

### §3 Tournaments

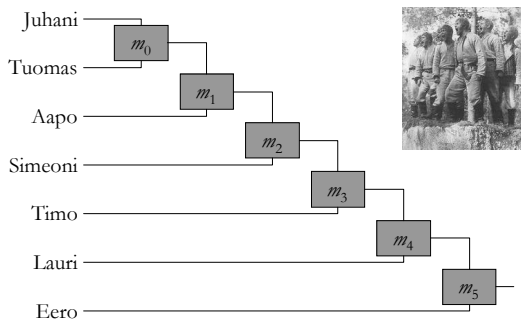
- rank adjustment (or challenge) tournament
  - each match is a challenge for a rank exchange
  - types: ladder, hill climbing, pyramid, king of the hill
- elimination tournament (or cup)
  - each match eliminates the loser from the tournament
  - types: single elimination
- scoring tournament
  - each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

### Other uses

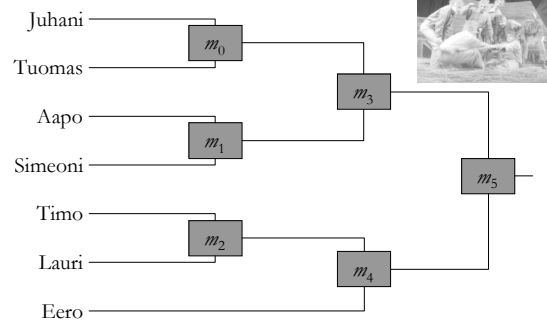
- game balancing
  - duelling synthetic players
  - adjusting point rewarding schemes
- heuristic search
  - selecting suboptimal candidates for a genetic algorithm
- group behaviour
  - modelling pecking order
- learning player characteristics
  - managing history knowledge



### 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

$p_i: rank(i) = 0$   
 $p_j: rank(j) = 1$   
 $p_k: rank(k) = 2$   
 $p_m: rank(m) = 3$   
 $p_n: rank(n) = 4$

$p_i: rank(i) = 0$   
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 $p_m: rank(m) = 2$   
 $p_n: rank(n) = 2$

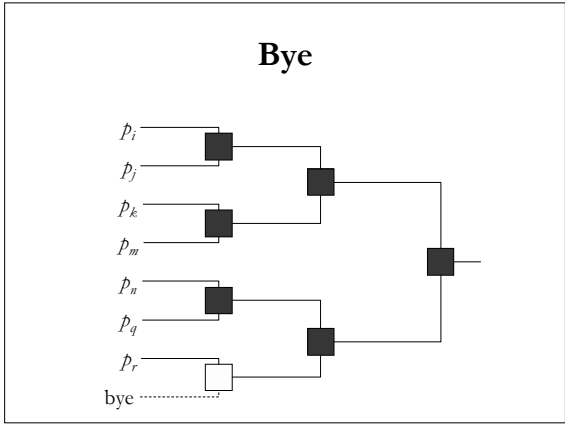
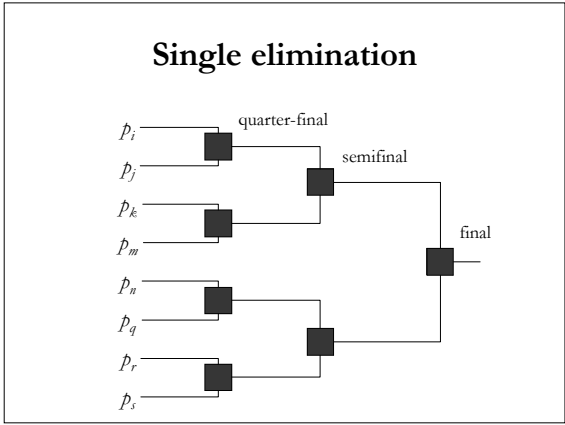
$ranked(2) = \{k, m, n\}$

### Hill-climbing tournament

- a.k.a.
  - top-of-the-mountain tournament
  - last man standing tournament
- specialization of the ladder tournament
  - reigning champion defends the title against challengers
  - similarly: king of the hill tournament specializes the pyramid tournament
- initialization
  - based on previous competitions
  - random

### 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



## 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

## Byes and fairness

- the byes have bottom ranks so that they get paired with best players
- the byes appear only in the first round



## Runners-up

- we find only the champion
  - how to determine the runners-up (e.g. silver and bronze medallists)?
- random pairing can reduce the effect of seeding
  - best players are put into different sub-brackets
  - the rest is seeded randomly
- re-seed the players before each round
  - previous matches indicate the current position
- multiple matches per round (best-of- $m$ )

## Double elimination tournament

- two brackets
  - winners' bracket
  - losers' (or consolation) bracket
- initially everyone is in the winners' bracket
  - if a player loses, he is moved to the losers' bracket
  - if he loses again, he is out from the tournament
- the brackets are combined at some point
  - for example, the champion of the losers' bracket gets to the semifinal in the winners' bracket

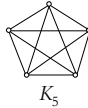
## Scoring tournaments

- 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

### 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

