

# OpenFST Library

**SOME of the available FST operations**

**<https://www.openfst.org>**

## OpenFst Library

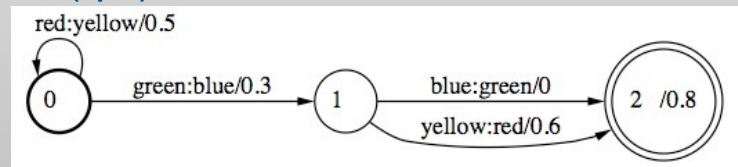
### Definition of the symbols (syms.txt)

```
red      1
green    2
blue     3
yellow   4
```

### Definition of a transducer (t.txt)

```
0 0 red yellow .5
0 1 green blue .3
1 2 blue green
1 2 yellow red .6
2 .8
```

### Graphical version (t.pdf)



30

©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## OpenFst Library

### Definition of the symbols (syms.txt)

```
red      1
green    2
blue     3
yellow   4
```

### Definition of a transducer (t.txt)

```
0 0 red yellow .5
0 1 green blue .3
1 2 blue green
1 2 yellow red .6
2 .8
```

### Generation of the binary version (t.fst)

```
fstcompile --isymbols=syms.txt --osymbols=syms.txt t.txt | fstarcsort > t.fst
```

### Generation of the graphical version (t.pdf)

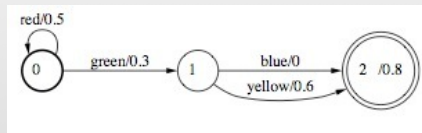
```
fstdraw --portrait --isymbols=syms.txt --osymbols=syms.txt t.fst | dot -Tpdf > t.pdf
```

31

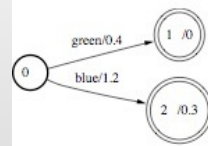
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## UNION of TRANSDUCES

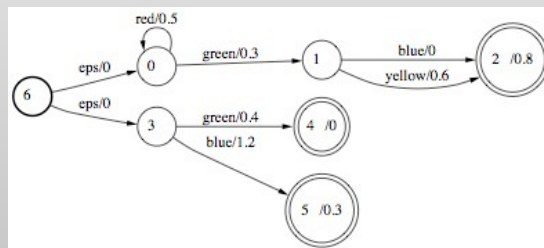
**fstunion A.fsm B.fsm > C.fsm**



**A.fsm**



**B.fsm**



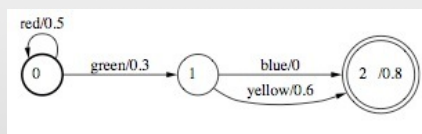
**C.fsm**

32

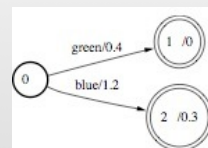
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## CONCATENATION of TRANSDUCES

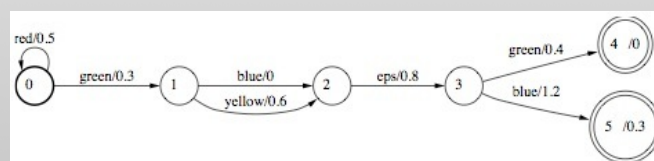
**fstconcat A.fsm B.fsm > C.fsm**



**A.fsm**



**B.fsm**



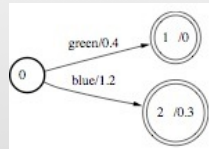
**C.fsm**

33

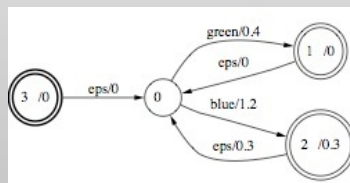
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## CLOSURE of TRANSDUCES

