	ru	rU	ṛṛ	ṛṝ	ḷ	re	rE	ro	rO
ṝ	ra	rA	ri	rI	ru	rU	ṛṛ	ṛṝ	ḷ	re	rE	ro	rO
ḷ	la	lA	li	lI	lu	lU	ṛ	ṝ	ḷ	le	lE	lo	lO
e	eZ	ayA	ayi	ayI	ayu	ayU	ayṛ	ayṝ	ayḷ	aye	ayE	ayo	ayO
E	Aya	AyA	Ayi	AyI	Ayu	AyU	Ayṛ	Ayṝ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avA	avi	avI	avu	avU	avṛ	avṝ	avḷ	ave	avE	avo	avO
O	Ava	AvA	Avi	AvI	Avu	AvU	Avṛ	Avṝ	Avḷ	Ave	AvE	Avo	AvO

Observation: The rows corresponding to short and long vowels are same. So it is sufficient to write rules for short vowels. Same rules will follow for the long vowels.

Pāṇini's sūtras

- 6.1.77 ikaḥ yaṇ aci (saṁhitāyām) इकः यण् अचि
  {i,u,ṛ,ḷ} aC ⇒ {y,v,r,l} aC, in closed contact.
- 6.1.78 ecaḥ ay-av-āy-āvaḥ एचोऽयवायाव
  {e,E,o,O} aC ⇒ {ay,av,āy,āv} aC, in closed contact.
- 6.1.87 ād guṇaḥ (ekaḥ pūrvaparayoḥ aci saṁhitāyām) आद् गुणः
  a (short or long) and a vowel are (together) replaced by guṇa (a,e,o) in close contact.
- 6.1.88 vṛddhiḥ eci (ekaḥ pūrvaparayoḥ ād saṁhitāyām) वृद्धिः एचि
  a (short or long) and e,o,E,O are (together) replaced by vṛddhi (ā, E,O), in close contact.
- 6.1.101 akaḥ savarṇe dīrghaḥ (aci ekaḥ pūrvaparayoḥ saṁhitāyām) अकः सवर्णे दीर्घः
  aK (a,i,u,ṛ,ḷ) and a following vowel of the same features (color) are (together) replaced by a long vowel in close contact.
- 6.1.109 eṅaḥ padāntādati एङः पदान्तादति
  The initial 'a' of a word, if preceeded by a word ending in 'e' or 'o' gets elided. This elision is sometimes shown by the symbol 'avagraha' ऽ.

Data for sandhi in Sanskrit

F/I	a	A	i	I	u	U	ṛ	ṛṛ	ḷ	e	E	o	O
a	A	A	e	e	o	o	ar	ar	al	E	E	O	O
i	ya	yA	I	I	yu	yU	yṛ	yṛṛ	yḷ	ye	yE	yo	yO
u	va	vA	vi	vI	U	U	vṛ	vṛṛ	vḷ	ve	vE	vo	vO
ṛ	ra	rA	ri	rI	ru	rU	ṛṛ	ṛṛ	ḷ	re	rE	ro	rO
ḷ	la	lA	li	lI	lu	lU	ṛ	ṛṛ	ḷ	le	lE	lo	lO
e	eZ	ayA	ayi	ayI	ayu	ayU	ayṛ	ayṛṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	AyA	Ayi	AyI	Ayu	AyU	Ayṛ	Ayṛṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avA	avi	avI	avu	avU	avṛ	avṛṛ	avḷ	ave	avE	avo	avO
O	Ava	AvA	Avi	AvI	Avu	AvU	Avṛ	Avṛṛ	Avḷ	Ave	AvE	Avo	AvO

Observation:

- The First letter undergoes change.
- The Second letter undergoes change.
- A new varṇa comes in the place of both.
- In all the cases where a new varṇa comes, the columns for short and long vowels are the same. Hence columns for long vowels can also be eliminated.

Data for sandhi in Sanskrit

So the reduced Matrix is as follows:

F/I	a	i	u	ṛ	ḷ	e	E	o	O
a	A	e	o	ar	al	E	E	O	O
i	ya	I	yu	yṛ	yḷ	ye	yE	yo	yO
u	va	vi	U	vṛ	vḷ	ve	vE	vo	vO
ṛ	ra	ri	ru	ṛṛ	!	re	rE	ro	rO
ḷ	la	li	lu	ṛ	!	le	lE	lo	lO
e	eZ	ayi	ayu	ayṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	Ayi	Ayu	Ayṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avi	avu	avṛ	avḷ	ave	avE	avo	avO
O	Ava	Avi	Avu	Avṛ	Avḷ	Ave	AvE	Avo	AvO

{i,u,ṛ,ḷ} Vowel $\Rightarrow$ {y,v,r,l} Vowel

इकः यण् अचि

{i,u,ṛ,ḷ} aC $\Rightarrow$ {y,v,r,l} aC, in closed contact.

Data for sandhi in Sanskrit

F/I	a	i	u	ṛ	ḷ	e	E	o	O
a	A	e	o	ar	al	E	E	O	O
i	ya	I	yu	yṛ	yḷ	ye	yE	yo	yO
u	va	vi	U	vṛ	vḷ	ve	vE	vo	vO
ṛ	ra	ri	ru	ṛṛ	ḷ	re	rE	ro	rO
ḷ	la	li	lu	ṛ	ḷ	le	lE	lo	lO
e	eZ	ayi	ayu	ayṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	Ayi	Ayu	Ayṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avi	avu	avṛ	avḷ	ave	avE	avo	avO
O	Ava	Avi	Avu	Avṛ	Avḷ	Ave	AvE	Avo	AvO

{i,u,ṛ,ḷ} Vowel ⇒ {y,v,r,l} Vowel

{e,E,o,O} Vowel ⇒ {ay,Ay,av,Av} Vowel

एचोऽयवायाव

{e,E,o,O} aC ⇒ {ay,av,āy,āv} aC, in closed contact.

