

# REVIEW TIMES IN PEER REVIEW

## Quantitative analysis of editorial workflows



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## Review times in peer review: quantitative analysis of editorial workflows

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We examine selected aspects of peer review and suggest possible improvements. To this end, we analyse a dataset containing information about the Biotechnology section of the Journal of the Serbian Chemical Society. After separating the peer review process into stages that each reviewer describes, we describe it in a probabilistic manner and test the impact of some modifications of the editorial policy on the efficiency of the whole process.

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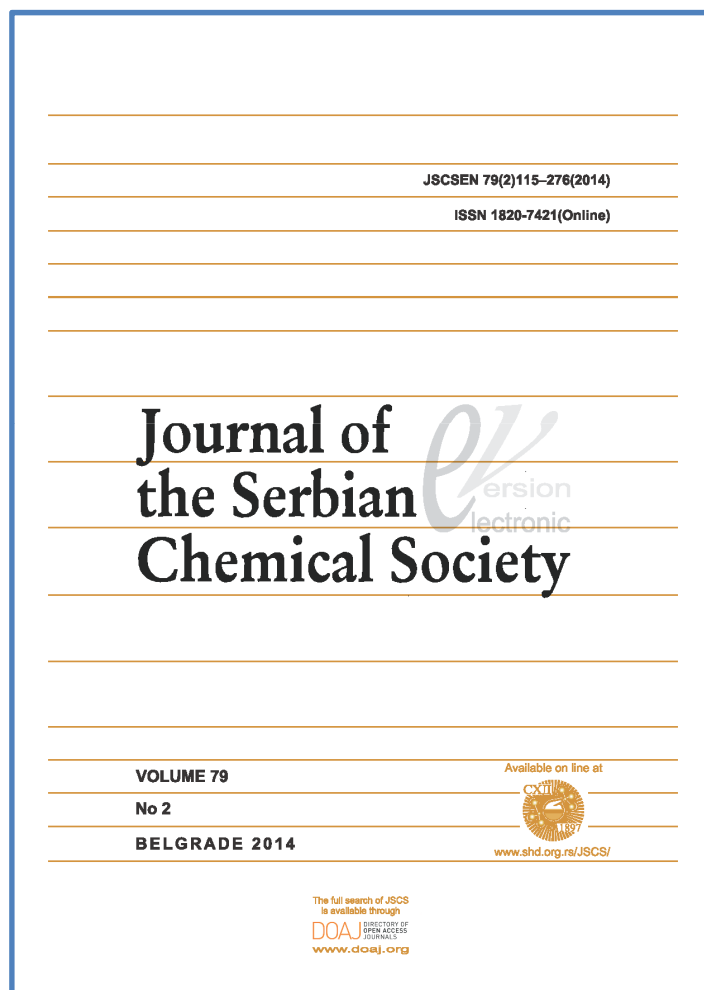
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## IN SHORT: WHAT HAS BEEN DONE?

- We have examined selected aspects of peer review in a scientific journal.
- We analysed a dataset containing information about 58 manuscripts submitted to the *Biochemistry and Biotechnology* section of the *Journal of the Serbian Chemical Society*.
- Data were provided by Prof. Olgica Nedic (sub-editor in the journal).
- Some interesting findings were obtained from this approach, which can be used as a starting point for realistic agent-based models of peer-review:
  - In particular, we separated the peer review process into stages that each review has to go through, and use a weighted directed diagrams to describe it in a probabilistic manner.
  - We have identified two classes of reviewers (known and other) who behave quite differently, when they interact with the editor.
- Finally, we have tested the impact of some modifications of the editorial strategy on the efficiency of the whole review process.

# REAL DATA



8 information about the review process of **58 manuscript** submitted to **one of the editors of JSCS** between November 2011 and July 2014

58 manuscripts = **323 reviewers**

323 reviewers = 323 realisations of the review process as related to single reviewers

323 reviewers = **65 known + 258 other**

**known:** personally known by editor

**other:** e.g. picked up from SCOPUS database as experts in a topic of the submitted manuscript.

Number of reviewers invited to review one manuscript:  $323/58 \approx 5$

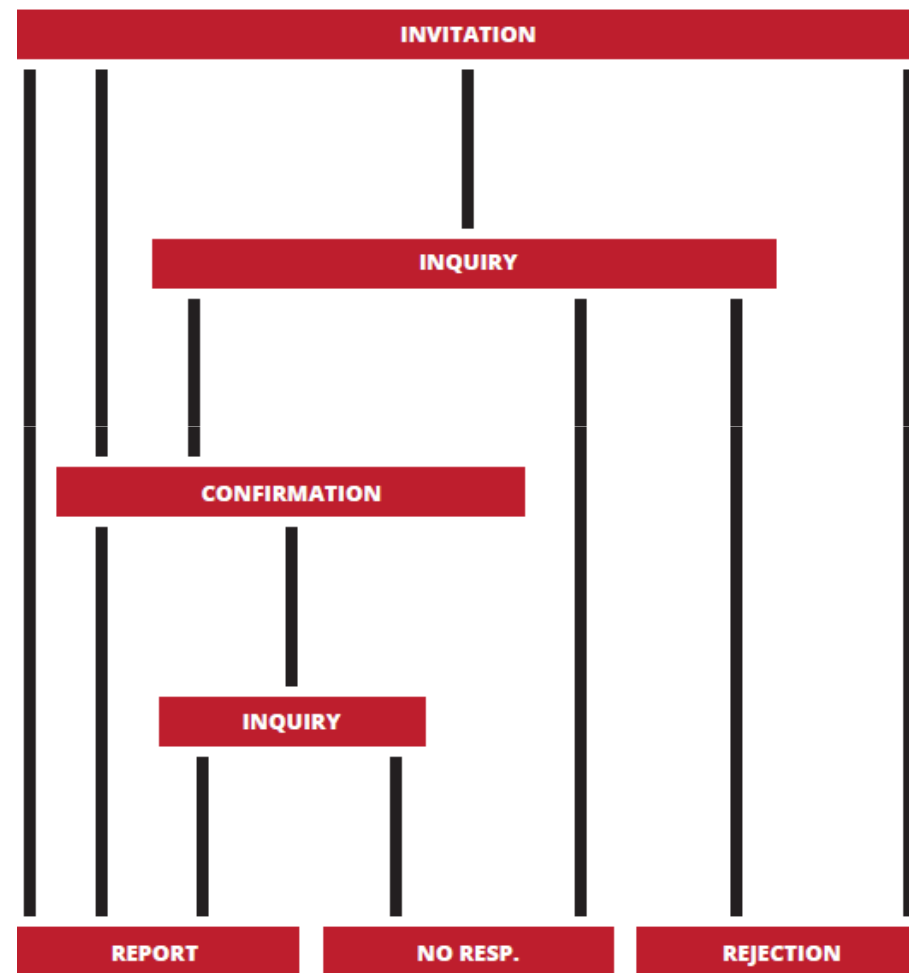
$5 = 1 \text{ known} + 4 \text{ other}$

# PHASES OF THE REVIEW PROCESS

Review process which is related to a single manuscript can be treated as consisting of *independent threads*, which relate to *separate reviewers*.

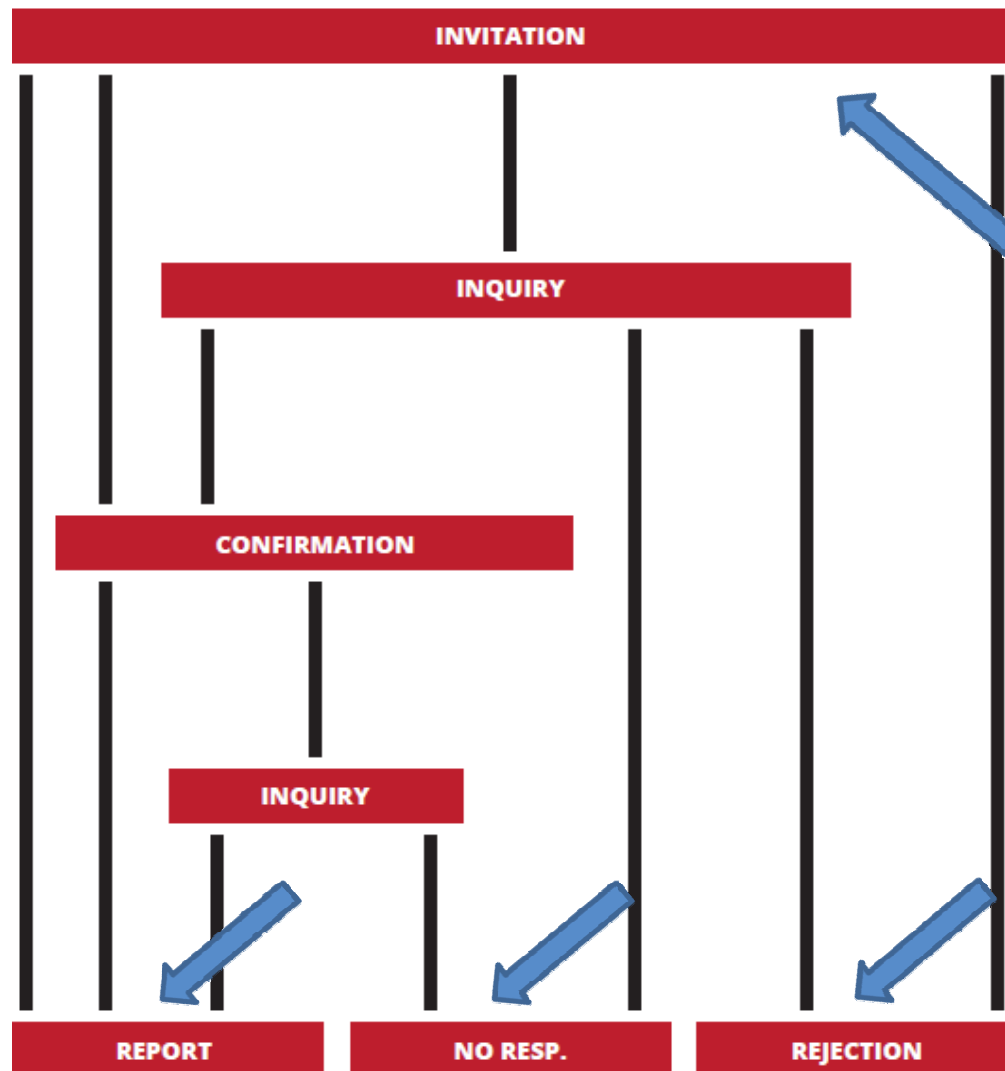
For a single reviewer the process is itself separable into *distinct phases which illustrate interactions* between the editor, authors, and the reviewer.

