

Algorithms and Networking for Computer Games

Chapter 3: Tournaments

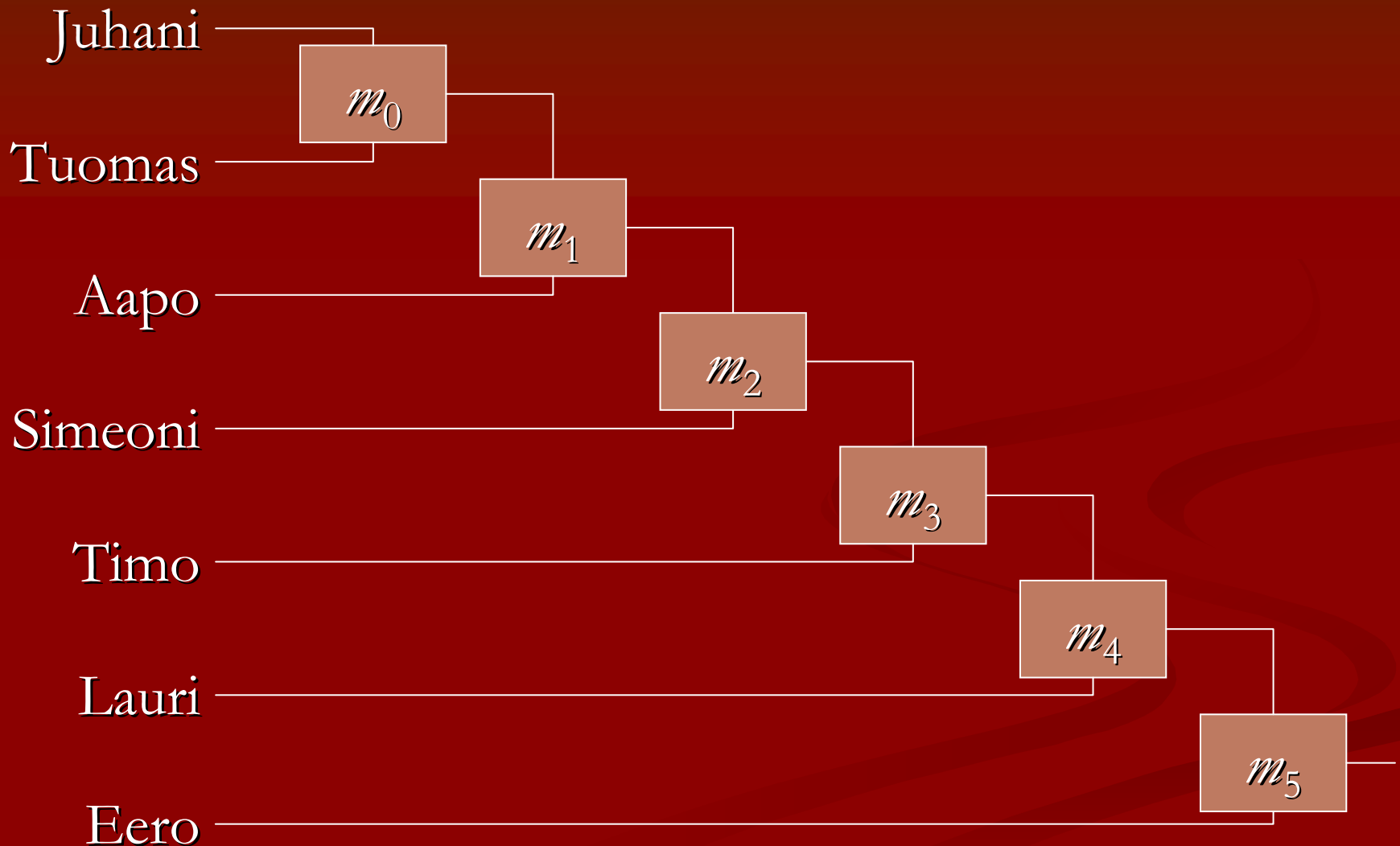
Tournament types

- rank adjustment (or challenge) tournament
 - each match is a challenge for a rank exchange
 - types: ladder, hill climbing, pyramid, king of the hill
- elimination tournament (or cup)
 - each match eliminates the loser from the tournament
 - types: random selection, random pairing, single elimination
- scoring tournament
 - each match rewards the winner
 - types: round robin
- hybridizations