**fstclosure B.fsm > C.fsm**



**B.fsm**



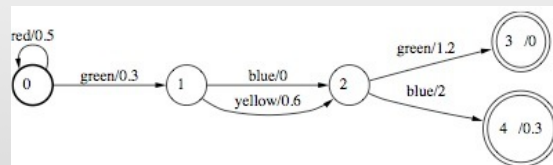
**C.fsm**

34

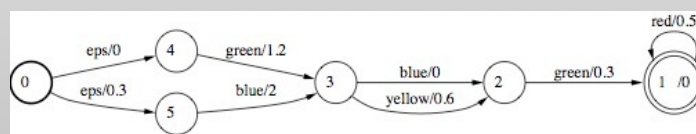
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## “ REVERSAL ” of TRANSDUCES

**fstreverse A.fsm > C.fsm**



**A.fsm**



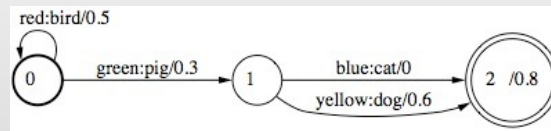
**C.fsm**

35

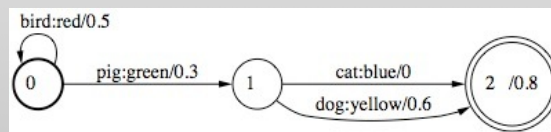
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## INVERSION of TRANSDUCES

```
fstinvert A.fsm > C.fsm
```



A.fsm



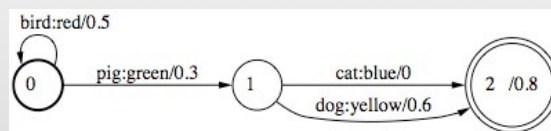
C.fsm

36

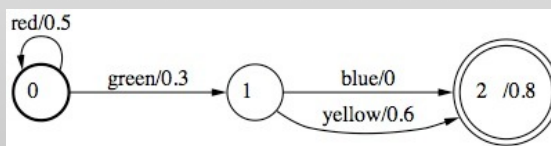
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## PROJECTION (output) of TRANSDUCES

```
fstproject --project_output=true A.fsm > C.fsm
```



A.fsm



C.fsm

37

©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## COMPOSITION of TRANSDUCES

Para obter o transdutor composto:

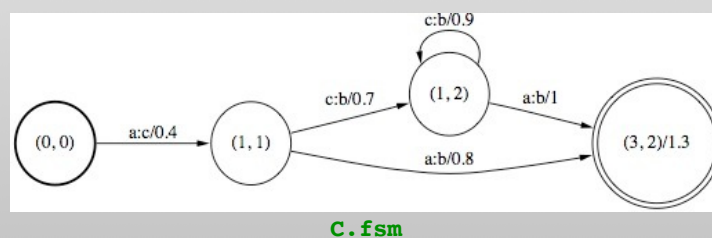
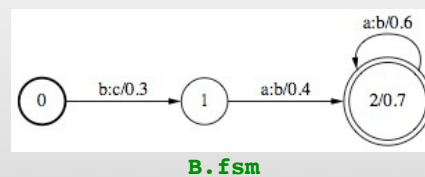
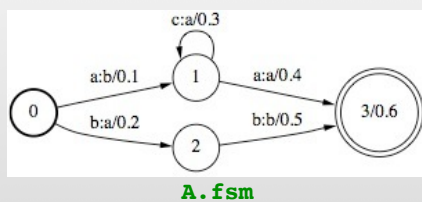
- Cria um novo estado  $(x,y)$  para todos os pares de estados  $x \in Q_1$  e  $y \in Q_2$
- A função de transição da composição é definida por  
 $\delta((x,y),i:o)=(v,z)$  se  $\delta_1(x,i:c) = v$  e  $\delta_2(y,c:o) = z$

38

©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## COMPOSITION of TRANSDUCES

`fstcompose A.fsm B.fsm > C.fsm`



39

©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## INTERSECTION of TRANSDUCES