**The diagram represents perspective of a single reviewer**



# FIRST PHASE OF THE REVIEW PROCESS (1)

The diagram represents perspective of a single reviewer



## Invitation:

The process starts when the editor receives a new submission and sends out invitation to a reviewer.

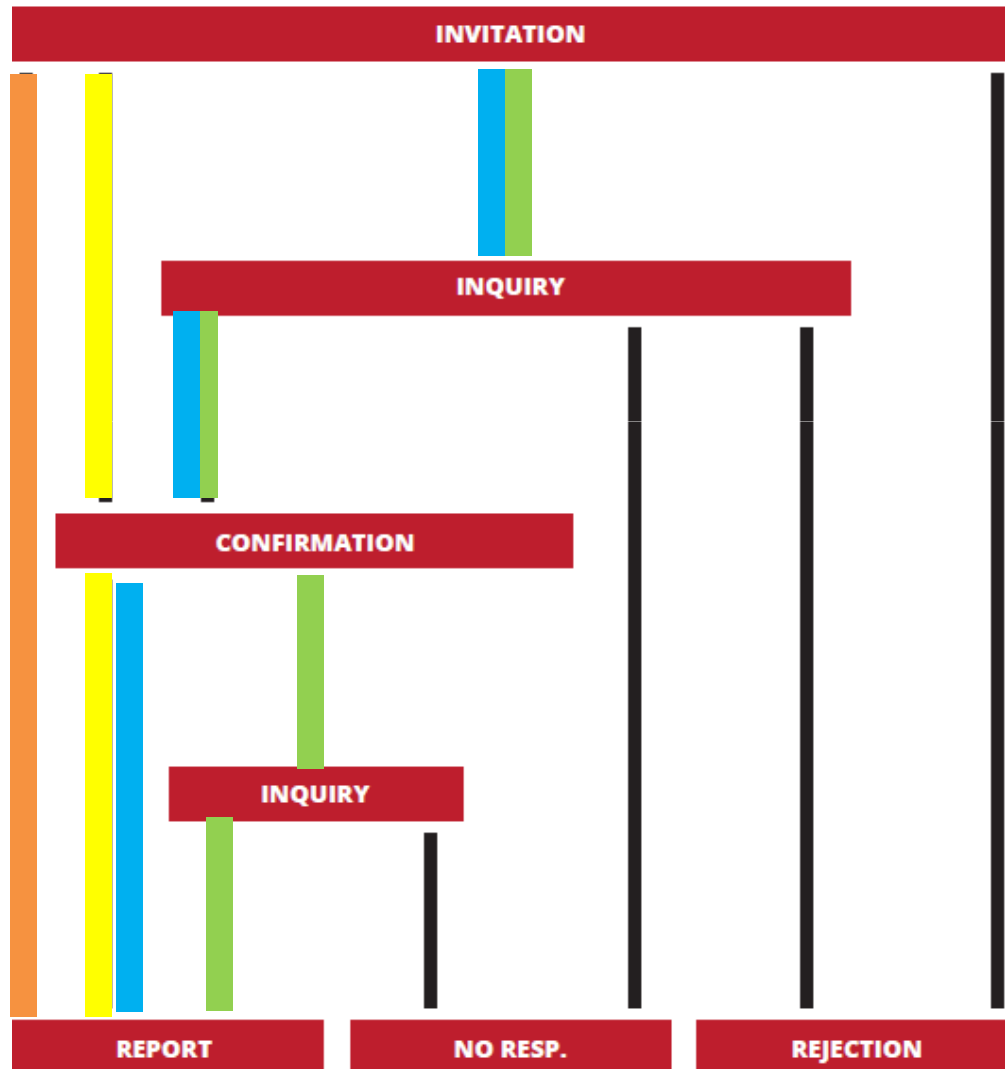
## Outcomes of the process

There are three possible outcomes of this process:

**Report,  
No Response,  
Rejection**

# FIRST PHASE OF THE REVIEW PROCESS (2)

The diagram represents perspective of a single reviewer



## Report:

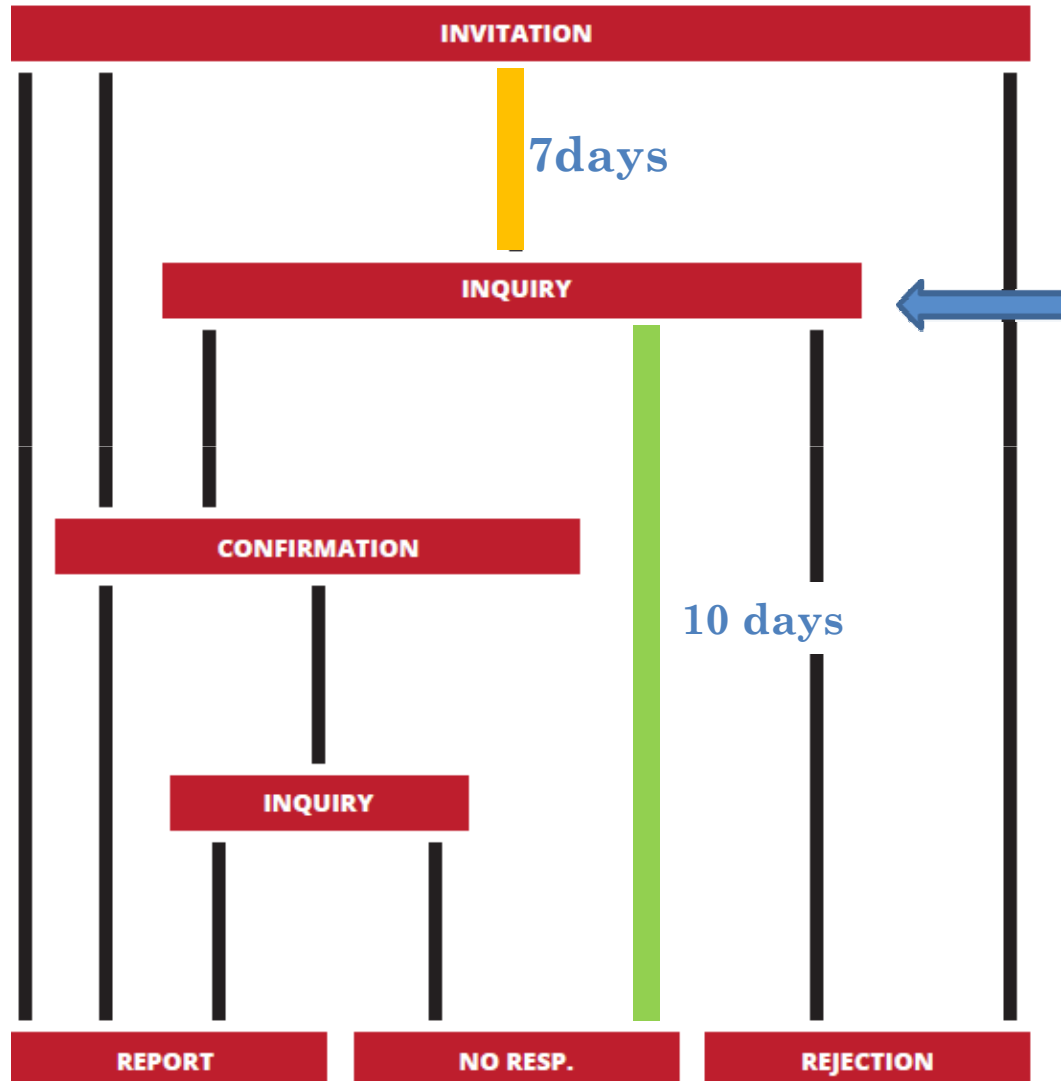
Sometimes it happens that the report comes quickly without an inquiry

Sometimes it goes through Confirmation

Sometimes it goes through a series of Inquiries

# FIRST PHASE OF THE REVIEW PROCESS

The diagram represents perspective of a single reviewer



## Inquiry

If the invited referee does not respond, then after 7 days an inquiry is sent.

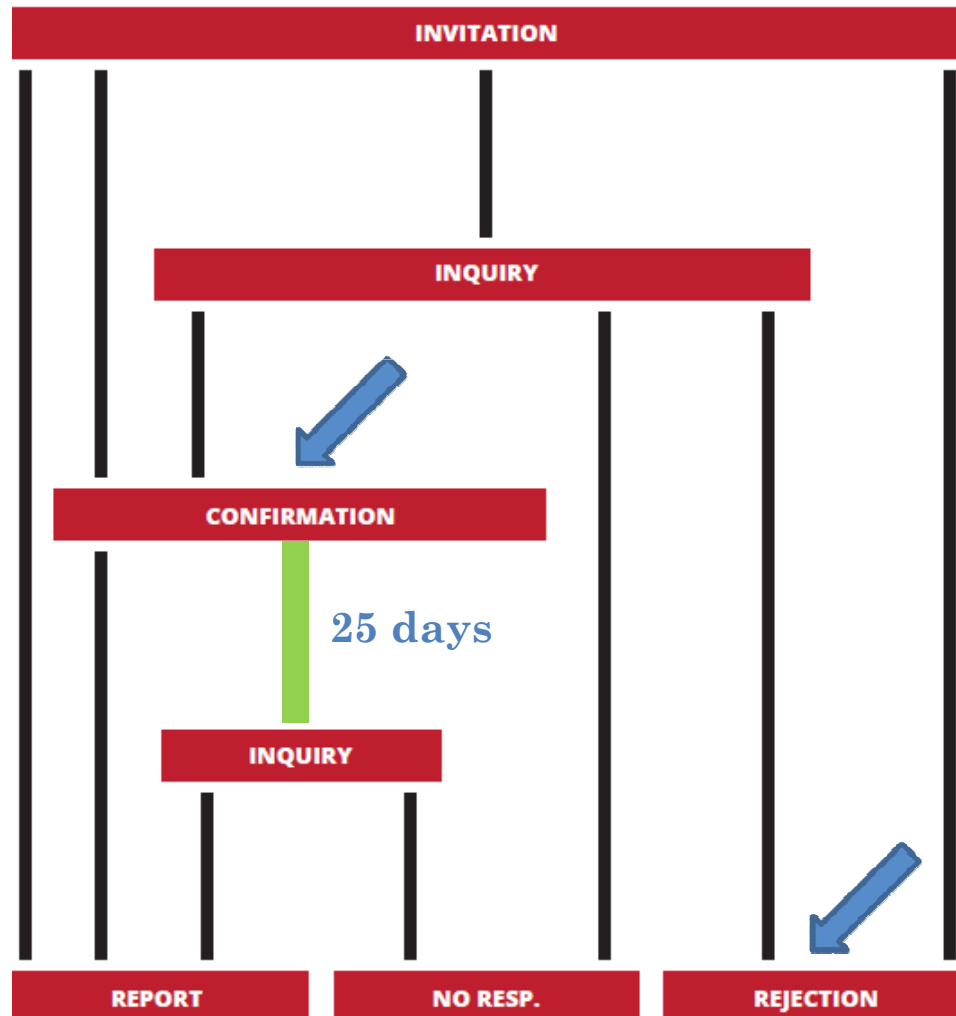
If the inquiry is also without an answer then after 10 days the process is considered finished with the negative outcome:

