XFST and FSA syntax – a comparison table

1 Symbols

XFST syntax	FSA syntax	Meaning
a	a	single symbol a
$\%*$ or "*"	escape(*) or '*'	escape literal symbol
abc	abc	multi-character symbol
?	?	any symbol [1]
0 or [ ] or " "	[ ]	epsilon symbol, the empty string
$\{abcd\}$	[a,b,c,d]	single character brace

2 Simple operators

XFST syntax	FSA syntax	Meaning
$A*$	$A*$	Kleene star
$A+$	$A+$	iteration (Kleene plus)
$A \mid B$	$\{A, B\}$	union
$A \,\&\, B$	$A \,\&\, B$	intersection
$A - B$	$A - B$	A minus B
$\backslash A$	$[\sim A] \,\&\, ?$	term complement
$\sim A$	$\sim A$	complement
A/B	ignore(A,B)	A ignoring B
$A./.B$	ignore(A,B) - {[B,?*],[?*,B]}	A ignoring internally B
$\$A$	$\$A$	containment
$\$.A$	$A - ignore([A,A],?*)	one containment
$\$?A$	{$A - ignore([A,A],?*),?* - $A}	maximum one containment
$A\ B$	[A,B]	concatenation
$A\hat{}n$		n-ary concatenation
$A\hat{}\{n,k\}$		n to k concatenations of A
$A\hat{} > n$		more than n concatenations of A
$A\hat{} < n$		less than n concatenations of A
$A.x.B$	A x B	crossproduct
$A.o.B$	A o B	composition
(A)	A^	optionality
$a : b$	$a : b$	symbol pair
[ ]	( )	order control

XFST syntax	FSA syntax	Meaning
$R.P.Q$	{R,(domain(Q) - domain(R)) o Q}	upper-side priority union
$R.p.Q$	{R,Q o (range(Q) - range(R))}	lower-side priority union
$R.-u.Q$	(domain(R) - domain(Q)) o R	upper-side minus
$R.-l.Q$	R o (range(R) - range(Q))	lower-side minus
$A < B$	$\sim \$[B, A]$	A before B
$A > B$	$\sim \$[A, B]$	A after B
$A.r$	reverse(A)	reverse
$R.u$ or $R.1$	domain(R)	upper language of the regular relation R
$R.l$ or $R.2$	range(R)	lower language of the regular relation R
$R.i$	invert(R) or inverse(R)	regular relation inverse

3 Restriction

XFST restriction rules do not exist in FSA, therefore we only bring the list of xfst restriction rule syntax.

- $A => L\_ R$
- $A => L_1\_ R_1, L_2\_ R_2, \ldots, L_n\_ R_n$

4 Replacement

XFST replace rules do not exist in FSA, therefore we only bring the list of xfst replace rule syntax. xfst replace rules can be divided into 4 groups:

1. Unconditional replace rules (one rule with no context).
2. Unconditional parallel replace rules (several rules with no context that are performed at the same time).
3. Conditional replace rules (one rule and one condition).
4. Conditional parallel replace rules (several rules and/or several contexts).

4.0.1 $->$ (obligatory, upper to lower replacement)

- $A -> B$
- $A_1 -> B_1, \ldots, A_n -> B_n$
- $A -> B \mid\mid L \_ R$
- $A -> B \,//\, L \_ R$
- $A -> B \setminus\setminus L \_ R$
- $A -> B \setminus/ L \_ R$
- $A_{11} -> B_{11}, \ldots, A_{1n} -> B_{1n} \mid\mid L_{11}\_ R_{11}, \ldots, L_{1m}\_ R_{1m}$
- $A_{11} -> B_{11}, \ldots, A_{1n} -> B_{1n} \,//\, L_{11}\_ R_{11}, \ldots, L_{1m}\_ R_{1m}$

