Phonetic Inventory for Lexicon: Singapore English (SgE) [1]

ARPAbet Symbol	SAMPA	IPA	Type	Orthography	Example ARPAbet and SAMPA below
Plosives					
P	p	p	voiceless bilabial plosive	pin	P IY1 N p "i n
B	b	b	voiced bilabial plosive	bin	B IY1 N b "i n
T	t	t	voiceless alveolar plosive	tin	T IY1 N t "i n
D	d	d	voiced dental plosive	din	D IY1 N d "i n
K	k	k	voiceless velar plosive	kin	K IY1 N k "i n
G	g	g	voiced velar plosive	give	G IY1 V g "i v
Affricates					
CH	tS	t͡ʃ	voiceless palato-alveolar affricate	chin	CH IY1 N tS "i n
JH	dZ	d͡ʒ	voiced palato-alveolar affricate	gin	JH IY1 N dZ "i n
Nasals					
M	m	m	bilabial nasal	**m**ock	M AO1 K m "O k
N	n	n	alveolar nasal	**n**ight	N AY1 T n "ai t
NG	N	ŋ	velar nasal	thi**ng**	TH IY1 NG T "i N

[1]The variety described here is used in everyday conversation, soaps, music and folk literature (cf. Deterding 2005, 2007a, Leimgruber2013). The officially accepted "Standard Singapore English" (SSgE) is used in formal situations and in education. It is close to Standard UK English. (cf. Leimgruber 2011, Deterding 2011).
SgE shows specific phonological features that vary from structural properties of other 'Englishes'. The variation is ascribed to the influence of other languages spoken in Singapore: Chinese, Malay and Indian languages. The realization of sounds may vary from speaker to speaker or even within the same speaker depending on several factors like ethnicity, education, situation, medium (cf. Lim (2004a:6), Deterding (2007a:5). For special treatment of Chinese words additional phonemes were included.

Fricatives					
F	f	f	voiceless labiodental fricative	**f**in	F IY1 N f "i n
V	v	v	voiced labiodental fricative	**v**im	V IY1 M v "i m
TH[2]	T	θ	voiceless dental fricative	**th**in	TH IY1 N T "i n
DH	D	ð	voiced dental fricative	**th**is	DH IY1 S D "i s
S	s	s	voiceless alveolar fricative	**s**in	S IY1 N s "i n
Z	z	z	voiced alveolar fricative	**z**oo	Z UW1 z "u
SH	S	ʃ	voiceless postalveolar fricative	**sh**in	SH IY1 N S "i n
ZH	Z	ʒ	voiced postalveolar fricative	vi**si**on	V IH1 ZH N v "i Z n
HH	h	h	voiceless glottal fricative	**h**it	HH IY1 T h "i t
Approximants					
R[3]	r\	ɹ	alveolar approximant	**r**oom	R UW1 M r\ "u m
Y	j	j	palatal approximant	**y**es	Y EH1 S j "e s
W	w	w	voiced labial-velar approximant	**w**it	W IY1 T w "i t
Lateral Approximants					
L[4]	l	l	alveolar lateral approximant	**l**ong	L AO1 N l "O N

[2]The dental fricatives are often realized as alveolar plosives /t, d/ in initial position and as a labiodental fricative / f / at the end of words; cf. Lim (2004:29), Deterding (2005:12).

[3]In most work on British and American English the IPA sound /r/ is used though IPA symbol [ɹ] might be a better description for the consonant in 'room' or 'arrow' in many accents of English. ARPAbet inventory has no special symbol for the alveolar approximant so we use the symbol /R/ here instead to denote the alveolar approximant. In SAMPA inventory the corresponding symbol is /r\/.

[4]Please note: ARPAbet inventory does not provide a separate symbol for the velarized alveolar lateral approximant / ɬ / (dark 'l').