No response



# FIRST PHASE OF THE REVIEW PROCESS

The diagram represents perspective of a single reviewer



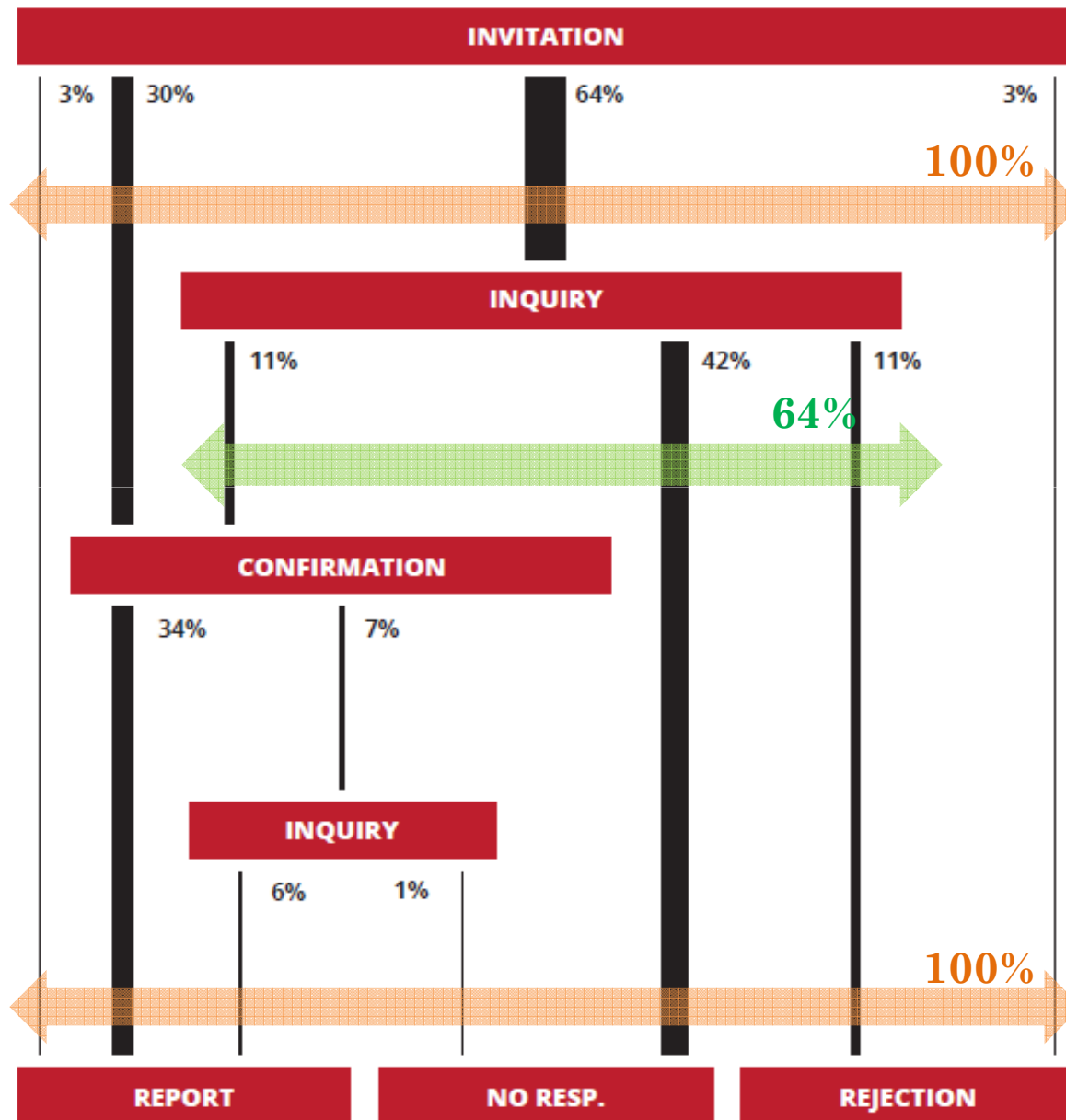
## Confirmation and Rejection:

Reviewers who answer either confirm their willingness to write the report or refuse.

In the former case, the editor waits for the report 25 days before sending the second inquiry.

# PEER REVIEW IN NUMBERS: **ALL REVIEWERS**

(averaged over the sample of 323 reviewers)



Next to each edge are **probabilities of realisation** of the process passing through the edge.

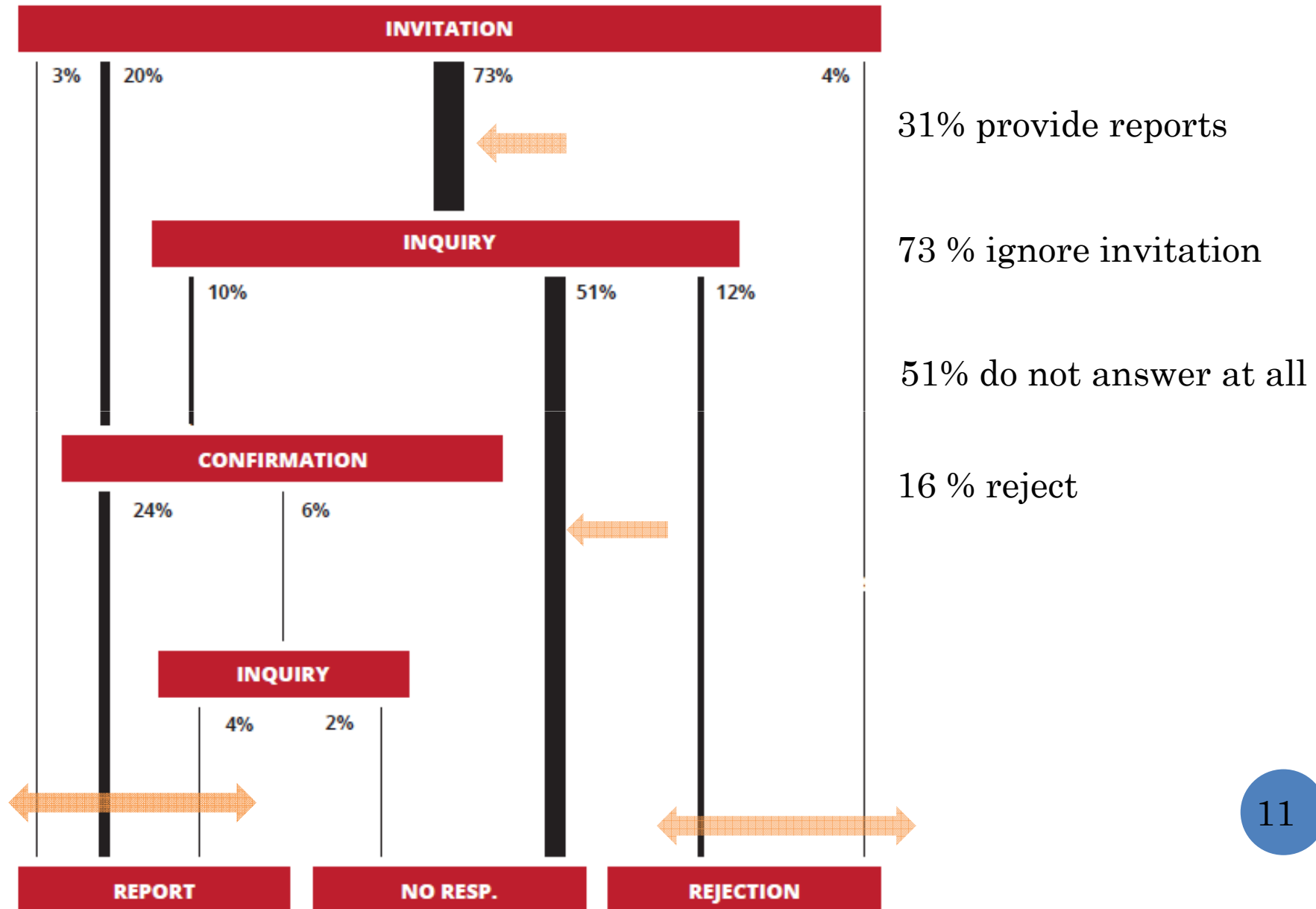
At each level probabilities of all edges sum up to 100%.

Only **43%** of all the invitations resulted in **receiving the report**

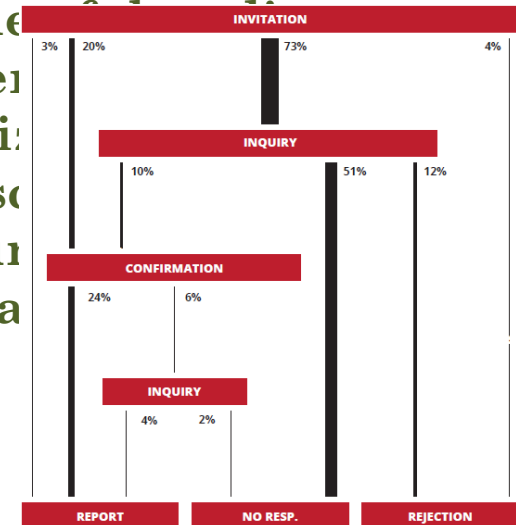
**64%** of reviewers **do not respond** the initial invitation.