- $A_{11} -> B_{11}, \ldots, A_{1n} -> B_{1n}$ \\ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} -> B_{11}, \ldots, A_{1n} -> B_{1n}$ \/ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} -> B_{11}\ ,\ \ldots\ ,\ A_{1n} -> B_{1n}$ || $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> B_{21}\ ,\ \ldots\ ,\ A_{2p} -> B_{2p}$ || $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> B_{kr}$ || $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} -> B_{11}\ ,\ \ldots\ ,\ A_{1n} -> B_{1n}$ // $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> B_{21}\ ,\ \ldots\ ,\ A_{2p} -> B_{2p}$ // $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> B_{kr}$ // $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} -> B_{11}\ ,\ \ldots\ ,\ A_{1n} -> B_{1n}$ \\ $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> B_{21}\ ,\ \ldots\ ,\ A_{2p} -> B_{2p}$ \\ $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> B_{kr}$ \\ $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} -> B_{11}\ ,\ \ldots\ ,\ A_{1n} -> B_{1n}$ \/ $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> B_{21}\ ,\ \ldots\ ,\ A_{2p} -> B_{2p}$ \/ $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> B_{kr}$ \/ $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

4.0.2 $(->)$ (optional, upper to lower replacement)

- $A(->)B$
- $A_1(->)B_1, \ldots, A_n(->)B_n$
- $A(->)B$ || L_R
- $A(->)B$ // L_R
- $A(->)B$ \\ L_R
- $A(->)B$ \/ L_R
- $A_{11}(->)B_{11}, \ldots, A_{1n}(->)B_{1n}$ || $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(->)B_{11}, \ldots, A_{1n}(->)B_{1n}$ // $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(->)B_{11}, \ldots, A_{1n}(->)B_{1n}$ \\ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(->)B_{11}, \ldots, A_{1n}(->)B_{1n}$ \/ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$

- $A_{11}(->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(->)B_{1n} \mid\mid L_{11\_}R_{11}\ ,\ \ldots\ ,\ L_{1m\_}R_{1m}$
  $,,$
  $A_{21}(->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(->)B_{2p} \mid\mid L_{21\_}R_{21}\ ,\ \ldots\ ,\ L_{2q\_}R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(->)B_{kr} \mid\mid L_{k1\_}R_{k1}\ ,\ \ldots\ ,\ L_{ks\_}R_{ks}$
- $A_{11}(->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(->)B_{1n} \,//\, L_{11\_}R_{11}\ ,\ \ldots\ ,\ L_{1m\_}R_{1m}$
  $,,$
  $A_{21}(->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(->)B_{2p} \,//\, L_{21\_}R_{21}\ ,\ \ldots\ ,\ L_{2q\_}R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(->)B_{kr} \,//\, L_{k1\_}R_{k1}\ ,\ \ldots\ ,\ L_{ks\_}R_{ks}$
- $A_{11}(->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(->)B_{1n} \setminus\setminus L_{11\_}R_{11}\ ,\ \ldots\ ,\ L_{1m\_}R_{1m}$
  $,,$
  $A_{21}(->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(->)B_{2p} \setminus\setminus L_{21\_}R_{21}\ ,\ \ldots\ ,\ L_{2q\_}R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(->)B_{kr} \setminus\setminus L_{k1\_}R_{k1}\ ,\ \ldots\ ,\ L_{ks\_}R_{ks}$
- $A_{11}(->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(->)B_{1n} \setminus/ L_{11\_}R_{11}\ ,\ \ldots\ ,\ L_{1m\_}R_{1m}$
  $,,$
  $A_{21}(->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(->)B_{2p} \setminus/ L_{21\_}R_{21}\ ,\ \ldots\ ,\ L_{2q\_}R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(->)B_{kr} \setminus/ L_{k1\_}R_{k1}\ ,\ \ldots\ ,\ L_{ks\_}R_{ks}$

4.0.3 $<-$ (obligatory, lower to upper replacement)