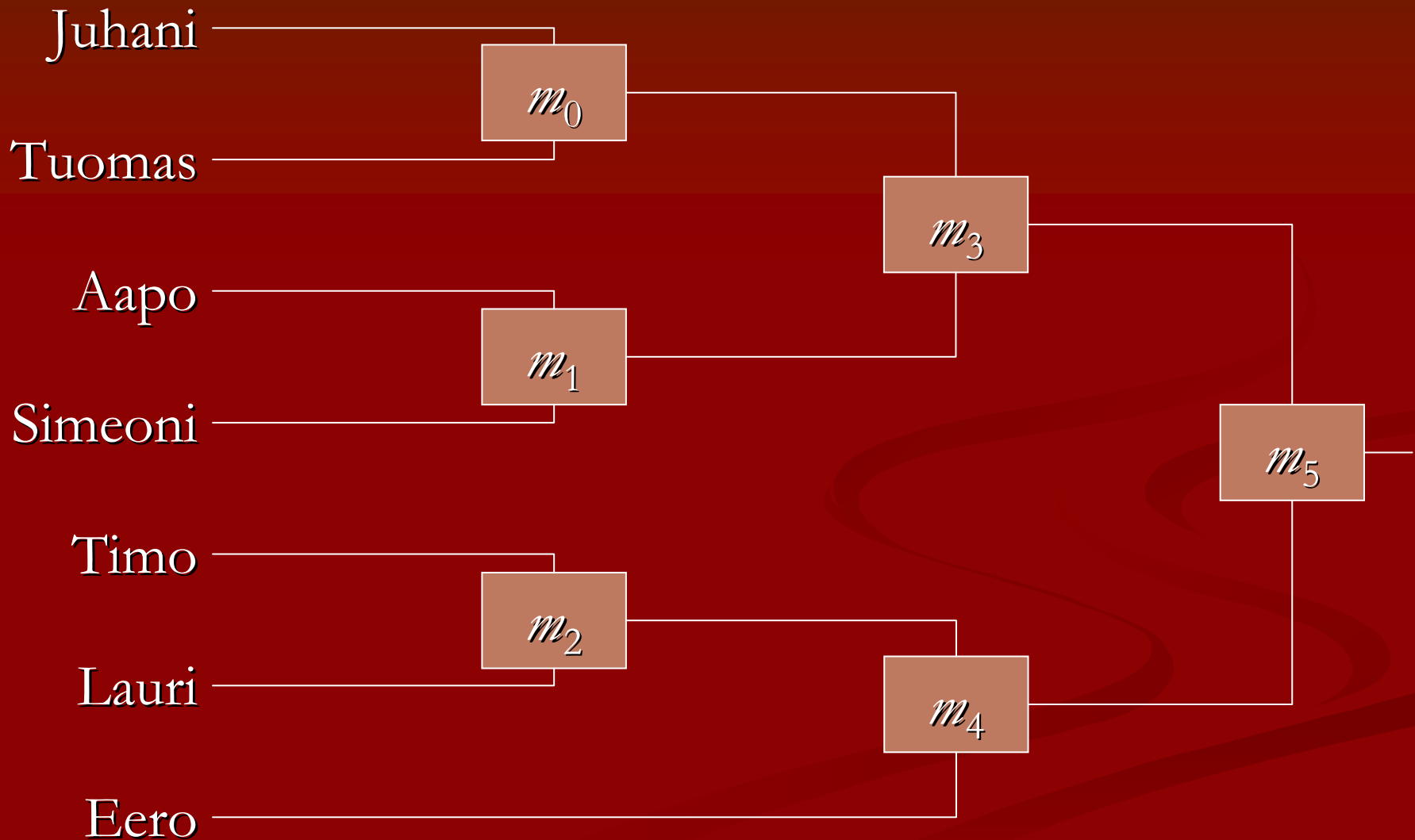
Other uses for tournaments

- game balancing
 - duelling synthetic players
 - adjusting point rewarding schemes
- heuristic search
 - selecting suboptimal candidates for a genetic algorithm
- group behaviour
 - modelling pecking order
- learning player characteristics
 - managing history knowledge