# PEER REVIEW IN NUMBERS: **OTHER REVIEWERS**

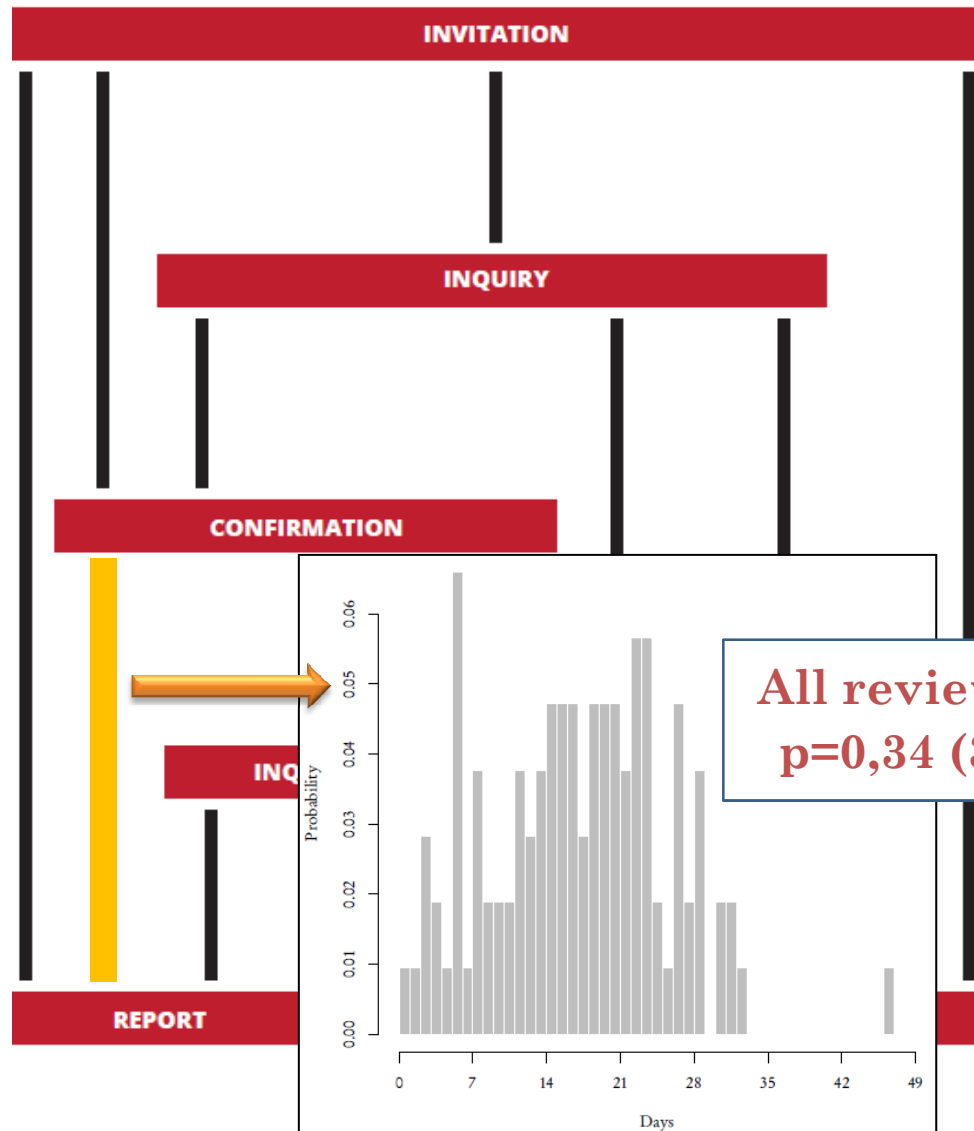
(258 reviewers)



(65 reviewers)



# DISTRIBUTION OF DURATIONS OF EACH LINE

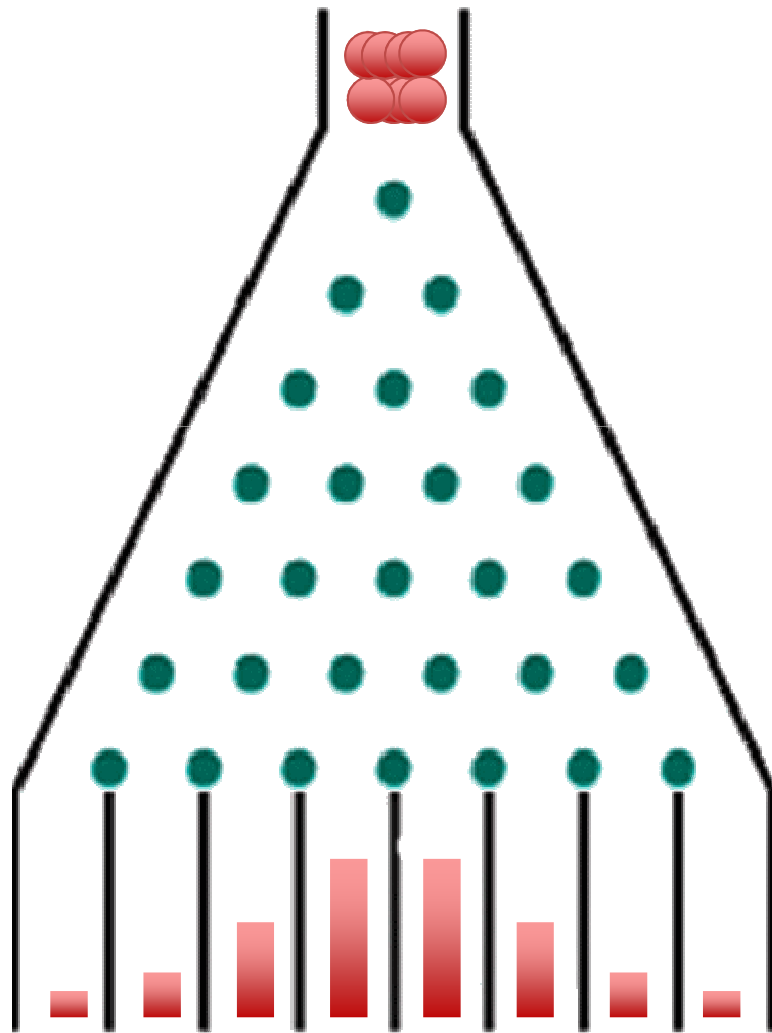


The data we have, contain information about **the beginning and end of each phase.**

Therefore, we were able to acquire **partial time distributons for all lines** in the diagram and for different types of reviewers.

**All reviewers  
 $p=0,34$  (34%)**

# PRIMER IN STATISTICS: GALTON'S BOARD



A Galton's board consists of a pyramidal arrangement of pegs and a row of bins at the bottom.

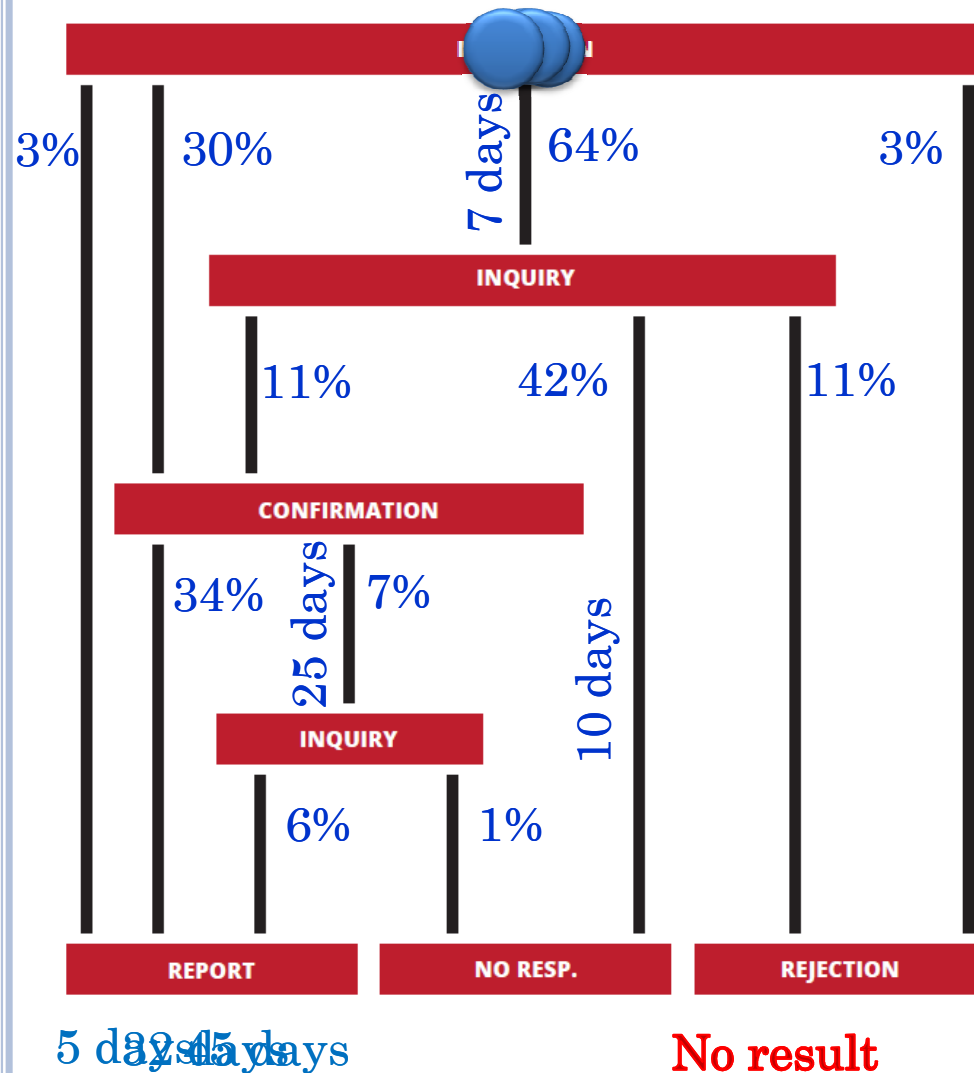
Balls are dropped onto the top peg and travel toward the bins.

At each peg, there is a 50 % chance of moving left or right.

The balls in the bins approximate a bell-curve distribution.

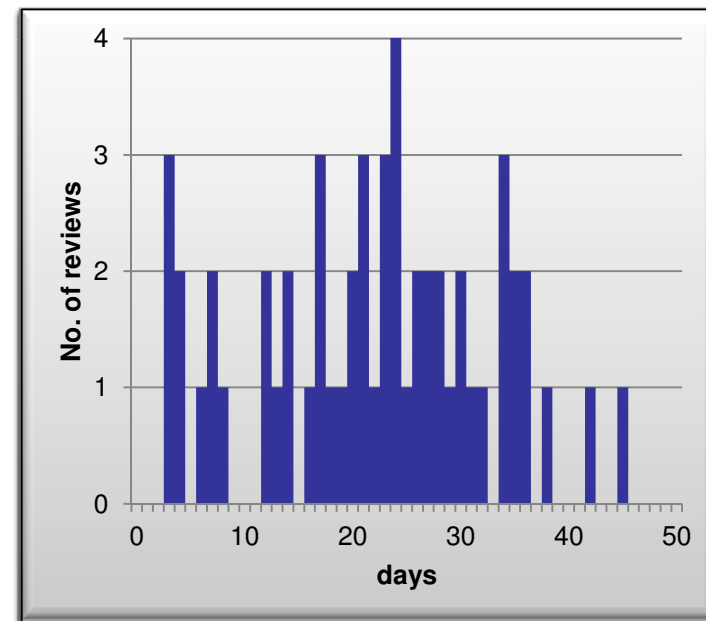
# DIAGRAMS AS GALTON'S BOARDS

A ball corresponds to review process as realized by a single reviewer.



