CSCI 3110
Fun with Algorithms

Norbert Zeh
nzeh@cs.dal.ca

Faculty of Computer Science
Dalhousie University

Fall 2015

Stable Matching: An Introductory Example

Given:

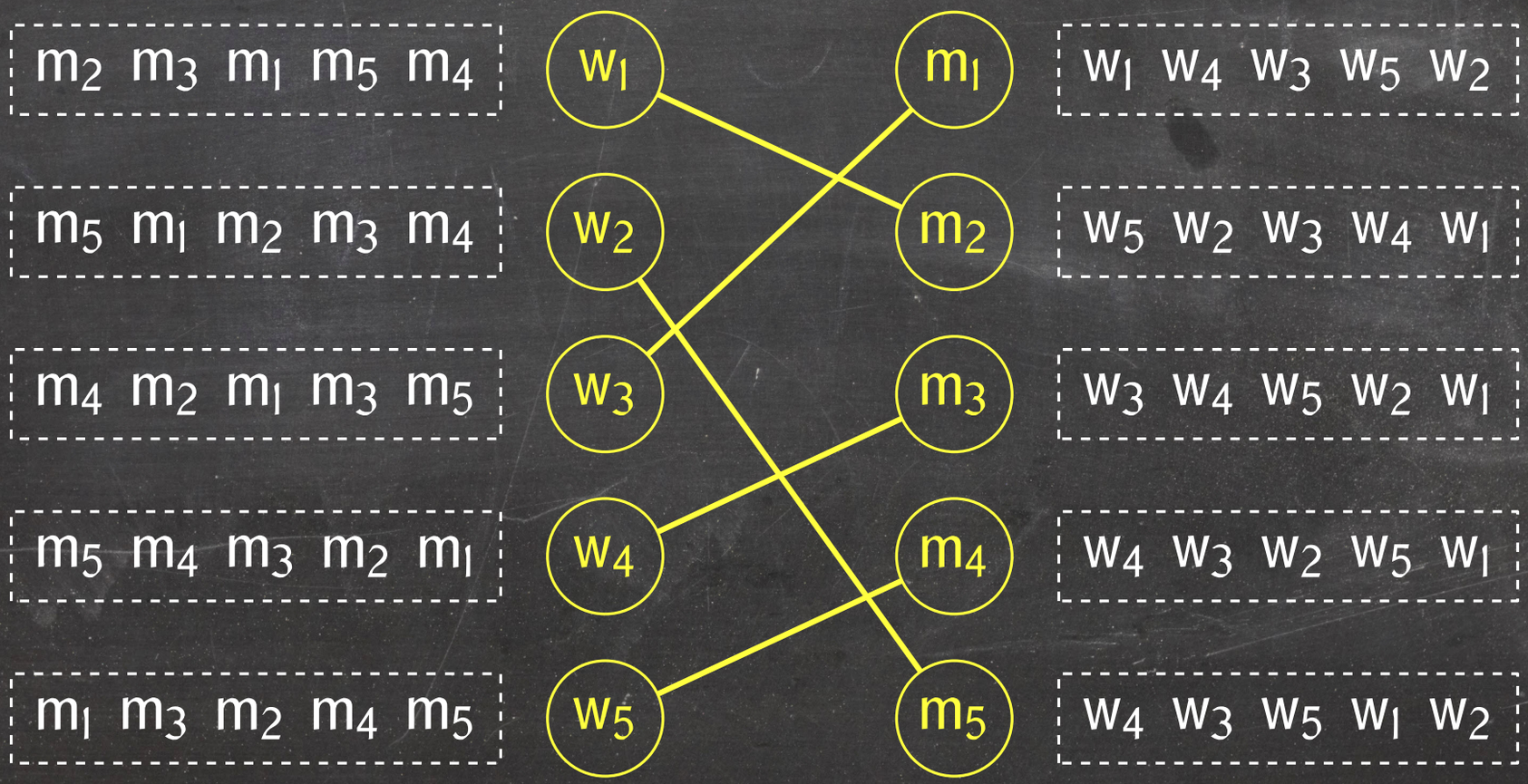
- n women $w_1, w_2, \ldots, w_n$
- n men $m_1, m_2, \ldots, m_n$
- A preference list for each