Data for sandhi in Sanskrit

F/I	a	i	u	ṛ	ḷ	e	E	o	O
a	A	e	o	ar	al	E	E	O	O
i	ya	I	yu	yṛ	yḷ	ye	yE	yo	yO
u	va	vi	U	vṛ	vḷ	ve	vE	vo	vO
ṛ	ra	ri	ru	ṛ	ḹ	re	rE	ro	rO
ḷ	la	li	lu	ṛṛ	ḷ	le	lE	lo	lO
e	eZ	ayi	ayu	ayṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	Ayi	Ayu	Ayṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avi	avu	avṛ	avḷ	ave	avE	avo	avO
O	Ava	Avi	Avu	Avṛ	Avḷ	Ave	AvE	Avo	AvO

{i,u,ṛ,ḷ} Vowel ⇒ {y,v,r,l} Vowel

{e,E,o,O} Vowel ⇒ {ay,Ay,av,Av} Vowel

a {i,u,ṛ,ḷ} ⇒ a {e,o,ar,al}

आद् गुणः

a (short or long) and a vowel are (together) replaced by guṇa (a,e,o) in close contact.

Data for sandhi in Sanskrit

F/I	a	i	u	ṛ	ḷ	e	E	o	O
a	A	e	o	ar	al	E	E	O	O
i	ya	I	yu	yṛ	yḷ	ye	yE	yo	yO
u	va	vi	U	vṛ	vḷ	ve	vE	vo	vO
ṛ	ra	ri	ru	ṛ	ḹ	re	rE	ro	rO
ḷ	la	li	lu	ṛṛ	ḹ	le	lE	lo	lO
e	eZ	ayi	ayu	ayṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	Ayi	Ayu	Ayṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avi	avu	avṛ	avḷ	ave	avE	avo	avO
O	Ava	Avi	Avu	Avṛ	Avḷ	Ave	AvE	Avo	AvO

{i,u,ṛ,ḷ} Vowel ⇒ {y,v,r,l} Vowel

{e,E,o,O} Vowel ⇒ {ay,Ay,av,Av} Vowel

a {i,u,ṛ,ḷ} ⇒ a {e,o,ar,al}

a {e,o,E,O} ⇒ a {E,O,E,O}

वृद्धिः एचि

a (short or long) and e,o,E,O are (together) replaced by vṛddhi (ā, E,O), in close contact.

Data for sandhi in Sanskrit

F/I	a	i	u	ṛ	ḷ	e	E	o	O
a	A	e	o	ar	al	E	E	O	O
i	ya	I	yu	yṛ	yḷ	ye	yE	yo	yO
u	va	vi	U	vṛ	vḷ	ve	vE	vo	vO
ṛ	ra	ri	ru	ṛṛ	ḷ	re	rE	ro	rO
ḷ	la	li	lu	ṛ	ḷ	le	lE	lo	lO
e	eZ	ayi	ayu	ayṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	Ayi	Ayu	Ayṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avi	avu	avṛ	avḷ	ave	avE	avo	avO
O	Ava	Avi	Avu	Avṛ	Avḷ	Ave	AvE	Avo	AvO

{i,u,ṛ,ḷ} Vowel ⇒ {y,v,r,l} Vowel

{e,E,o,O} Vowel ⇒ {ay,Ay,av,Av} Vowel

a {i,u,ṛ,ḷ} ⇒ a {e,o,ar,al}

a {e,o,E,O} ⇒ a {E,O,E,O}

X X ⇒ Long X, where X = {a,i,u,ṛ,ḷ}

अकः सवर्णे दीर्घः

aK (a,i,u,ṛ,ḷ) and a following vowel of the same features (color) are (together) replaced by a long vowel in close contact.

Data for sandhi in Sanskrit

F/I	a	i	u	ṛ	ḷ	e	E	o	O
a	A	e	o	ar	al	E	E	O	O
i	ya	I	yu	yṛ	yḷ	ye	yE	yo	yO
u	va	vi	U	vṛr	vḷ	ve	vE	vo	vO
ṛ	ra	ri	ru	ṛ	ḷ	re	rE	ro	rO
ḷ	la	li	lu	ṛ	ḷ	le	lE	lo	lO
e	eZ	ayi	ayu	ayṛ	ayḷ	aye	ayE	ayo	ayO
E	Aya	Ayi	Ayu	Ayṛ	Ayḷ	Aye	AyE	Ayo	AyO
o	oZ	avi	avu	avṛ	avḷ	ave	avE	avo	avO
O	Ava	Avi	Avu	Avṛ	Avḷ	Ave	AvE	Avo	AvO

{i,u,ṛ,ḷ} Vowel ⇒ {y,v,r,l} Vowel

{e,E,o,O} Vowel ⇒ {ay,Ay,av,Av} Vowel

a {i,u,ṛ,ḷ} ⇒ a {e,o,ar,al}

a {e,o,E,O} ⇒ a {E,O,E,O}

X X ⇒ Long X, where X = {a,i,u,ṛ,ḷ}

{e,o} a ⇒ {e,o} Z

Regular blocking and collective blocking from
On the Architecture of Panini's Grammar by Kiparsky (pages 43-45)