 O algoritmo de intersecção apenas considera o produto cartesiano dos estados

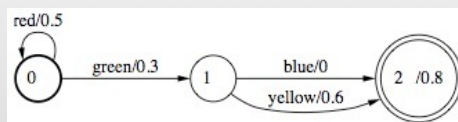
- Para cada estado  $q_i$  do primeiro transdutor, e  $q_j$  do segundo transdutor, cria-se um novo estado  $q_{ij}$
- Para o símbolo de entrada  $a$ , se o primeiro transdutor transitava para o estado  $q_n$  e o segundo transdutor transitava para o estado  $q_m$  o novo transdutor transita para o estado  $q_{nm}$

40

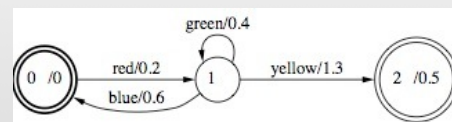
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## INTERSECTION of TRANSDUCES

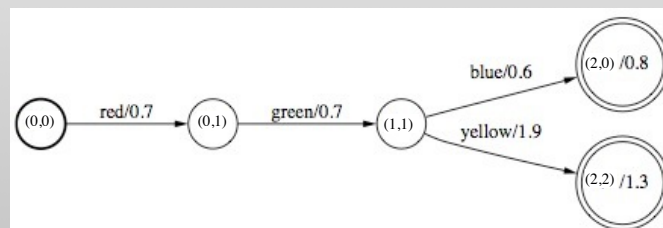
`fstintersect A.fsm B.fsm > C.fsm`



A.fsm



B.fsm



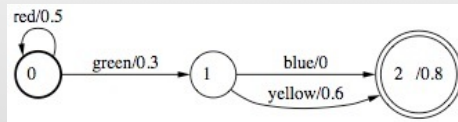
C.fsm

41

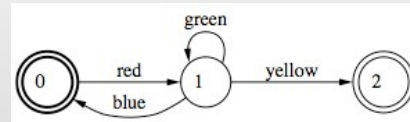
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

## DIFERENÇA DE TRANSDUTORES

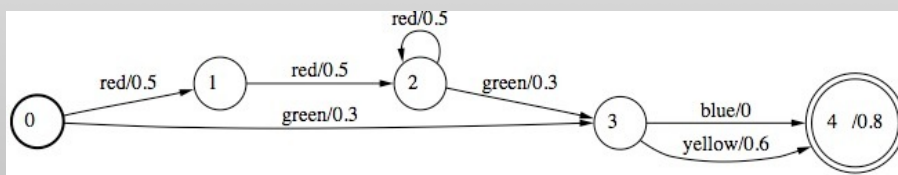
`fsmdifference A.fsm B.fsm > C.fsm`



A.fsm



B.fsm



C.fsm

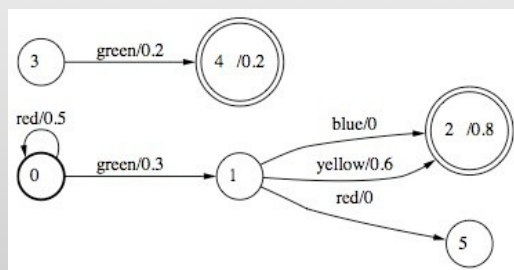
©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

42

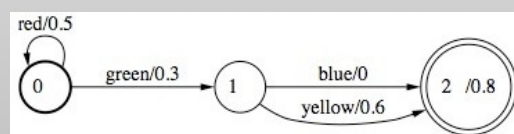
## REMOVAL OF INACCESSIBLE STATES

- With the option `-t`, returns (exit status) 1 if the output has no states, useful to test the empty output ...

`fstconnect A.fsm > C.fsm`



A.fsm



C.fsm

©2021 Nuno J. Mamede  
IST, Dpt. Eng. Informática  
All rights reserved

43