Example: Hill climbing tournament



Example: Elimination tournament



Example: Scoring tournament

	Tuomas	Aapo	Simeoni	Timo	Lauri	Eero
Juhani	m_0	m_6	m_{11}	m_{15}	m_{18}	m_{20}
	Tuomas	m_1	m_7	m_{12}	m_{16}	m_{19}
		Aapo	m_2	m_8	m_{13}	m_{17}
			Simeoni	m_3	m_9	m_{14}
				Timo	m_4	m_{10}
					Lauri	m_5

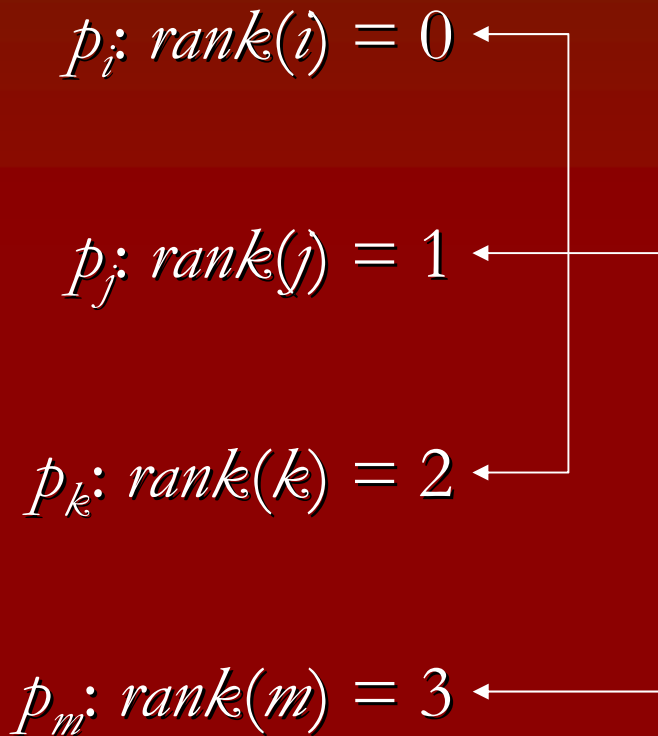
Terms

- players: $p_0 \dots p_{n-1}$
- match between p_i and p_j : $match(i, j)$
- outcome: WIN, LOSE, TIE
- rank of p_i : $rank(i)$
- players with the rank r : $rankeds(r)$
- round: a set of (possibly) concurrent matches
- bracket: diagram of match pairings and rounds