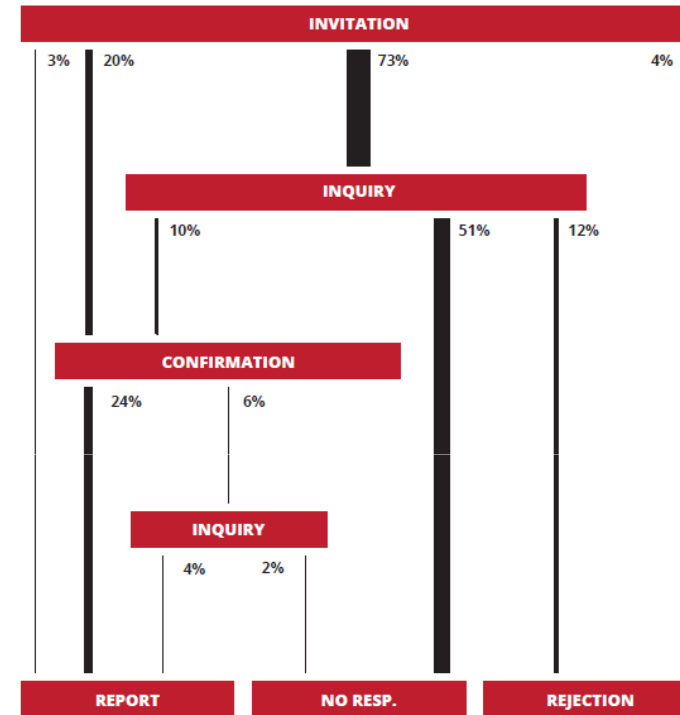
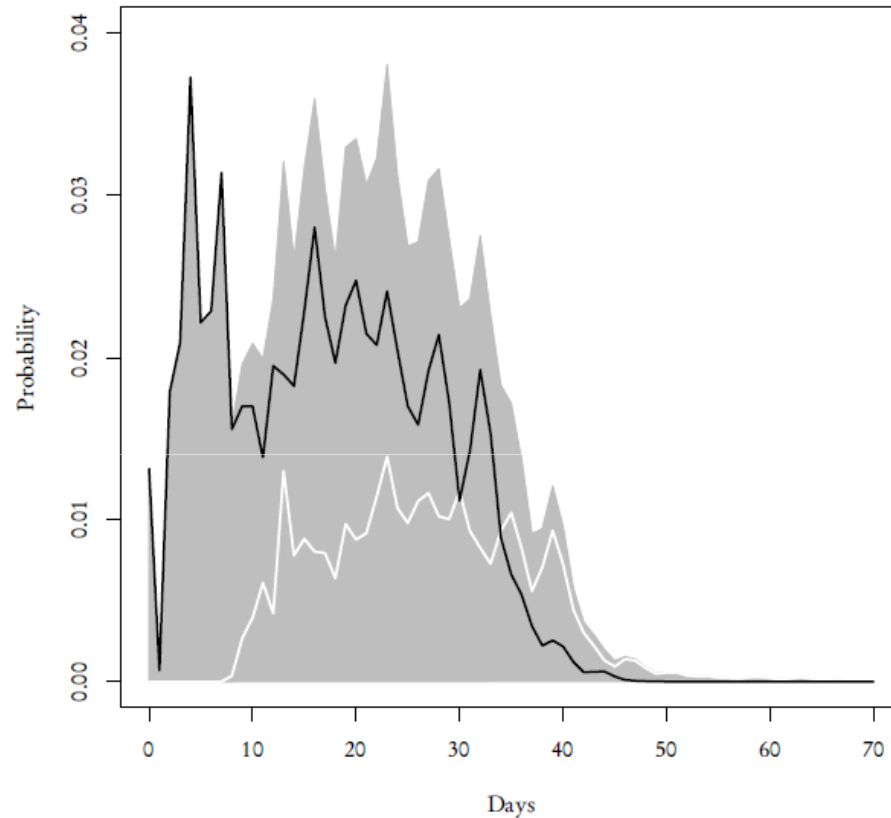
Non uniform choice probabilities

Non uniform time passages  
(here we use the concept of  
*partial time distributions*)



# REVIEW TIMES: OTHER REVIEWERS

theoretical distribution from Galton's like process



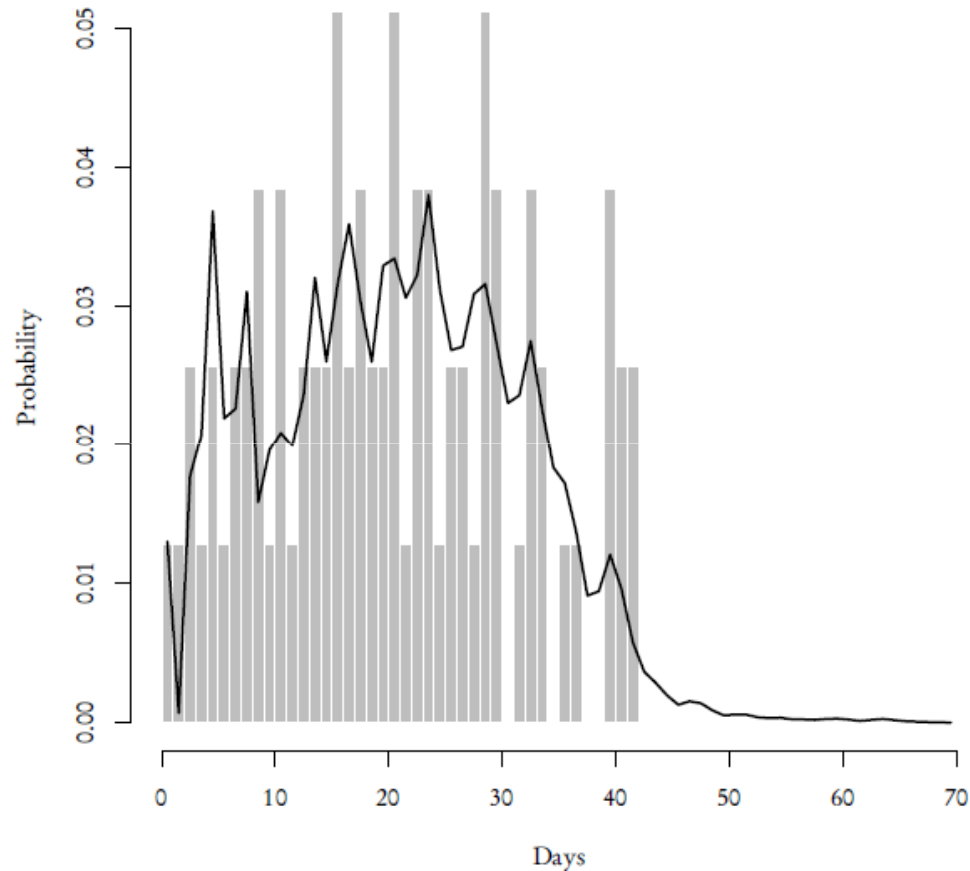
## Theoretical probability distribution of review time for other reviewers:

Black line: Reviewers who responded the initial invitation,  
White line: Reviewers who received an inquiry,  
Filled polygon: All other reviewers who delivered a report



## REVIEW TIMES: OTHER REVIEWERS

real data vs. theoretical distribution (memoryless process)



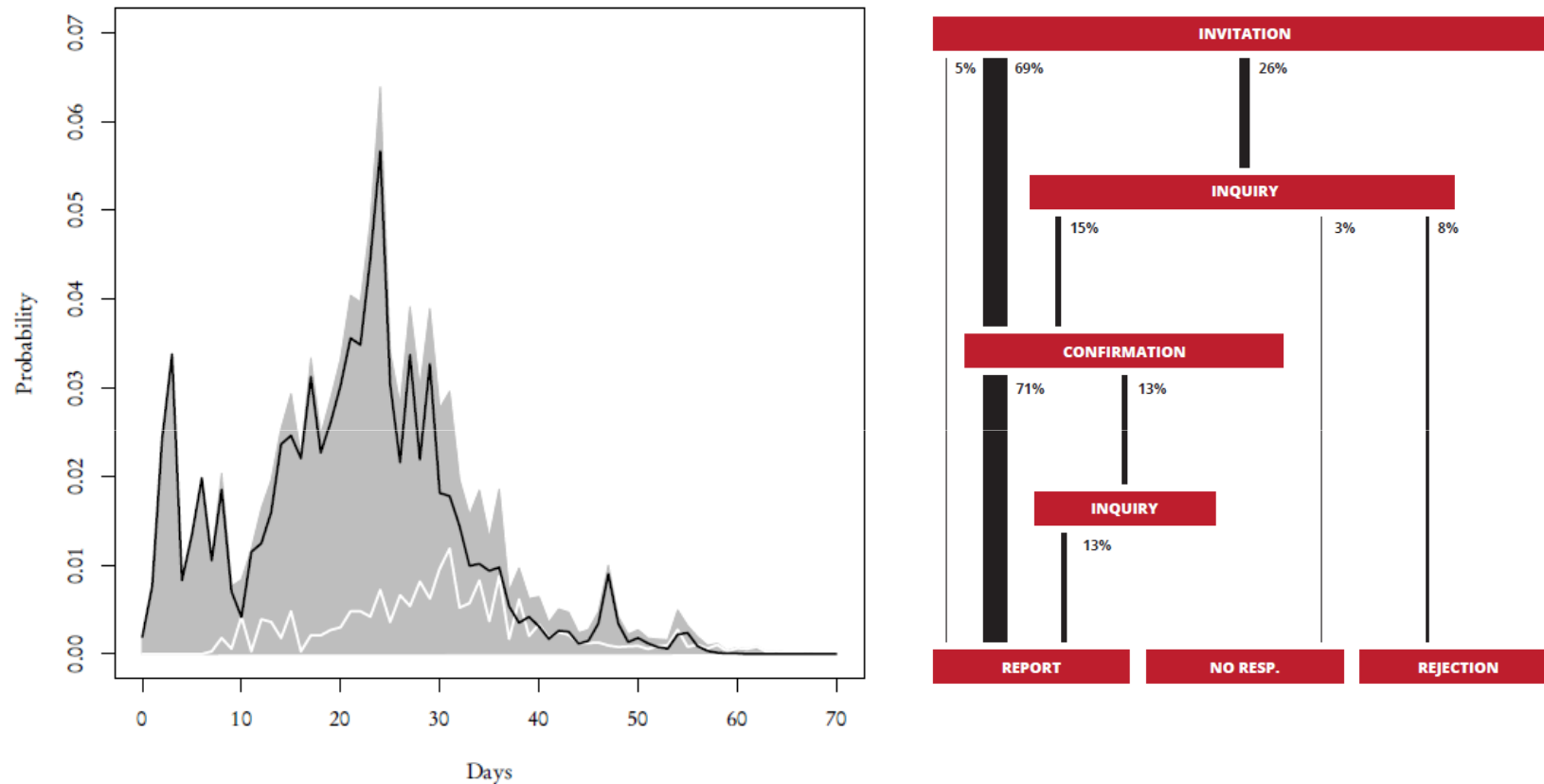
**Probability distribution of review time for other reviewers:**

Grey bars: real data,

Black line: theoretical distribution from the Galton's like process.