- $A <- B$
- $A_1 <- B_1, \ldots, A_n <- B_n$
- $A <- B \mid\mid L\_R$
- $A <- B \,//\, L\_R$
- $A <- B \setminus\setminus L\_R$
- $A <- B \setminus/ L\_R$
- $A_{11} <- B_{11}, \ldots, A_{1n} <- B_{1n} \mid\mid L_{11\_}R_{11}, \ldots, L_{1m\_}R_{1m}$
- $A_{11} <- B_{11}, \ldots, A_{1n} <- B_{1n} \,//\, L_{11\_}R_{11}, \ldots, L_{1m\_}R_{1m}$
- $A_{11} <- B_{11}, \ldots, A_{1n} <- B_{1n} \setminus\setminus L_{11\_}R_{11}, \ldots, L_{1m\_}R_{1m}$
- $A_{11} <- B_{11}, \ldots, A_{1n} <- B_{1n} \setminus/ L_{11\_}R_{11}, \ldots, L_{1m\_}R_{1m}$
- $A_{11} <- B_{11}\ ,\ \ldots\ ,\ A_{1n} <- B_{1n} \mid\mid L_{11\_}R_{11}\ ,\ \ldots\ ,\ L_{1m\_}R_{1m}$
  $,,$
  $A_{21} <- B_{21}\ ,\ \ldots\ ,\ A_{2p} <- B_{2p} \mid\mid L_{21\_}R_{21}\ ,\ \ldots\ ,\ L_{2q\_}R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1} <- B_{k1}\ ,\ \ldots\ ,\ A_{kr} <- B_{kr} \mid\mid L_{k1\_}R_{k1}\ ,\ \ldots\ ,\ L_{ks\_}R_{ks}$

- $A_{11} < -B_{11}\ ,\ \ldots\ ,\ A_{1n} < -B_{1n}\ //\ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21} < -B_{21}\ ,\ \ldots\ ,\ A_{2p} < -B_{2p}\ //\ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1} < -B_{k1}\ ,\ \ldots\ ,\ A_{kr} < -B_{kr}\ //\ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} < -B_{11}\ ,\ \ldots\ ,\ A_{1n} < -B_{1n}\ \backslash\backslash\ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21} < -B_{21}\ ,\ \ldots\ ,\ A_{2p} < -B_{2p}\ \backslash\backslash\ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1} < -B_{k1}\ ,\ \ldots\ ,\ A_{kr} < -B_{kr}\ \backslash\backslash\ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} < -B_{11}\ ,\ \ldots\ ,\ A_{1n} < -B_{1n}\ \backslash/\ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21} < -B_{21}\ ,\ \ldots\ ,\ A_{2p} < -B_{2p}\ \backslash/\ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1} < -B_{k1}\ ,\ \ldots\ ,\ A_{kr} < -B_{kr}\ \backslash/\ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

4.0.4 $(< -)$ (optional, lower to upper replacement)

- $A(< -)B$
- $A_1(< -)B_1, \ldots, A_n(< -)B_n$
- $A(< -)B\ ||\ L\ \_\ R$
- $A(< -)B\ //\ L\ \_\ R$
- $A(< -)B\ \backslash\backslash\ L\ \_\ R$
- $A(< -)B\ \backslash/\ L\ \_\ R$
- $A_{11}(< -)B_{11}, \ldots, A_{1n}(< -)B_{1n}\ ||\ L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(< -)B_{11}, \ldots, A_{1n}(< -)B_{1n}\ //\ L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(< -)B_{11}, \ldots, A_{1n}(< -)B_{1n}\ \backslash\backslash\ L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(< -)B_{11}, \ldots, A_{1n}(< -)B_{1n}\ \backslash/\ L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(< -)B_{11}\ ,\ \ldots\ ,\ A_{1n}(< -)B_{1n}\ ||\ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21}(< -)B_{21}\ ,\ \ldots\ ,\ A_{2p}(< -)B_{2p}\ ||\ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(< -)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(< -)B_{kr}\ ||\ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}(< -)B_{11}\ ,\ \ldots\ ,\ A_{1n}(< -)B_{1n}\ //\ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21}(< -)B_{21}\ ,\ \ldots\ ,\ A_{2p}(< -)B_{2p}\ //\ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(< -)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(< -)B_{kr}\ //\ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

- $A_{11}(<-)B_{11}\ ,\ \ldots\ ,\ A_{1n}(<-)B_{1n}\ \backslash\backslash\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  $,,$
  $A_{21}(<-)B_{21}\ ,\ \ldots\ ,\ A_{2p}(<-)B_{2p}\ \backslash\backslash\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(<-)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(<-)B_{kr}\ \backslash\backslash\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$
- $A_{11}(<-)B_{11}\ ,\ \ldots\ ,\ A_{1n}(<-)B_{1n}\ \backslash/\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  $,,$
  $A_{21}(<-)B_{21}\ ,\ \ldots\ ,\ A_{2p}(<-)B_{2p}\ \backslash/\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}(<-)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(<-)B_{kr}\ \backslash/\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$

4.0.5 $<->$ (obligatory, upper to lower, lower to upper replacement)