Vowels[5]					
IY	i	i	close front unrounded vowel	**ea**t b**i**t	IY1 T "i t B IY1 T b "i t
UW	u	u	close back rounded vowel	l**o**se put	L UW1 Z l "u z P UW1 T p "u t
EY[6]	e	e	close-mid front unrounded vowel	h**a**ste f**a**ce	HH EY1 S T h "e s t F EY1 S f "e s
OW[7]	o	o	close-mid back rounded vowel	m**o**st g**oa**t	M OW1 S T m "o s t G OW1 T g "o t
AX	@	ə	mid central unrounded vowel (schwa)	n**ur**se lett**er**	N AX1 S n "@ s L EH1. T AX l "E t @
EH	E	ɛ	open-mid front unrounded vowel	dr**e**ss p**a**t[8]	D R EH1 S d r\ "E s P EH1 T p "E t
AO	O	ɔ	open-mid back rounded vowel	c**au**ght c**o**t c**ur**e[9]	K AO1 T k "O t K AO1 T k "O t K Y AO1 k j "O
AA[10]	a	a	open front to central back unrounded vowel	st**a**r c**u**t	S T AA1 s t "a r\ K AA1 T k "a t

[5]The vowel set presented here is based on Deterding (2007a:13). In recent studies Deterding (2007a:13), Wee (2008:268) and Leimgruber (2012:3) - among other authors - describe the loss of vowel length as a characteristic pattern of SgE. The merging of vowels and diphthongs leads to a reduced vowel set compared to the Standard British English one.
[6]Merger with diphthong / e͡ɪ /.
[7]Merger with diphthong / ə͡ʊ /.
[8]Result of merger between vowel symbol /æ/ and / e /.
[9]Monophthongization of the diphthong /ʊ͡ə/ in contexts where the diphthong is preceded by approximant /j/, cf. Lim (2004:24) , Deterding (2007:13)
[10]Wee (2008:266) and Leimgruber (2011) describe this sound with sound symbol /ɑ/, Lim (2004:31) uses sound symbol /a/.

Diphthongs[11]					
AY	ai	a͡i	open front unrounded to near-close near-front unrounded	pr**i**ce	P R AY1 S p r\ "ai s
OY	Oi	ɔ͡i	open-mid back unrounded to -close front unrounded	ch**oi**ce	CH OY1 S tS "Oi s
AW	au	a͡u	open front unrounded to close back unrounded	r**ou**se	R AW1 Z r\ "au z
IY AX[12]	i@	iə	close -front unrounded to central (schwa)	f**ea**rs	F IY1 AX Z f "i@ z
UW AX	u@	uə	close back unrounded to central (schwa)	p**oor**	P UW1 AX p "u@
EH AX	E@	ɛə	open-mid front unrounded to central (schwa)	st**ai**rs	S T EH AX Z s t "E@ z

Additional phonemes for treatment of words from Chinese[13]

ARPAbet Symbol (mapped)	**SAMPA**	**IPA**	**Type (IPA)**	**Orthography**	**Example ARPAbet and SAMPA below**
Plosive					
T	t_h	t^h	voiceless alveolar plosive aspirated	**T**ang	T AA NG t_h a N

[11]Please note: the ARPAbet inventory only provides symbols for the following diphthongs / a͡i, ɔ͡i, a͡U /. Additional diphthongs will be therefore not provided here as single phonemes but as a combination of two separate phonemes from the monophthong set.

[12]Due to the increasing influence of American English e.g. through mass media pronunciations of the 'r-coloured' diphthongs vary. In contrast to SAMPA there is no single symbol for the r-coloured diphthongs. We use a combination of vowel + schwa to describe them.

[13]The phoneme inventory follows SAMPA-C with adaptations to SGE.

Affricate					
D S	ts	t͡s	voiceless alveolar affricate	**Z**eng	D S AX NG ts @ N
T S	ts_h	t͡sʰ	voiceless alveolar affricate aspirated	**c**ai	T S AY ts_h ai
D SH	ts`	t͡ʂ	voiceless retroflex affricate	**Zh**ang	D SH AA NG ts` a N
CH	ts`_h	t͡ʂʰ	voiceless retroflex affricate aspirated	**Ch**ua	CH UW AA ts`_h u a
D SH	ts\	t͡ɕ	voiceless alveolo-palatal affricate	**J**in	D SH IY N ts\ i n
CH	ts_h	t͡ɕʰ	voiceless alveolo-palatal affricate aspirated	**Q**i	CH IY ts_h i
Fricative					
SH	s\	ɕ	voiceless alveoalo-palatal fricative	**X**i	SH IY s\ i
SH	s`	ʂ	voiceless retroflex fricative	**Sh**eng	SH AX NG s` @ N
R	z`	ʐ	voiced retroflex fricative	**R**en	R AX N z`@ n
HH	x	x	voiceless velar fricative	**H**eng	HH AX NG x @ N