$m_2\ m_3\ m_1\ m_5\ m_4$	w_1	m_1	$w_1\ w_4\ w_3\ w_5\ w_2$
$m_5\ m_1\ m_2\ m_3\ m_4$	w_2	m_2	$w_5\ w_2\ w_3\ w_4\ w_1$
$m_4\ m_2\ m_1\ m_3\ m_5$	w_3	m_3	$w_3\ w_4\ w_5\ w_2\ w_1$
$m_5\ m_4\ m_3\ m_2\ m_1$	w_4	m_4	$w_4\ w_3\ w_2\ w_5\ w_1$
$m_1\ m_3\ m_2\ m_4\ m_5$	w_5	m_5	$w_4\ w_3\ w_5\ w_1\ w_2$

Stable Matching: An Introductory Example

Output:

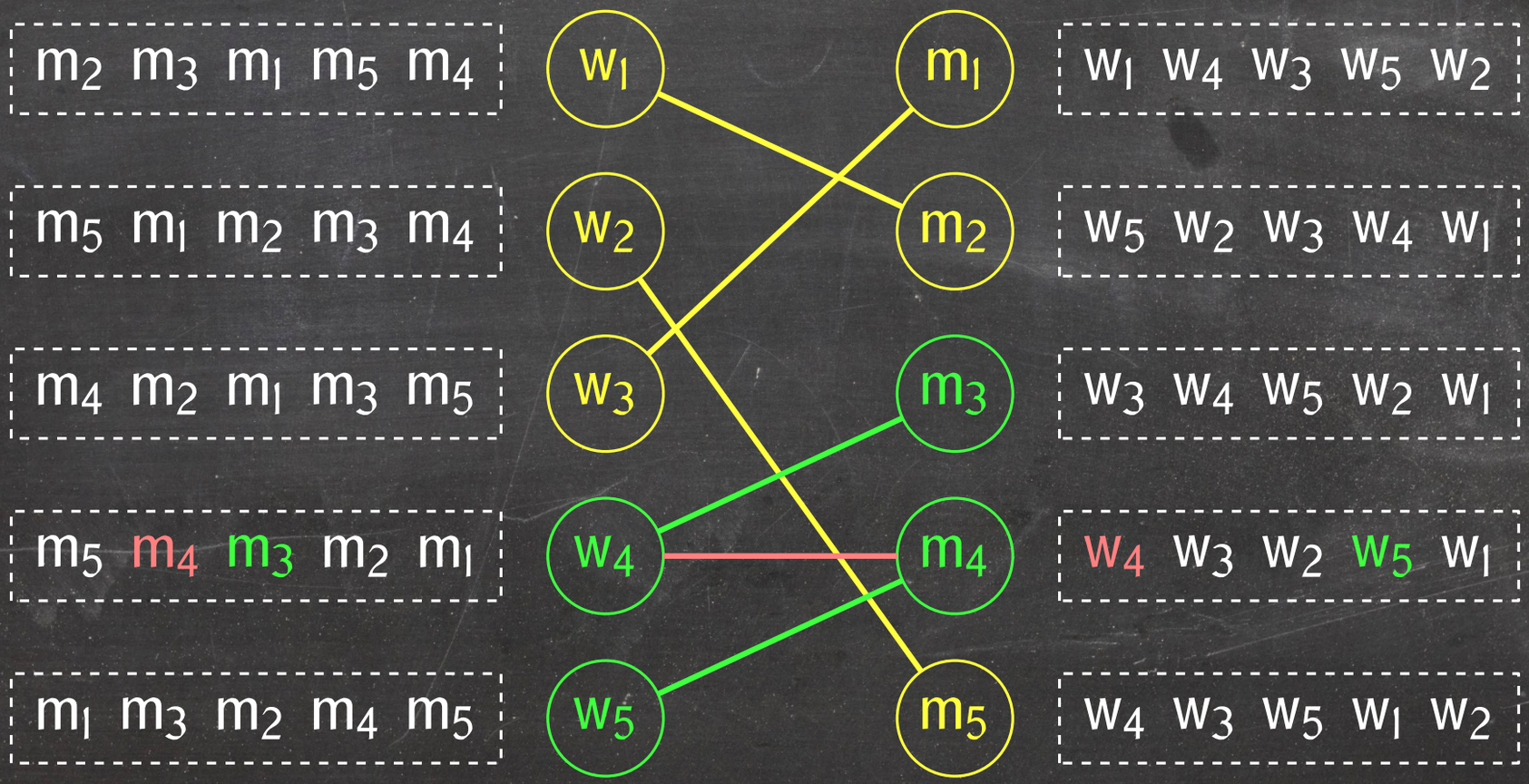
- A set of n marriages $\{(w_{i_1}, m_{j_1}), ((w_{i_2}, m_{j_2}), \ldots, (w_{i_n}, m_{j_n})\}$
- Every man is married
- Every woman is married
- The marriages are stable



