

# Minimizing Wiggles in Storyline Visualizations

Theresa Fröschl and Martin Nöllenburg

Algorithms and Complexity Group, TU Wien, Vienna, Austria

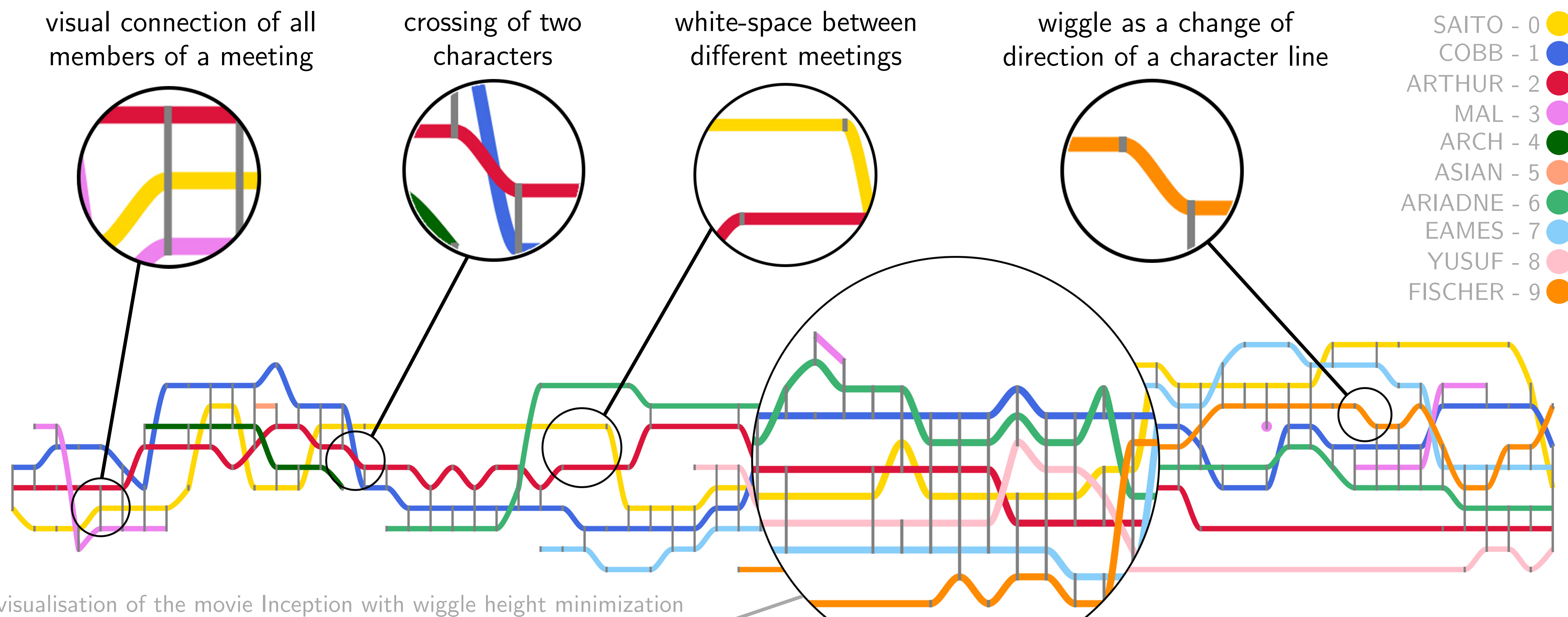


A storyline visualisation [5] is a two-dimensional drawing of a set of characters (vertices, illustrated by x-monotone curves) and meetings (hyperedges, illustrated by vertical proximity) over time on the x-axis.

Proposed optimization criteria [3,6] are minimizations of

- crossings
- line wiggles
- white-space gaps

Previous papers had their focus on crossing minimization [1,2,4]. This poster presents an integer linear programming (ILP) model for exact wiggle minimization in storyline visualizations.



visualisation of the movie Inception with wiggle height minimization

time points

slots	0	1	2	3	4	5	6	7	8	9	10	11	12
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	0	0	0	0	0	0
3	0	1	0	1	1	1	0	0	0	0	0	0	1
4	0	0	0	0	0	0	0	0	0	1	0	0	0
5	1	0	0	0	0	0	1	1	1	0	1	1	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0

position variables for character 6

The position of character  $i$  at time point  $t$  as binary variable  $x_{i,j}^t$  is set to 1 if and only if  $i$  uses slot  $j$  at time point  $t$ . No slot is used twice and each character uses at most one slot at time  $t$ .

### Meetings

Constraints are added that confine meeting members to consecutive slots between start and end time of the corresponding meeting.

time points

slots	0	1	2	3	4	5	6	7	8	9	10	11	12
0													
1				3									
2			6	3									
3		6	6	6	6			1			6		
4	1	1	1	1	1	1	1	1	1	6	1	1	1
5	6					0	6	6	6	8	6	6	
6	2	2	2	2	2	2	2	2	2	8	8	0	
7	0	0	0	0	0	0	0	0	0	0	0	8	
8	8	8	8	8	8	8	8	8	8	2	2	2	2
9	7	7	7	7	7	7	7	7	7	7	7	7	
10							9			9	9	7	7
11	9	9	9	9	9	9	9			9		9	9

matrix view of the storyline

### Objective function for wiggle height minimization

$$\text{minimize } \sum_{i=1}^n \sum_{t=1}^{p-1} z_i^t$$

subject to

$$\sum_{j=1}^m j \cdot (x_{i,j}^t - x_{i,j}^{t+1}) \leq z_i^t,$$

$$-\sum_{j=1}^m j \cdot (x_{i,j}^t - x_{i,j}^{t+1}) \leq z_i^t$$

### Alternative objectives

- minimize number of wiggles
- minimize maximum wiggle height

time points

slots	0	1	2	3	4	5	6	7	8	9	10	11	12
0													
1			1										
2			1	0									
3		1	0	0	2					1		4	
4	0	0	0	0	0	0	0	0	1	1	0	0	0
5	2				2	0	0	1	1	0	2		
6	0	0	0	0	0	0	0	2		0	1	0	
7	0	0	0	2		0	0	0	0	0	1	2	
8	0	0	0	0	0	0	0	3	0	0	0	0	
9	0	0	0	0	0	0	0	0	1		1	0	
10							1		0	1	0	0	
11	0	0	0	0	0	1		1			0	6	

wiggle variables for all characters

With the position variables  $x_{i,j}^t$  the characters' wiggles and their height can be determined by comparing the position of any character  $i$  for successive time points  $t$  and  $t+1$ . The exact height of a wiggle is identified with the integer variable  $z_i^t$ .

### Crossings

Position variables of characters are used to determine the relative position between the characters to find crossings; similar to the crossing minimization ILP of Gronemann et al. [1].