Vowel					
IY	y	y	close front rounded vowel	**Y**un	IY N y n

General rule for changing the phoneme inventory or adding phoneme pronunciation variants in ASR**:**

- significant differences in spectral content
- severe temporal mismatch

Rules applied on consonant set for creating pronunciation variants:

1. Dental fricatives / θ / and / ð /

- Initial dental fricatives / TH, DH / (/ T, D/[14]) may be substituted with alveolar plosives / T, D / (/ t, d /) respectively. Final position dental fricatives can be replaced with the unvoiced labiodental fricative / F / (/ f /).

IPA	ARPA	SAMPA	IPA substitute	ARP/SAM	Example ARPAbet	Example SAMPA
θ_	TH_	T_	t_	T_ / t_	TH R EH D -> T R EH D	T r\ E d -> t r\ E d
ð_	DH_	D_	d_	D_ / d_	DH EH AX -> D EH AX	D E@ -> d E@
_θ	_TH	_T	_f	_F / _f	B OW TH -> B OW F	b o T -> b o f
_ð [15]	_DH	_D	_f	_F/ _f	B R IY DH -> B R IY F	b r\ i D -> b r\ i f

Example:

Orthography	ARPAbet Original -> Mapped	SAMPA Original -> Mapped
thread	TH R EH D -> T R EH D	T r\ E d -> t r\ E d
their	DH EH AX -> D EH AX	D E@ -> d E@
both	B OW TH -> B OW F	b o T -> b o f
breathe	B R IY DH -> B R IY F	b r\ i D -> b r\ i f

2. Devoicing of word-final voiced fricatives and plosives[16]

IPA	ARPA	SAMPA	IPA substitute	ARP/SAM	Example ARPAbet	Example SAMPA
_z	Z	z	s	S / s	D EY Z -> D EY S	d e z -> d e s

Example:

Orthography	ARPAbet Original -> Mapped	SAMPA Original -> Mapped
days	D EY Z -> D EY S	d e z -> d e s

3. l- variants

- We can keep the 'dark l' phoneme in our original lexicon and invent a symbol for it in ARPAbet. Another option is to map the ‘dark l’ phoneme to /u/ (/ UW /) (/ u /).

[14] corresponding SAMPA symbols in brackets here
[15] cf. Brown & Deterding(2005:12)
[16] cf. Brown & Deterding(2005:11)

IPA	ARPA	SAMPA	IPA substitute	ARP/SAM	Example ARPAbet	Example SAMPA
ɬ		5	ʊ	UW / u	M IY L K -> M IY UW K	m i 5 k -> m i u k

Example:

Orthography	ARPAbet Original -> Mapped	SAMPA Original -> Mapped
milk	M IY L K -> M IY UW K	m i 5 k -> m i u k
wheel	W IY L -> W IY UW	w i 5 -> w i u

4. Format of lexicon would be:

WordA pronunciation

WordA(1) pronunciation variant 1

WordA(2) pronunciation variant 2

Treatment and mappings of foreign phonemes (from Chinese languages)

Notes:

ARPAbet was originally designed for English American sounds. It therefore does not provide symbols for foreign phonemes.

In ASR systems, foreign phonemes are most often mapped to the standard inventory. Below, we provide suggestions for mapping Chinese sound symbols to their closest equivalents within the standard inventory, which is currently in ARPAbet.

The SAMPA alphabet acts as an IPA equivalent, and was considered for use in this project. As such, we have also provided plausible additional phonemes with their corresponding SAMPA symbols as a means of dealing with foreign phonemes. For SAMPA, no mappings will be provided until a decision on the final phoneme inventory is settled (in either ARPAbet or SAMPA).

For the additional phonemes below, the following table format was chosen:

Grapheme	**IPA symbol**	**SAMPA symbol**	**Mapped IPA**	**Mapped ARPAbet**

Example words are listed below each grapheme and corresponding phonemes. The mappings of the additional phonemes should be consistent! Rule of thumb: map phonemes to the closest equivalent in the IPA chart.