- $A<->B$
- $A_1<->B_1,\ldots,A_n<->B_n$
- $A<->B\ ||\ L\_R$
- $A<->B\ //\ L\_R$
- $A<->B\ \backslash\backslash\ L\_R$
- $A<->B\ \backslash/\ L\_R$
- $A_{11}<->B_{11},\ldots,A_{1n}<->B_{1n}\ ||\ L_{11}\_\ R_{11},\ldots,L_{1m}\_\ R_{1m}$
- $A_{11}<->B_{11},\ldots,A_{1n}<->B_{1n}\ //\ L_{11}\_\ R_{11},\ldots,L_{1m}\_\ R_{1m}$
- $A_{11}<->B_{11},\ldots,A_{1n}<->B_{1n}\ \backslash\backslash\ L_{11}\_\ R_{11},\ldots,L_{1m}\_\ R_{1m}$
- $A_{11}<->B_{11},\ldots,A_{1n}<->B_{1n}\ \backslash/\ L_{11}\_\ R_{11},\ldots,L_{1m}\_\ R_{1m}$
- $A_{11}<->B_{11}\ ,\ \ldots\ ,\ A_{1n}<->B_{1n}\ ||\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  $,,$
  $A_{21}<->B_{21}\ ,\ \ldots\ ,\ A_{2p}<->B_{2p}\ ||\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}<->B_{k1}\ ,\ \ldots\ ,\ A_{kr}<->B_{kr}\ ||\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$
- $A_{11}<->B_{11}\ ,\ \ldots\ ,\ A_{1n}<->B_{1n}\ //\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  $,,$
  $A_{21}<->B_{21}\ ,\ \ldots\ ,\ A_{2p}<->B_{2p}\ //\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}<->B_{k1}\ ,\ \ldots\ ,\ A_{kr}<->B_{kr}\ //\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$
- $A_{11}<->B_{11}\ ,\ \ldots\ ,\ A_{1n}<->B_{1n}\ \backslash\backslash\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  $,,$
  $A_{21}<->B_{21}\ ,\ \ldots\ ,\ A_{2p}<->B_{2p}\ \backslash\backslash\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}<->B_{k1}\ ,\ \ldots\ ,\ A_{kr}<->B_{kr}\ \backslash\backslash\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$

- $A_{11} <-> B_{11}\ ,\ \ldots\ ,\ A_{1n} <-> B_{1n} \backslash/ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} <-> B_{21}\ ,\ \ldots\ ,\ A_{2p} <-> B_{2p} \backslash/ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ⋯ ,,
  $A_{k1} <-> B_{k1}\ ,\ \ldots\ ,\ A_{kr} <-> B_{kr} \backslash/ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

4.0.6 $(<->)$ (optional, upper to lower, lower to upper replacement)

- $A(<->)B$
- $A_1(<->)B_1, \ldots, A_n(<->)B_n$
- $A(<->)B \mid\mid L\_R$
- $A(<->)B \mathbin{//} L\_R$
- $A(<->)B \backslash\backslash L\_R$
- $A(<->)B \backslash/ L\_R$
- $A_{11}(<->)B_{11}, \ldots, A_{1n}(<->)B_{1n} \mid\mid L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(<->)B_{11}, \ldots, A_{1n}(<->)B_{1n} \mathbin{//} L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(<->)B_{11}, \ldots, A_{1n}(<->)B_{1n} \backslash\backslash L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(<->)B_{11}, \ldots, A_{1n}(<->)B_{1n} \backslash/ L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11}(<->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(<->)B_{1n} \mid\mid L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21}(<->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(<->)B_{2p} \mid\mid L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ⋯ ,,
  $A_{k1}(<->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(<->)B_{kr} \mid\mid L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}(<->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(<->)B_{1n} \mathbin{//} L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21}(<->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(<->)B_{2p} \mathbin{//} L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ⋯ ,,
  $A_{k1}(<->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(<->)B_{kr} \mathbin{//} L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}(<->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(<->)B_{1n} \backslash\backslash L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21}(<->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(<->)B_{2p} \backslash\backslash L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ⋯ ,,
  $A_{k1}(<->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(<->)B_{kr} \backslash\backslash L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}(<->)B_{11}\ ,\ \ldots\ ,\ A_{1n}(<->)B_{1n} \backslash/ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21}(<->)B_{21}\ ,\ \ldots\ ,\ A_{2p}(<->)B_{2p} \backslash/ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ⋯ ,,
  $A_{k1}(<->)B_{k1}\ ,\ \ldots\ ,\ A_{kr}(<->)B_{kr} \backslash/ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