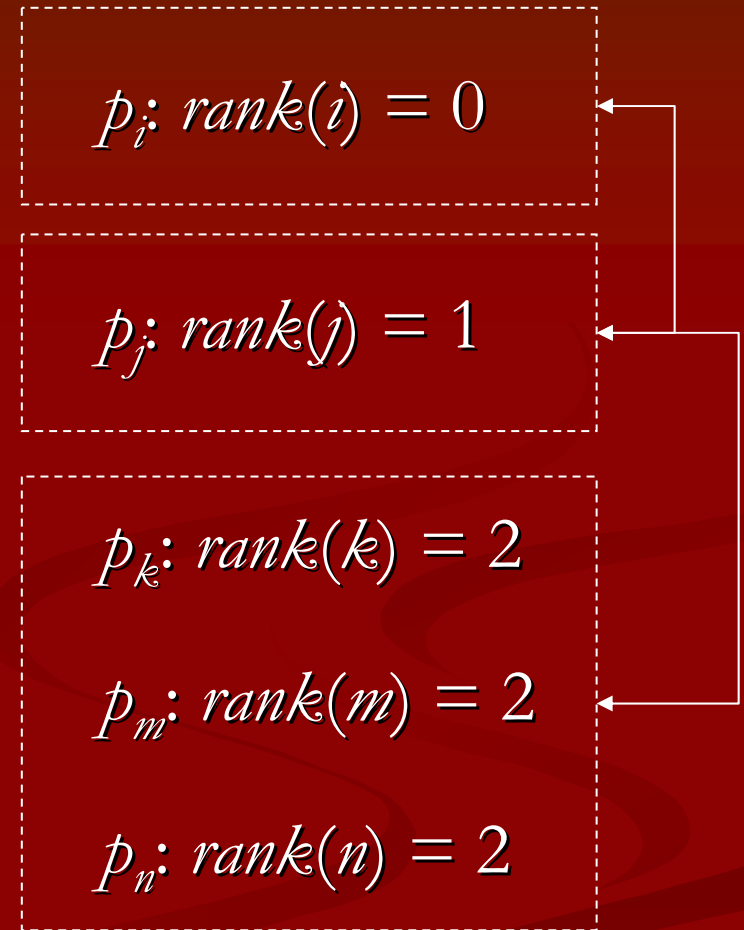
Rank adjustment tournaments

- a set of already ranked players
- matches
 - independent from one another
 - outcome affects only the participating players
- suits on-going tournaments
 - example: boxing
- matches can be limited by the rank difference