# REVIEW TIMES: KNOWN REVIEWERS

theoretical distribution from Galton's like process

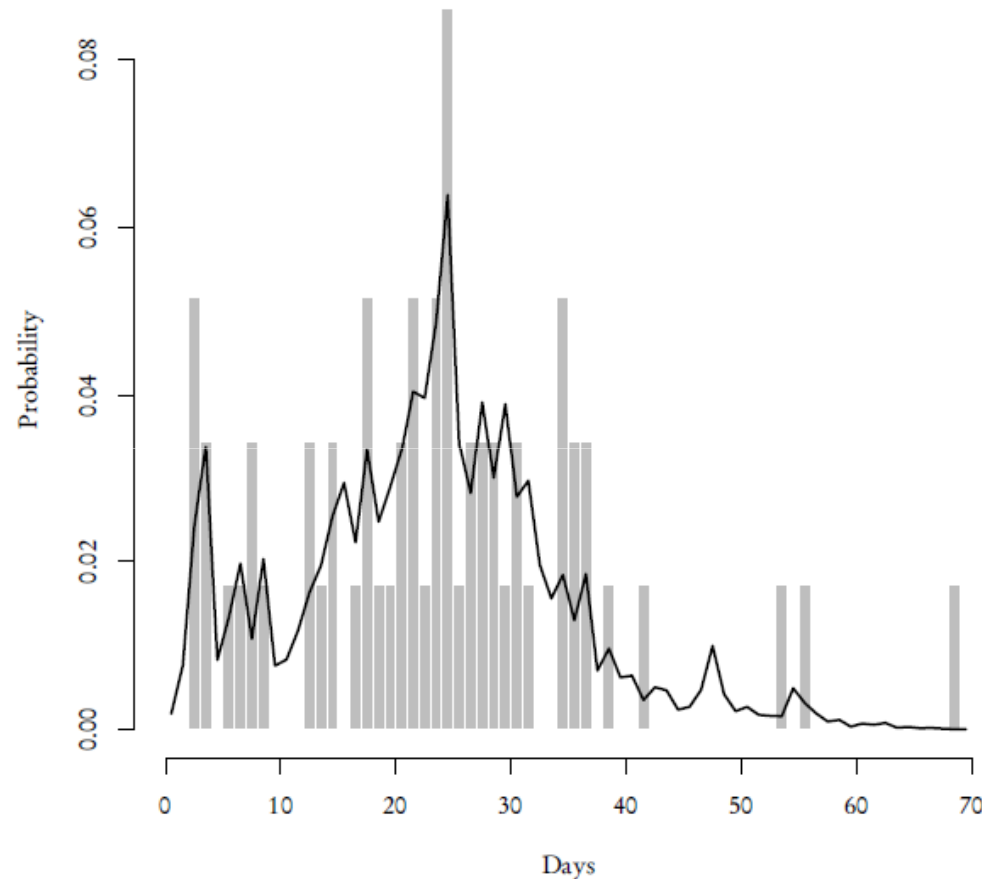


## Theoretical probability distribution of review time for known reviewers:

Black line: Reviewers who responded the initial invitation,  
White line: Reviewers who received an inquiry,  
Filled polygon: All known reviewers who delivered a report

# REVIEW TIMES: KNOWN REVIEWERS

real data vs. theoretical distribution (memoryless process)



**Probability distribution of review time for known reviewers:**

Grey bars: real data,

Black line: theoretical distribution from the diagram.

# SINGLE REVIEWER

## SUMMARY OF STATISTICAL DATA

Distributions of review times given that the report was provided

Completion rate for  
**Other reviewers** is 31%

Completion rate for  
**Known reviewers** is 89%

From any practical standpoint and from the perspective of statistical tests (e.g. two-sample Kolomogorov-Smirnow test)

**the two distributions are almost the same!**

**Completion rate is the leading factor which distinguishes known reviewers from the other reviewers.**

- Minimum time: 0 days
- Maximal time: 71 days
- Anerage time: 20 days
- Median: 20 days
- Standard deviation: 11 days

- Minimum time: 0 days
- Maximal time: 88 days
- Anerage time: 23 days
- Median: 23 days
- Standard deviation: 12 days

# SIMULATIONS OF THE REVIEW PROCESS (1)

So far we have considered review times for single reviewers.

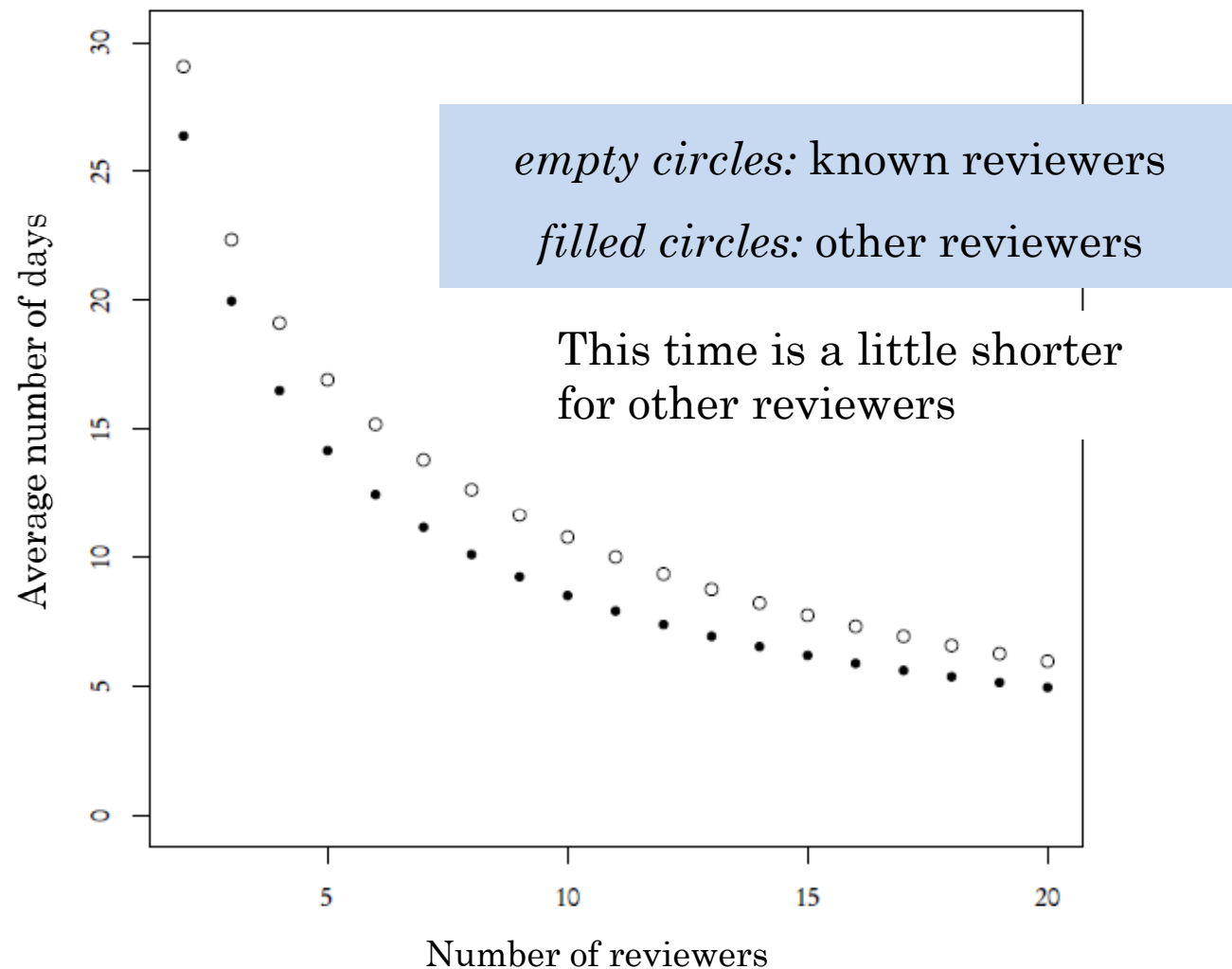
Editors usually need more than one review to judge whether to publish an article.