Stable Matching: An Introductory Example

A pair of marriages (m, w) and (m', w') is unstable if

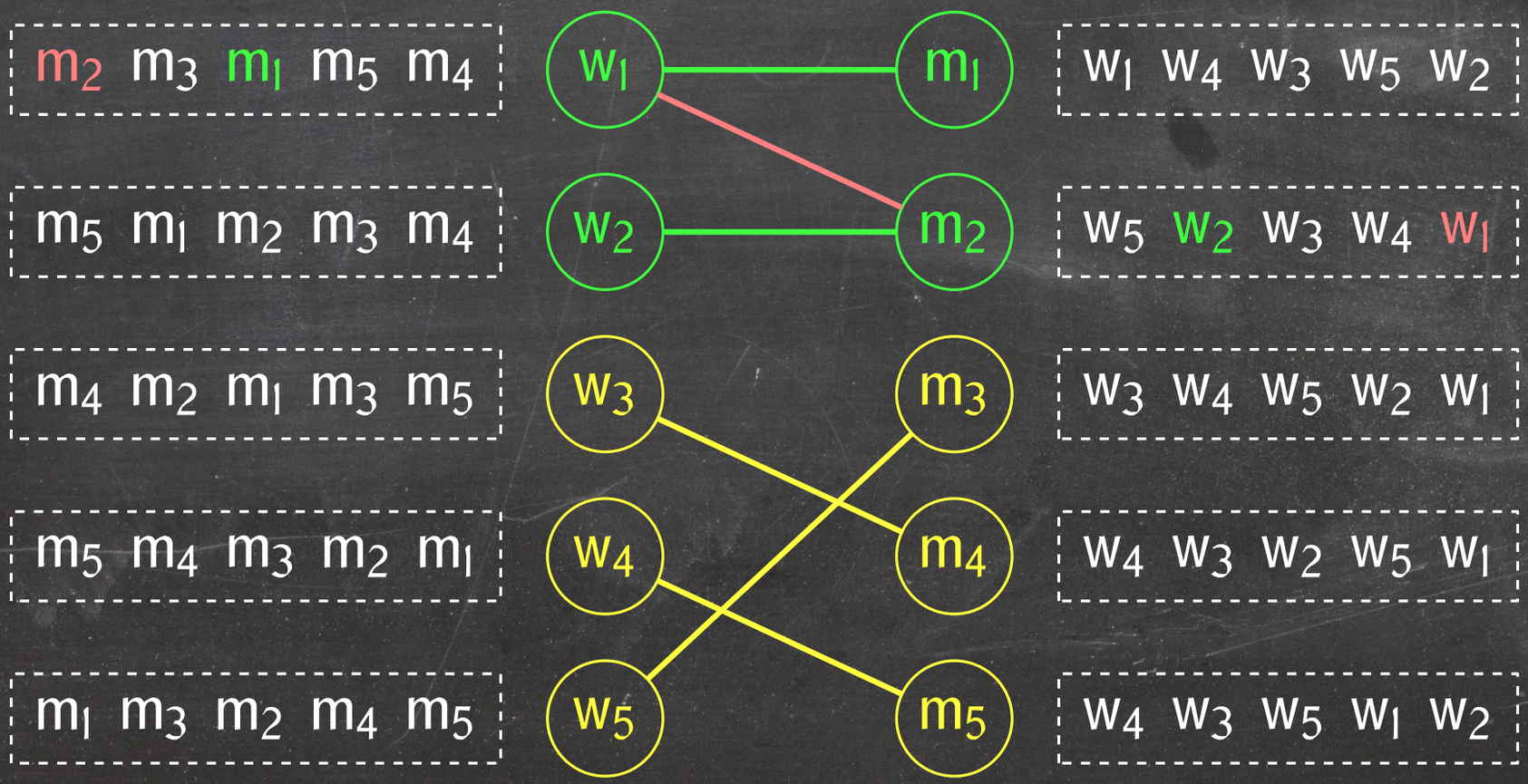
- w prefers m' over m ($m' \prec_w m$)
- m' prefers w over w' ($w \prec_{m'} w'$)