Ladder and pyramid tournaments



$$p_n: \text{rank}(n) = 4$$

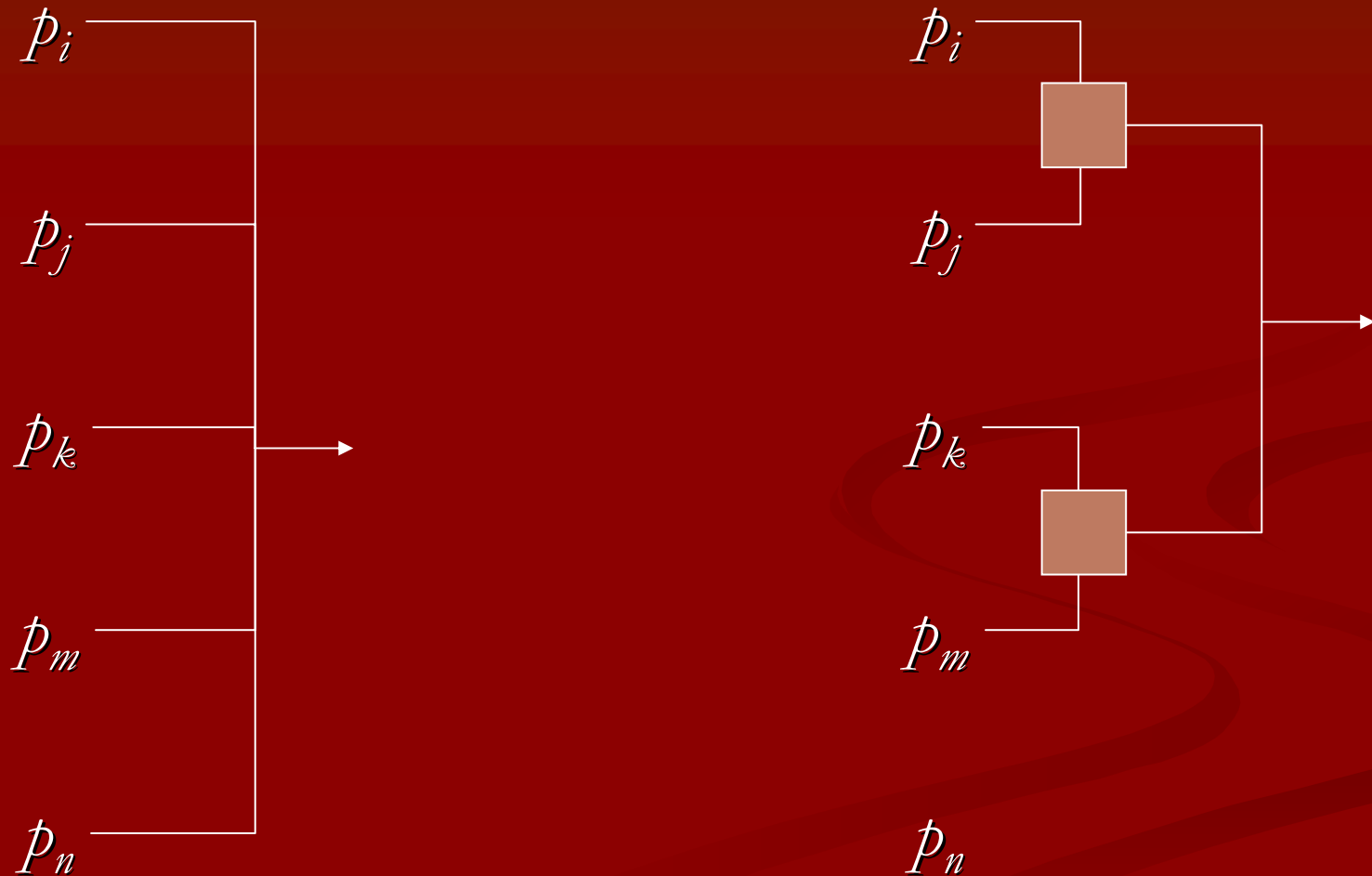


$$\text{rankeds}(2) = \{ k, m, n \}$$

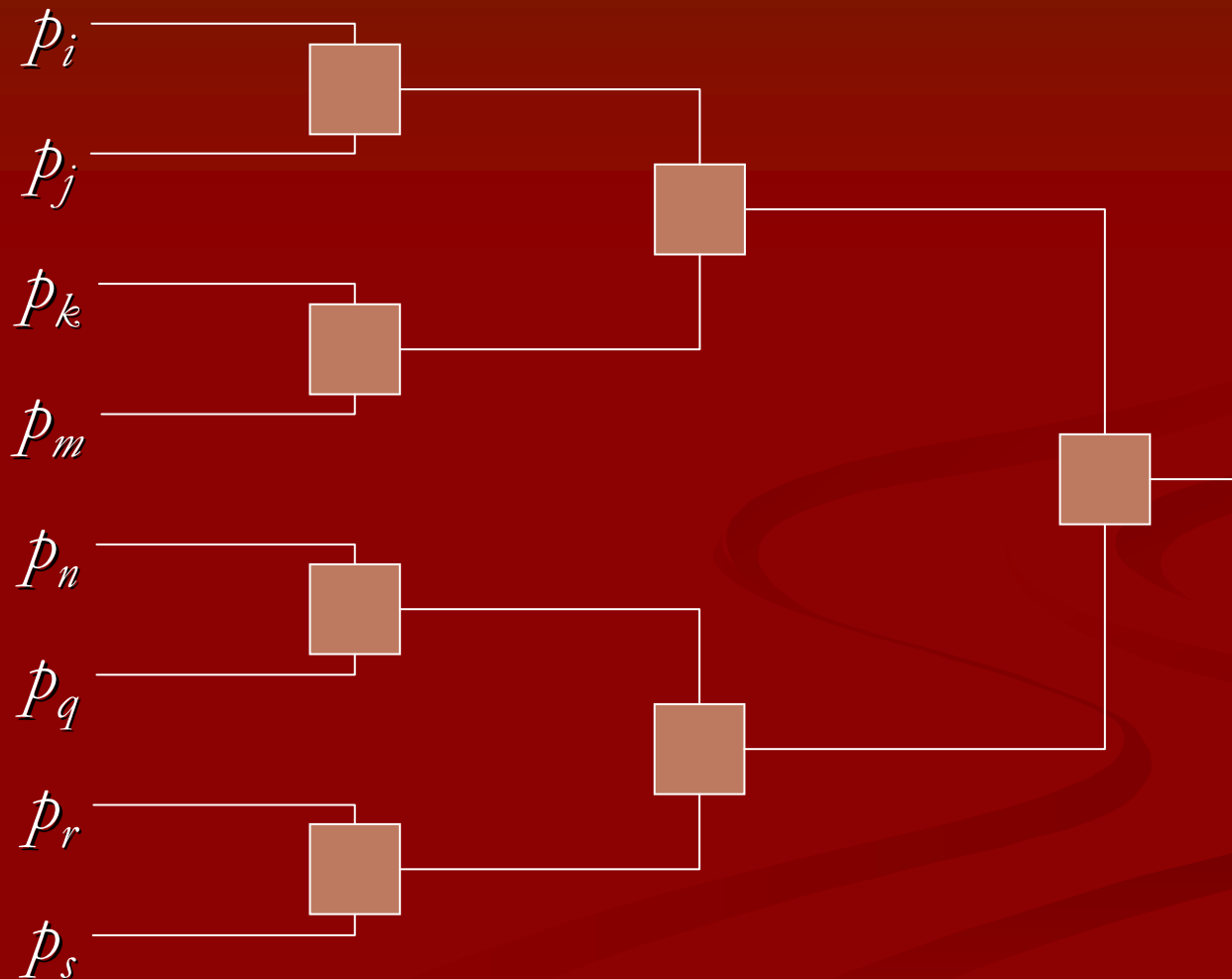
Elimination tournaments

- loser of a match is eliminated from the tournament
 - no ties! → tiebreak competition
- winner of a match continues to the next round
- how to assign pairings for the first round?
 - seeding
- examples
 - football cups, snooker tournaments