In the case of JSCS, the editor required 2 reviews per article and sent invitations to 5 reviewers on average (1 known + 4 other)

*In the case of this editorial strategy results were the following:*

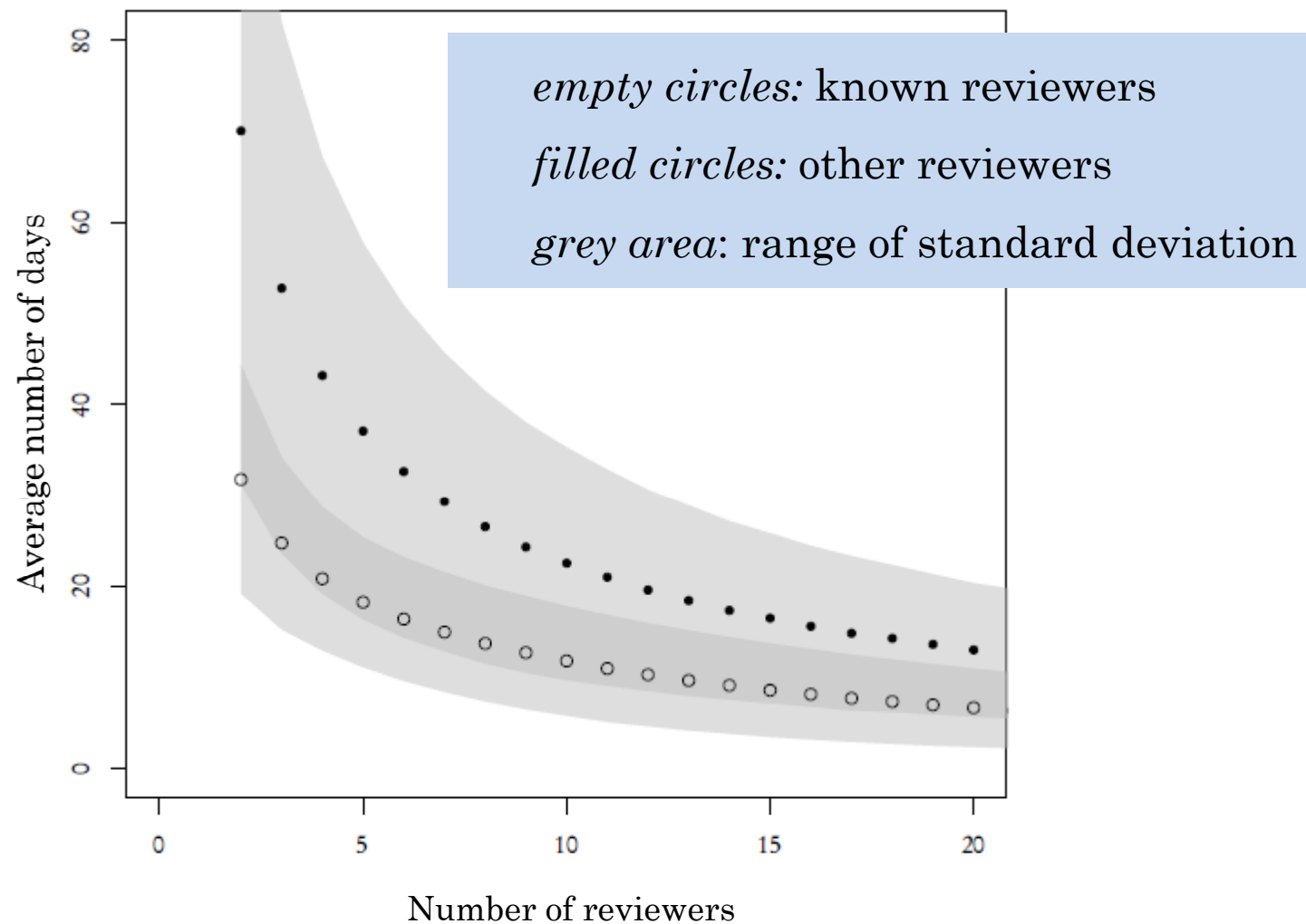
- *average number of reports per article = 2.34*
- *9 papers were published after receiving 1 report;*
- *24 with 2 reports;*
- *21 with 3 reports;*
- *4 with 4 reports;*

## SIMULATIONS OF THE REVIEW PROCESS (2)



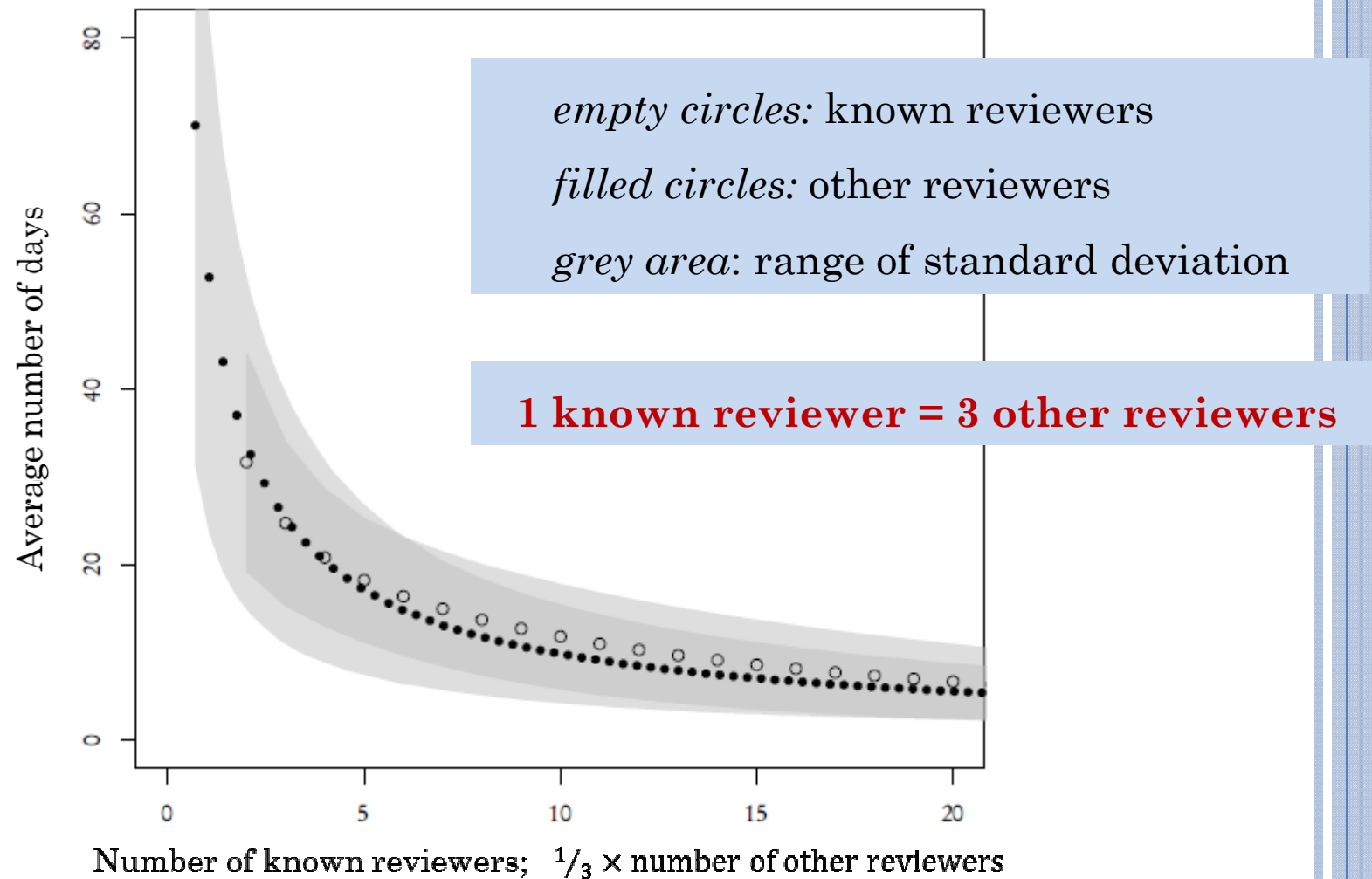
Average time of acquiring **2 reports** given that **all reviewers finish their reviews**, i.e. the completion rate is 100%;

## SIMULATIONS OF THE REVIEW PROCESS (3)



Average time of collecting **two reports with the completion rate taken into account**, i.e. 89% for known reviewers and 31% for other;

## SIMULATIONS OF THE REVIEW PROCESS (4)



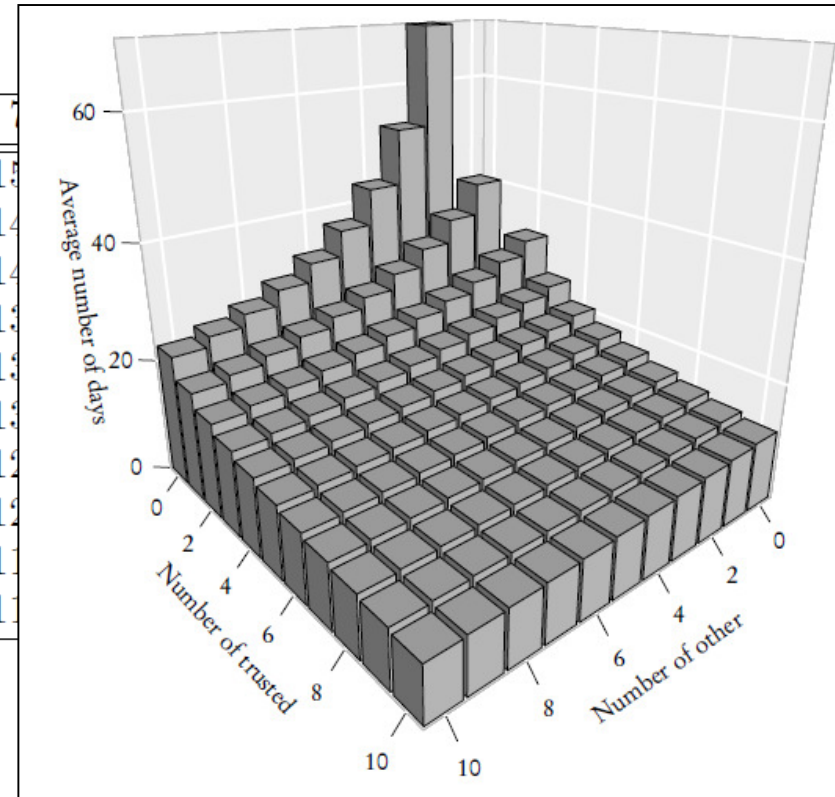
Average time of collecting **two reports with the completion rate taken into account**, i.e. 89% for known reviewers and 31% for other;



## SIMULATIONS OF THE REVIEW PROCESS (5)

- So far we have studied separately known and other reviewers.
- However, the group of reviewers invited to review a manuscript usually contains both types of reviewers.

		number of known reviewers							
		0	1	2	3	4	5	6	7
number of other reviewers	0	X	X	32	25	21	18	16	15
	1	X	42	29	23	20	17	16	14
	2	70	37	27	22	19	17	15	14
	3	53	33	25	20	18	16	15	13
	4	43	29	23	19	17	15	14	13
	5	37	27	22	18	16	15	14	13
	6	33	25	20	17	16	14	13	12
	7	29	23	19	17	15	14	13	12
	8	26	21	18	16	14	13	12	11
	9	24	20	17	15	14	13	12	11



Average number of days needed to collect 2 reports from a group of mixed reviewers (completion rate 100%).