Stable Matching: An Introductory Example

A pair of marriages (m, w) and (m', w') is unstable if

- w prefers m' over m ($m' \prec_w m$)
- m' prefers w over w' ($w \prec_{m'} w'$)



Stable Matching: A Solution Inspired By Real Life

StableMatching(M, W)

```
1  while there exists an unmarried man m
2      do m proposes to the most preferable woman w he has not proposed to yet
3          if w is unmarried or likes m better than her current partner m′
4              then if w is married
5                       then w divorces m′
6                   w marries m
```

Stable Matching: A Solution Inspired By Real Life

StableMatching(M, W)

```
1  while there exists an unmarried man m
2      do m proposes to the most preferable woman w he has not proposed to yet
3          if w is unmarried or likes m better than her current partner m′
4              then if w is married
5                       then w divorces m′
6                   w marries m
```

Questions we can and should ask about the algorithm:

- Is there always a stable matching?
- Does the algorithm always terminate?
- Does the algorithm always produce a stable matching?
- How efficient is the algorithm? Can we bound its running time?

Course Outline

- Correctness proofs
- Analysis of resource consumption
- Algorithm design techniques
  - Graph exploration
  - Greedy algorithms
  - Divide and conquer
  - Dynamic programming
  - Data structuring
  - Randomization
- NP-completeness and intractability

General Information

Instructor:	Norbert Zeh
Office:	Goldberg 313
Office hours:	Mon, Wed 1:30–3:00
Email:	nzeh@cs.dal.ca
Textbook:	Cormen, Leiserson, Rivest, Stein. Introduction to Algorithms. 3rd edition, MIT Press, 2009.
	Zeh. Data Structures. CSCI 3110 Lecture Notes, 2005.
Website:	http://www.cs.dal.ca/~nzeh/Teaching/3110
TAs:	David Samuel Mengdu Li Habibeh Naderi
Midterm:	Oct 30

Grading

- 10 Assignments (A)

  The best 8 count. Each carries equal weight.
- Midterm (M)
- Final (F)

$$\text{Final grade} = \max \begin{pmatrix} \text{F} \\ 60\% \cdot \text{F} + 40\% \cdot \text{M} \\ 60\% \cdot \text{F} + 40\% \cdot \text{A} \\ 40\% \cdot \text{F} + 20\% \cdot \text{M} + 40\% \cdot \text{A} \end{pmatrix}$$

Collaboration, Plagiarism, Late Assignments

Collaboration

- Groups of up to three people are allowed to collaborate on assignments.
- Every group hands in one set of solutions; every group member gets the same marks.
- Collaboration between groups is not allowed!

Plagiarism

- Plagiarism will not be tolerated.
- Collaboration between groups is a form of plagiarism.

Late assignments

. . . will not be accepted without a doctor's note.

Please see course website for a detailed discussion of these rules.

Things I Expect You To Know

- Basic rules concerning logarithms
- Basic rules concerning limits
- Basic derivatives
- Propositional logic
- Elementary combinatorics (counting permutations, combinations, ...)
- Elementary probability theory (linearity of expectation, ...)
- Elementary data structures (arrays, lists, stacks, queues, ...)
- Standard sorting algorithms (insertion sort, quick sort, merge sort)
- Binary heaps