# Labs: an introduction

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Automatic Speech Recognition— ASR Lecture 5
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# Labs

- Start this week, running for 8 weeks. Only labs 1-5 are compulsory.
- Work on the exercises with a lab partner
- Ask the demonstrator for help whenever you need it
- If working outside scheduled lab times, ask for help on Piazza
- If you need to find a partner feel free to post on Piazza or post privately and we will try to pair you up
- It's normal to continue with the same partner for all labs and the coursework, but not obligatory
- Attendance will be taken by the demonstrator

# Lab times

Labs take place in an AT 5.05

- - Lab 01: Tuesdays 10.00 (Zeyu)
  - Lab 02: Wednedays 10.00 (Christoph)
  - Lab 03: Wednedays 11.10 (Emily)
  - Lab 04: Wednedays 12.10 (Ariadna)
- Attend one lab per week
- You should attend the same lab as your partner
- To swap, use self-service timetabling: https://www.ed.ac.uk/timetabling-examinations/timetabling/personalised-timetables




# Technical setup

- Labs use the DICE computing platform: see https://computing.help.inf.ed.ac.uk/linux if you are not familiar with it.
- Get the labs from a Github repository https://github.com/ZhaoZeyu1995/asr_labs (linked from Learn and the course web page).
- Setup instructions are in the repository README.
- Feel free to ask for technical support on Piazza ahead of your lab
- The exercises have been tested on the Lab PCs.
- Instructions are available for running on your own machine via Remote Desktop (XRDP) or using SSH tunnels

# Lab exercises

- Skeleton code is provided in a Jupyter notebook. You will write and run your code within the notebook
  - If you prefer, you can work in pure Python you prefer to work with a different editor
- There is one notebook for each lab (except labs 3 and 4 share a notebook).
- Solutions will be available one week after the lab
- You will need to update the repo to receive subsequent weeks' exercises and the solutions, as well as any corrections or bug fixes

# Asessment

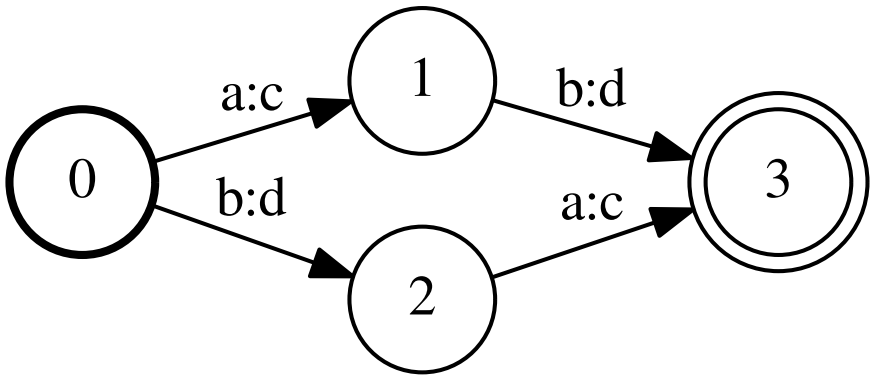
**Lab solutions are worth 10% of the course mark**

- 2 marks available for each lab
  - No submission – 0 marks
  - A weak/partial submission – 1 mark
  - A good effort – 2 marks
- Marks over the first five labs will be aggregated and scaled in accordance with the University's common marking scheme
- You will need to submit your solutions by Monday morning in the *second week* following the lab
- Only one person from each pair need submit a solution
- Submission will use CodeGrade, linked from the Learn page

# HMMs and WFSTs

- The labs will use OpenFst `http://openfst.org` to build and manipulate HMMs represented as weighted finite-state transducers (WFSTs)
- You will first build WFSTs for various phone and word structures, compute forward probabilities and implement your own Viterbi decoder
- A WFST consists of states and directed arcs between them
- Each arc has an input label, and output label and (optionally) a weight (or cost)
- Labels can be blank (epsilon): written $\varepsilon$ or `<eps>`
- The WFST *transduces* a sequence of input labels to a sequence of output labels (and optionally applies a weight to this)

# WFST example

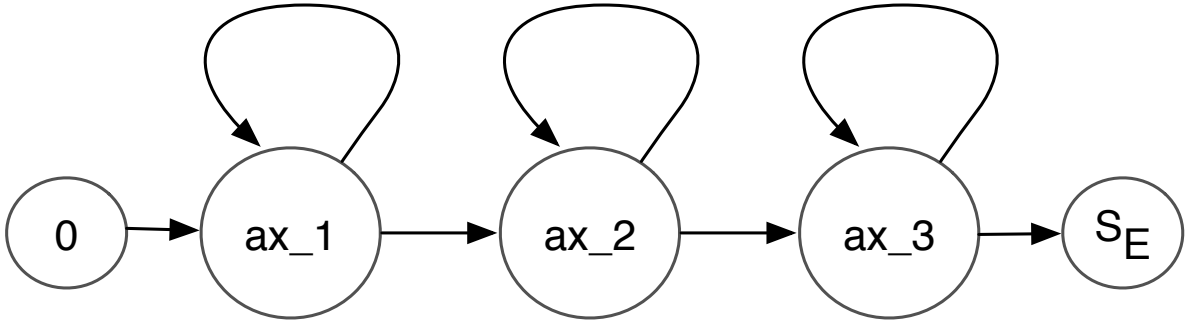



*A very simple transducer mapping the string "ab" to "cd" and the string "ba" to "dc". The initial state is shown in bold; the final state is shown with a double circle.*

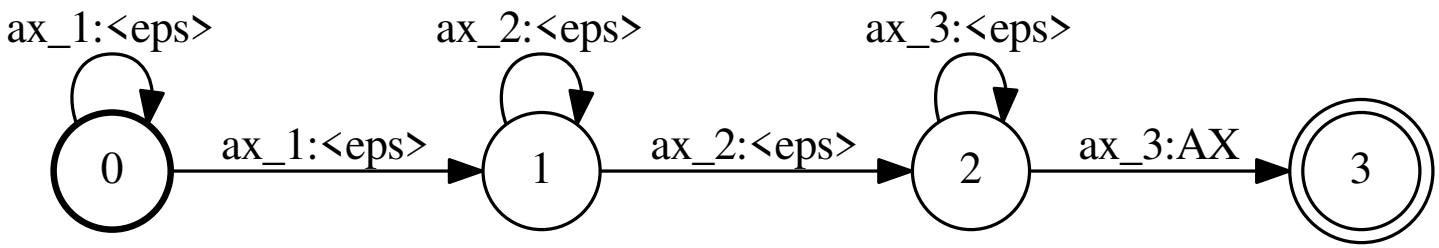
# HMMs as WFSTs

- Easier to think of the HMM emitting states as being on the arcs
- Input labels used to denote state ID
- Output labels can be used to encode symbols to be output by the recogniser, such as words or phones
- Internally, both input and output labels are stored as an integer index, with a *Symbol Table* mapping between the two
- The blank (epsilon label) is given index 0 by convention
- We will cover WFSTs in much more detail later in the course

# HMMs as WFSTs




*Conventional HMM for phone "AX" with three emitting states*




*WFST representation of the HMM. Note the output label "AX"*

# Documentation

The lab exercises are intended to be self-contained, but you can find additional documentation:

- About OpenFst in general at https://www.openfst.org/twiki/bin/view/FST/WebHome
- About the Python interface at https://www.openfst.org/twiki/bin/view/FST/PythonExtension
- *NEW* Our own technical documentation at https://openfst-python-documentation.readthedocs.io/