These phoneme conventions have been done in relation to their frequency of appearance in the data as well. Some conventions have been simplified because of low frequency.

1. Mappings graphemes <t>, <d>

For mapping of aspirated and unaspirated, the romanization conventions are kept: aspirated plosives are mapped to unvoiced, non-aspirated to the voiced pair.

Example:

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
grapheme <t>	t^h	t_h	t	T
grapheme <d>	t	t	d	D

2. Mapping of grapheme sequence <yu>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
grapheme <yu>	y	y	i	IY

Example:

Orthography	SAMPA transcription -> mapped SAMPA	mapped ARPAbet transcription
Yu	y	IY
Yun	y n	IY N
Yunnan	y n n a n	IY N N AA N

Note: The examples for SAMPA provided here includes allophones: due to their low frequency of appearance in the data, they are not given individual SAMPA conventions.

3. Mapping of grapheme <x>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<x>	ɕ	s\	ʃ	SH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Xu	s\ y	SH IY
Xi	s\ i	SH IY
xiao	s\ i au	SH IY AW
Xue	s\ y E	SH IY EH

4. Mapping of grapheme <j>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<j>	tɕ	ts\	dʃ	D SH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Jin	ts\ i n	D SH IY N
Jing	ts\ i N	D SH IY NG
Jinhua	ts\ i n x u a	D SH IY N H UW AA
Jinshan	ts\ i n s\ a n	D SH IY N SH AA N

5. Mapping of grapheme <q>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<q>	t͡ɕʰ	ts_h	ʧ	CH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Qi	ts_h i	CH IY
Qing	ts_h i N	CH IY NG
Qiao	ts_h i au	CH IY AW

6. Mapping of grapheme sequence <sh>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<sh>	ʂ	s`	ʃ	SH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Shao	s` au	SH AW
Sheng	s` @ N	SH AX NG
Shi	s` i	SH AX

Note: For the SAMPA transcription of <Shi>, we suggest to keep it as /s`i/ instead of /s`i`/, as the frequency for <Shi> is low.

7. Mapping of grapheme sequence <zh>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<zh>	t͡ʂ	ts`	d͡ʃ	D SH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Zhang	ts` a N	D SH AA NG
Zhangde	ts`a N d @	D SH AA NG D AX

8. Mapping of grapheme sequence <ch>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<ch>	t͡ʂʰ	ts`_h	ʧ	CH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Chua	ts`_h u a	CH UW AA
Chuan	ts`_h u a n	CH UW AA N
Chuang	ts`_h u a N	CH UW AA NG

9. Mapping of grapheme <z>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<z>	t͡s	ts	d s	D S

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Zeng	ts @ N	D S AX NG
Zi	ts i	D S AX
Ziang	ts i a N	D S IY AA NG

Note: For the SAMPA transcription of <Zi>, we suggest keeping it as / ts i / instead of / ts i\/, as the frequency for <Zi> is comparatively low.

10. Mapping of grapheme <c>

grapheme	original IPA	coresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<c>	t͡sʰ	ts_h	t͡s	T S

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
cai	ts_h ai	T S AY
Ci	ts_h i	T S AX

Note: For the SAMPA transcription of <Ci >, We suggest to keep it as / ts_h i / instead of / ts_h i\/, as the frequency for <Ci> is comparatively low.

11. Mapping of grapheme <r>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<r>	ʐ	z`	ɹ	R

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Ren	z` @ n	R AX N
Renci	z` @ n ts_h i	R AX N T S AX

12. Mapping of grapheme <x>

grapheme	original IPA	corresponding SAMPA symbol	mapped IPA symbol	mapped ARPAbet
<h>	x	x	h	HH

Example:

Orthography	SAMPA transcription	mapped ARPAbet transcription
Heng	x @ N	HH AX NG
Hai	x ai	HH AY
Hei	x e	HH EY

Note:

Retroflex plosives demonstrated by Tamil and Malay speakers will be treated the same as bilabial plosives. Therefore, only additional phonemes from the Chinese language are considered in this proposal.

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