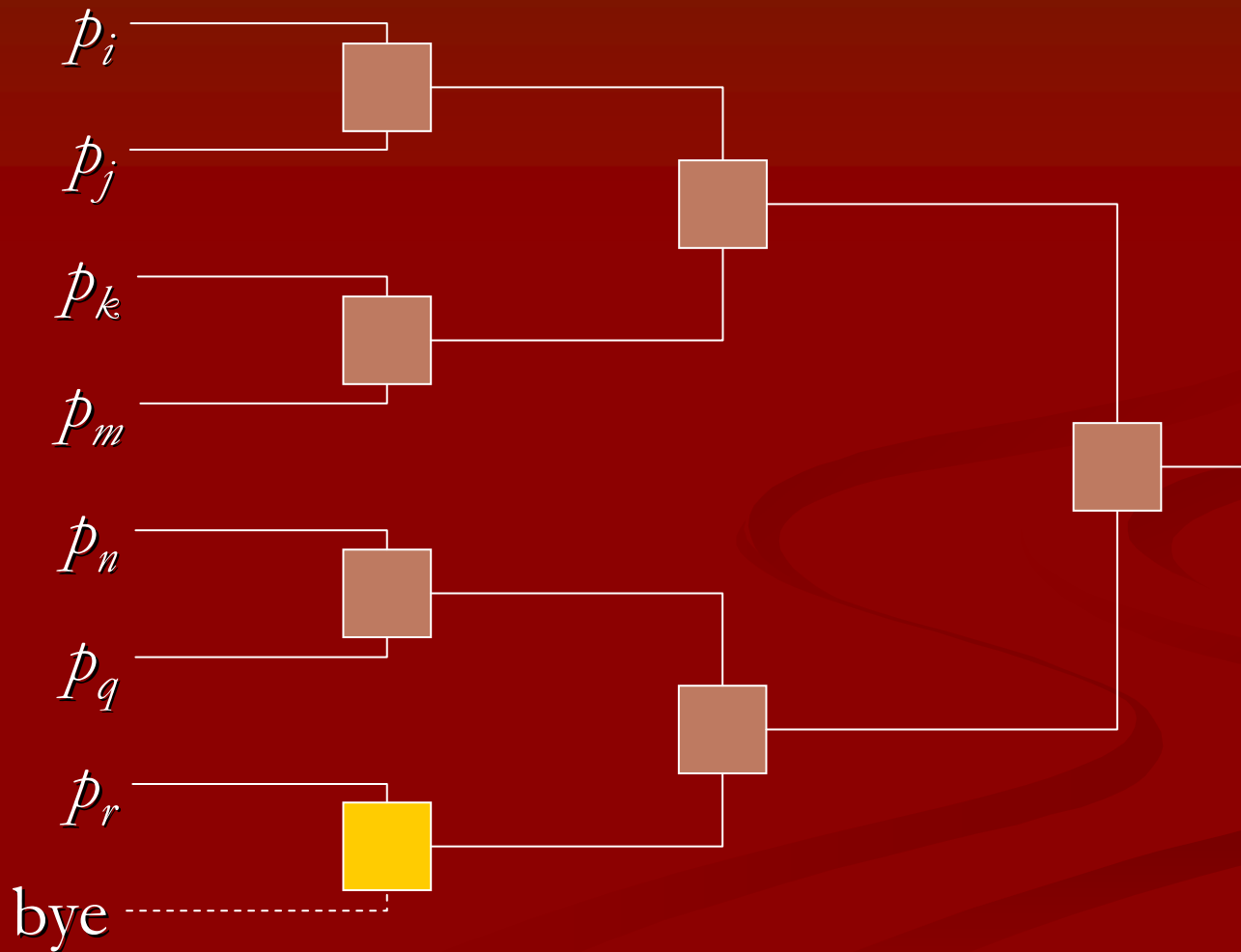
Random selection and random pairing



Single elimination



Bye



Seeding

- some match pairing will not occur in a single elimination tournament
- pairings for the first round (i.e., seeding) affects the future pairings
- seeding can be based on existing ranking
 - favour the top-ranked players
 - reachability: give the best players an equal opportunity to proceed the final rounds

Seeding methods

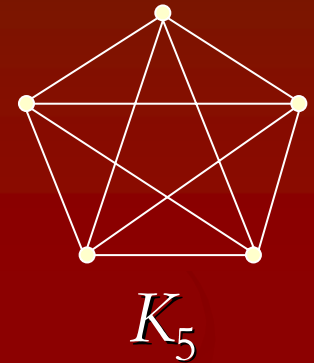
- random
 - does not favour any player
 - does not fulfil reachability criterion
- standard and ordered standard
 - favours the top-ranked players
 - ordered standard: matches are listed in increasing order
- equitable
 - in the first round, the rank difference between the players is the same for each match

Scoring tournaments

- round robin: everybody meets everybody else once
- scoring table determines the tournament winner
 - players are rewarded with scoring points
 - winner and tie
- matches are independent from one another

Reduction to a graph

- n players
- clique K_n
- players as vertices, matches as edges
- how to organize the rounds?
 - a player has at most one match in a round
 - a round has as many matches as possible



Reduction to a graph (cont'd)

- if n is odd, partition the edges of the clique to $(n - 1) / 2$ disjoint sets
 - in each turn, one player is resting
 - player p_i rests in the round i
- if n is even, reduce the problem
 - player p_{n-1} is taken out from the clique
 - solve the pairings for $n - 1$ players as above
 - for each round, pair the resting player p_i with player p_{n-1}

Round robin with seven players

round	matches			resting
0	1 – 6	2 – 5	3 – 4	0
1	2 – 0	3 – 6	4 – 5	1
2	3 – 1	4 – 0	5 – 6	2
3	4 – 2	5 – 1	6 – 0	3
4	5 – 3	6 – 2	0 – 1	4
5	6 – 4	0 – 3	1 – 2	5
6	0 – 5	1 – 4	2 – 3	6

Normalized round robin

- who is the resting player in a given round?
→ answered
- given two players, in which round they will face one another?
→ no simple rule?
- change the selection of the resting player
 - resting player: $r \cdot \lfloor (n + 1) / 2 \rfloor \bmod n$
 - if n is odd, p_i and p_j will face in the round $i + j \bmod (\text{number of rounds})$

Real-world tournament examples

- boxing
 - reigning champion and challengers
- sport wrestling
 - double elimination: consolation bracket
- professional wrestling
 - royal rumble
- World Cup
- ice hockey championship
- snooker

Practical considerations

- home matches
- venue bookings
- travelling times
- risk management
- other costs