# NEW IDEAS

## 1. Editorial strategies

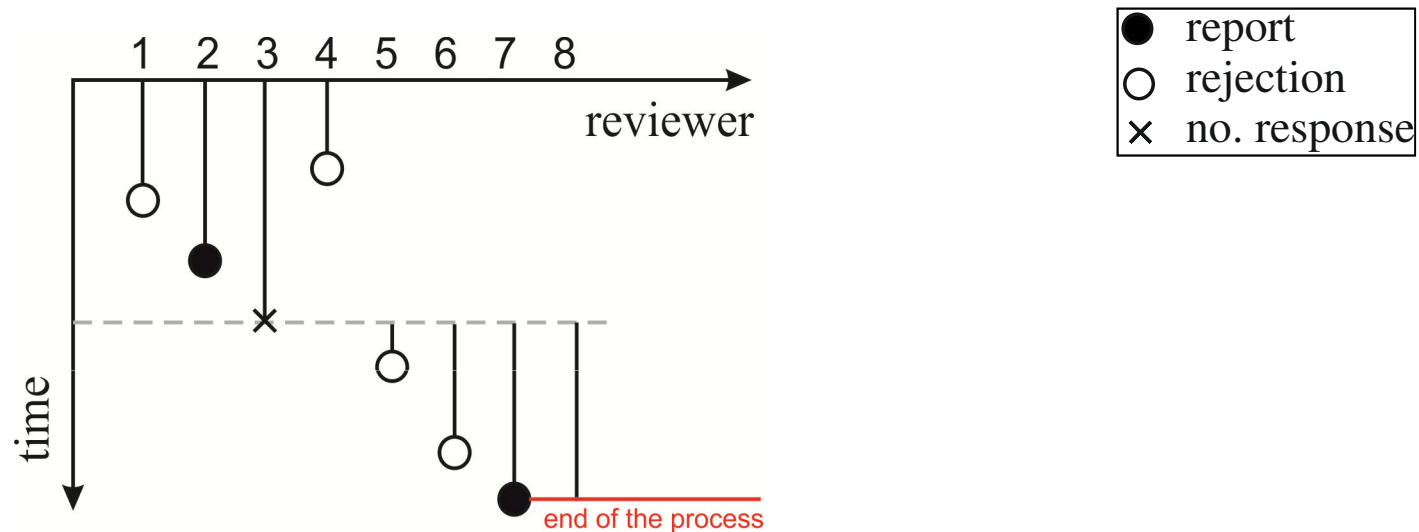
- How to improve efficiency of the review process?
- How to shorten review times?

## 2. New data on the review process in other journals would be very useful.

- Is the assumption about the same time distribution for both types of reviewers reasonable?
- How the IF of the journal influences the completion rate for other reviewers?

# EDITORIAL STRATEGIES (1)

Strategy I. „WAIT”



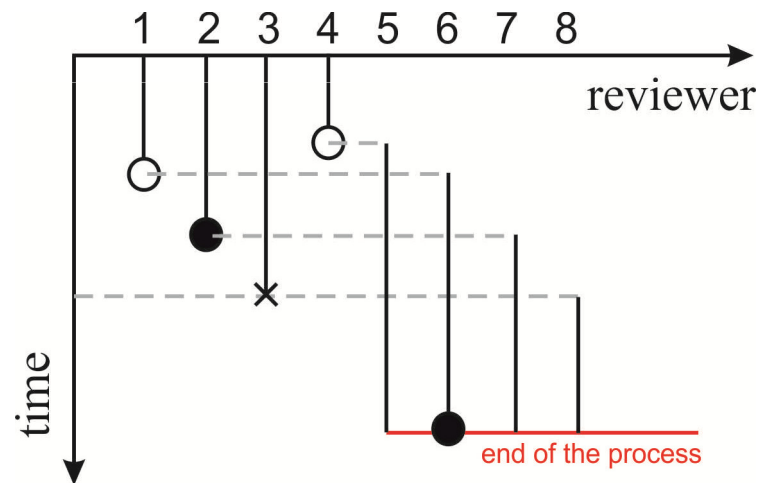
Editor sends invitations in batches and waits until all the threads of the batch will not be completed.

The process is considered to be finished when two reviews are delivered.

## EDITORIAL STRATEGIES (2)

### Strategy II. „DON'T WAIT”

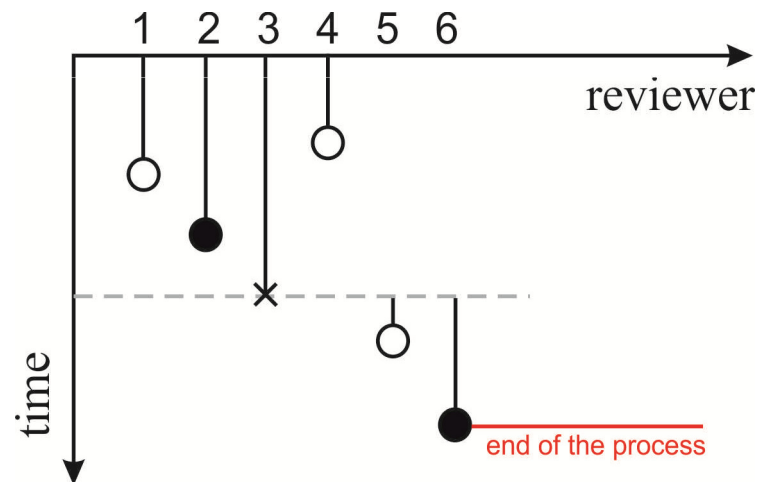
Send invitations to keep the number of invitations in progress constant.



## EDITORIAL STRATEGIES (3)

### Strategy III. „WAIT LIMITED”

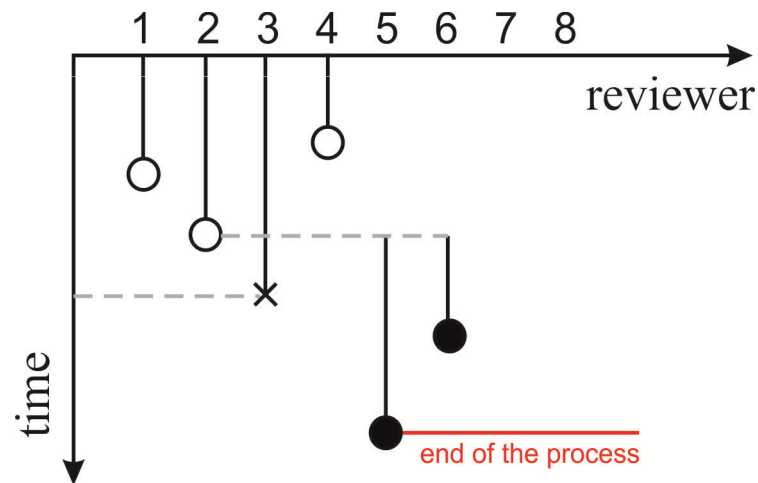
Send invitations in batch. No. of invitations in batch - 2 x no. of reviews needed.



## EDITORIAL STRATEGIES (4)

### Strategy IV. „DON'T WAIT - LIMITED”

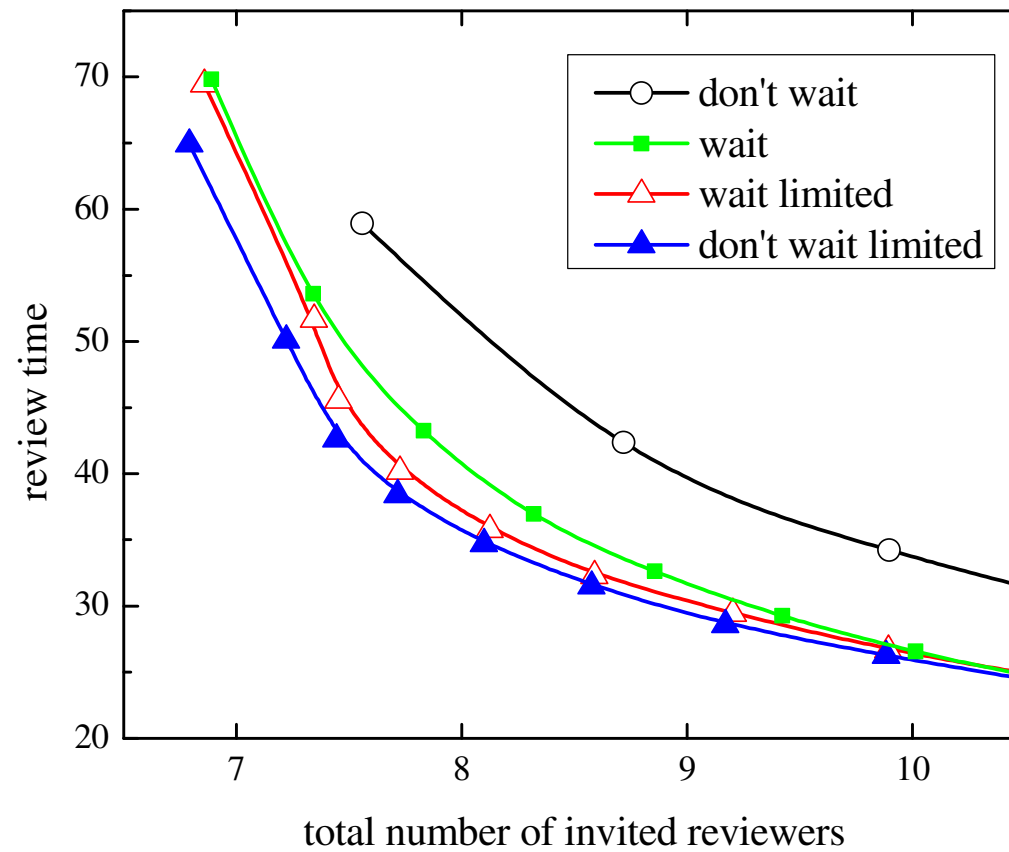
Send  $N$  new invitations if there is no chance to get two reviews.  $N = 2 \times$  no. of reviews needed assuming all invitations in progress will succeed.



- report
- rejection
- × no. response

# EDITORIAL STRATEGIES

## SIMULATION RESULTS



# EDITORIAL STRATEGIES

## NEXT STEPS

### 1. Mix **known** and **other** reviewers

Known reviewers are limited. One should use them wisely.

### 2. Apply artificial intelligence to develop better strategies

Too complex system to anticipate the best strategies.  
Genetic programming as a tool to evolve strategies

strategies  $\Leftrightarrow$  algorithms

„DON'T WAIT”

```
if (number_of_running_threads < batch_size) return 1
```

„WAIT”

```
if (number_of_running_threads == 0) return batch_size
```



**Thank you for your attention!**