4.0.7 $@->$ (obligatory, upper to lower, left to right, longest match replacement)

- $A@->B$
- $A_1@->B_1,\ldots,A_n@->B_n$
- $A@->B \mid\mid L\_R$
- $A@->B \,//\, L\_R$
- $A@->B \setminus\setminus L\_R$
- $A@->B \setminus/ L\_R$
- $A_{11}@->B_{11},\ldots,A_{1n}@->B_{1n} \mid\mid L_{11}\_R_{11},\ldots,L_{1m}\_R_{1m}$
- $A_{11}@->B_{11},\ldots,A_{1n}@->B_{1n} \,//\, L_{11}\_R_{11},\ldots,L_{1m}\_R_{1m}$
- $A_{11}@->B_{11},\ldots,A_{1n}@->B_{1n} \setminus\setminus L_{11}\_R_{11},\ldots,L_{1m}\_R_{1m}$
- $A_{11}@->B_{11},\ldots,A_{1n}@->B_{1n} \setminus/ L_{11}\_R_{11},\ldots,L_{1m}\_R_{1m}$
- $A_{11}@->B_{11}\ ,\ \ldots\ ,\ A_{1n}@->B_{1n} \mid\mid L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21}@->B_{21}\ ,\ \ldots\ ,\ A_{2p}@->B_{2p} \mid\mid L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}@->B_{k1}\ ,\ \ldots\ ,\ A_{kr}@->B_{kr} \mid\mid L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}@->B_{11}\ ,\ \ldots\ ,\ A_{1n}@->B_{1n} \,//\, L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21}@->B_{21}\ ,\ \ldots\ ,\ A_{2p}@->B_{2p} \,//\, L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}@->B_{k1}\ ,\ \ldots\ ,\ A_{kr}@->B_{kr} \,//\, L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}@->B_{11}\ ,\ \ldots\ ,\ A_{1n}@->B_{1n} \setminus\setminus L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21}@->B_{21}\ ,\ \ldots\ ,\ A_{2p}@->B_{2p} \setminus\setminus L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}@->B_{k1}\ ,\ \ldots\ ,\ A_{kr}@->B_{kr} \setminus\setminus L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11}@->B_{11}\ ,\ \ldots\ ,\ A_{1n}@->B_{1n} \setminus/ L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  $,,$
  $A_{21}@->B_{21}\ ,\ \ldots\ ,\ A_{2p}@->B_{2p} \setminus/ L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  $,,\ \cdots\ ,,$
  $A_{k1}@->B_{k1}\ ,\ \ldots\ ,\ A_{kr}@->B_{kr} \setminus/ L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

4.0.8 $@>$ (obligatory, upper to lower, left to right, shortest match replacement)

- $A@>B$
- $A_1@>B_1,\ldots,A_n@>B_n$
- $A@>B \mid\mid L\_R$

- $A@>B$ // L _ R
- $A@>B$ \\ L _ R
- $A@>B$ \/ L _ R
- $A_{11}@>B_{11},\ldots,A_{1n}@>B_{1n}$ || L_{11}_ $R_{11},\ldots,L_{1m}$_ R_{1m}
- $A_{11}@>B_{11},\ldots,A_{1n}@>B_{1n}$ // L_{11}_ $R_{11},\ldots,L_{1m}$_ R_{1m}
- $A_{11}@>B_{11},\ldots,A_{1n}@>B_{1n}$ \\ L_{11}_ $R_{11},\ldots,L_{1m}$_ R_{1m}
- $A_{11}@>B_{11},\ldots,A_{1n}@>B_{1n}$ \/ L_{11}_ $R_{11},\ldots,L_{1m}$_ R_{1m}
- $A_{11}@>B_{11}$, ... , $A_{1n}@>B_{1n}$ || L_{11}_ R_{11} , ... , L_{1m}_ R_{1m}
  ,,
  $A_{21}@>B_{21}$, ... , $A_{2p}@>B_{2p}$ || L_{21}_ R_{21} , ... , L_{2q}_ R_{2q}
  ,, ... ,,
  $A_{k1}@>B_{k1}$, ... , $A_{kr}@>B_{kr}$ || L_{k1}_ R_{k1} , ... , L_{ks}_ R_{ks}
- $A_{11}@>B_{11}$, ... , $A_{1n}@>B_{1n}$ // L_{11}_ R_{11} , ... , L_{1m}_ R_{1m}
  ,,
  $A_{21}@>B_{21}$, ... , $A_{2p}@>B_{2p}$ // L_{21}_ R_{21} , ... , L_{2q}_ R_{2q}
  ,, ... ,,
  $A_{k1}@>B_{k1}$, ... , $A_{kr}@>B_{kr}$ // L_{k1}_ R_{k1} , ... , L_{ks}_ R_{ks}
- $A_{11}@>B_{11}$, ... , $A_{1n}@>B_{1n}$ \\ L_{11}_ R_{11} , ... , L_{1m}_ R_{1m}
  ,,
  $A_{21}@>B_{21}$, ... , $A_{2p}@>B_{2p}$ \\ L_{21}_ R_{21} , ... , L_{2q}_ R_{2q}
  ,, ... ,,
  $A_{k1}@>B_{k1}$, ... , $A_{kr}@>B_{kr}$ \\ L_{k1}_ R_{k1} , ... , L_{ks}_ R_{ks}
- $A_{11}@>B_{11}$, ... , $A_{1n}@>B_{1n}$ \/ L_{11}_ R_{11} , ... , L_{1m}_ R_{1m}
  ,,
  $A_{21}@>B_{21}$, ... , $A_{2p}@>B_{2p}$ \/ L_{21}_ R_{21} , ... , L_{2q}_ R_{2q}
  ,, ... ,,
  $A_{k1}@>B_{k1}$, ... , $A_{kr}@>B_{kr}$ \/ L_{k1}_ R_{k1} , ... , L_{ks}_ R_{ks}

4.0.9 $->@$ (obligatory, upper to lower, right to left, longest match replacement)

- $A->@B$
- $A_1->@B_1,\ldots,A_n->@B_n$
- $A->@B$ || L _ R
- $A->@B$ // L _ R
- $A->@B$ \\ L _ R
- $A->@B$ \/ L _ R
- $A_{11}->@B_{11},\ldots,A_{1n}->@B_{1n}$ || L_{11}_ $R_{11},\ldots,L_{1m}$_ R_{1m}

- $A_{11} -> @B_{11}, \ldots, A_{1n} -> @B_{1n}$ // $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} -> @B_{11}, \ldots, A_{1n} -> @B_{1n}$ \\ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} -> @B_{11}, \ldots, A_{1n} -> @B_{1n}$ \/ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} -> @B_{11}\ ,\ \ldots\ ,\ A_{1n} -> @B_{1n}$ || $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> @B_{21}\ ,\ \ldots\ ,\ A_{2p} -> @B_{2p}$ || $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> @B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> @B_{kr}$ || $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} -> @B_{11}\ ,\ \ldots\ ,\ A_{1n} -> @B_{1n}$ // $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> @B_{21}\ ,\ \ldots\ ,\ A_{2p} -> @B_{2p}$ // $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> @B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> @B_{kr}$ // $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} -> @B_{11}\ ,\ \ldots\ ,\ A_{1n} -> @B_{1n}$ \\ $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> @B_{21}\ ,\ \ldots\ ,\ A_{2p} -> @B_{2p}$ \\ $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> @B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> @B_{kr}$ \\ $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$
- $A_{11} -> @B_{11}\ ,\ \ldots\ ,\ A_{1n} -> @B_{1n}$ \/ $L_{11}\_R_{11}\ ,\ \ldots\ ,\ L_{1m}\_R_{1m}$
  ,,
  $A_{21} -> @B_{21}\ ,\ \ldots\ ,\ A_{2p} -> @B_{2p}$ \/ $L_{21}\_R_{21}\ ,\ \ldots\ ,\ L_{2q}\_R_{2q}$
  ,, ... ,,
  $A_{k1} -> @B_{k1}\ ,\ \ldots\ ,\ A_{kr} -> @B_{kr}$ \/ $L_{k1}\_R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_R_{ks}$

4.0.10 $>$ @ right (obligatory, upper to lower, right to left, shortest match replacement)

- $A > @B$
- $A_1 > @B_1, \ldots, A_n > @B_n$
- $A > @B$ || L_R
- $A > @B$ // L_R
- $A > @B$ \\ L_R
- $A > @B$ \/ L_R
- $A_{11} > @B_{11}, \ldots, A_{1n} > @B_{1n}$ || $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} > @B_{11}, \ldots, A_{1n} > @B_{1n}$ // $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} > @B_{11}, \ldots, A_{1n} > @B_{1n}$ \\ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$
- $A_{11} > @B_{11}, \ldots, A_{1n} > @B_{1n}$ \/ $L_{11}\_R_{11}, \ldots, L_{1m}\_R_{1m}$

- $A_{11} > @B_{11}\ ,\ \ldots\ ,\ A_{1n} > @B_{1n}\ ||\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  ,,
  $A_{21} > @B_{21}\ ,\ \ldots\ ,\ A_{2p} > @B_{2p}\ ||\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  ,, ⋯ ,,
  $A_{k1} > @B_{k1}\ ,\ \ldots\ ,\ A_{kr} > @B_{kr}\ ||\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$
- $A_{11} > @B_{11}\ ,\ \ldots\ ,\ A_{1n} > @B_{1n}\ //\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  ,,
  $A_{21} > @B_{21}\ ,\ \ldots\ ,\ A_{2p} > @B_{2p}\ //\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  ,, ⋯ ,,
  $A_{k1} > @B_{k1}\ ,\ \ldots\ ,\ A_{kr} > @B_{kr}\ //\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$
- $A_{11} > @B_{11}\ ,\ \ldots\ ,\ A_{1n} > @B_{1n}\ \backslash\backslash\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  ,,
  $A_{21} > @B_{21}\ ,\ \ldots\ ,\ A_{2p} > @B_{2p}\ \backslash\backslash\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  ,, ⋯ ,,
  $A_{k1} > @B_{k1}\ ,\ \ldots\ ,\ A_{kr} > @B_{kr}\ \backslash\backslash\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$
- $A_{11} > @B_{11}\ ,\ \ldots\ ,\ A_{1n} > @B_{1n}\ \backslash/\ L_{11}\_\ R_{11}\ ,\ \ldots\ ,\ L_{1m}\_\ R_{1m}$
  ,,
  $A_{21} > @B_{21}\ ,\ \ldots\ ,\ A_{2p} > @B_{2p}\ \backslash/\ L_{21}\_\ R_{21}\ ,\ \ldots\ ,\ L_{2q}\_\ R_{2q}$
  ,, ⋯ ,,
  $A_{k1} > @B_{k1}\ ,\ \ldots\ ,\ A_{kr} > @B_{kr}\ \backslash/\ L_{k1}\_\ R_{k1}\ ,\ \ldots\ ,\ L_{ks}\_\ R_{ks}$

5 Markup

XFST markup rules do not exist in FSA, therefore we only bring the list of xfst markup rule syntax.

- $A -> L \ldots R$
- $A@-> L \ldots R$
- $A@> L \ldots R$
- $A -> @L \ldots R$
- $A > @L \ldots R$

6 Order of Precedence

6.1 XFST

The following list states the order of precedence of all above operators in XFST. Operators of same precedence are executed from left to right, except the prefix operators ($\sim$ $\backslash$ $ $? $.) that are executed from right to left. To enforce another order use angle brackets [ ]. The list begins with the operators of highest precedence, i.e. with the most tightly binding ones. Operators of same precedence are on the same line.

:
$\sim$ $\backslash$ $ $? $.
$+$ $*$ $\hat{}$ .1 .2 .u .l .i .r

/
concatenation
> <
| & −
=> −> (−>) <− (<−) <−> (<−>) @−> @> −>@ >@
.x. .o.

6.2 FSA

The following list states the order of precedence in FSA. The brackets () can always be used to express the desired grouping. The order of precedence of operators is as follows:

: /
..
+ * ^
& −
o x xx
! #

7 Advanced techniques

Both XFST and FSA have advanced techniques that do no exist in the other toolbox. For xfst these techniques include Compile-Replace and Flag-Diacritics; for FSA these techniques include predicates and weighted networks.