Using Appropriate Wear-leveling to Extend Product Lifespan

Presented by:
Bill Roman

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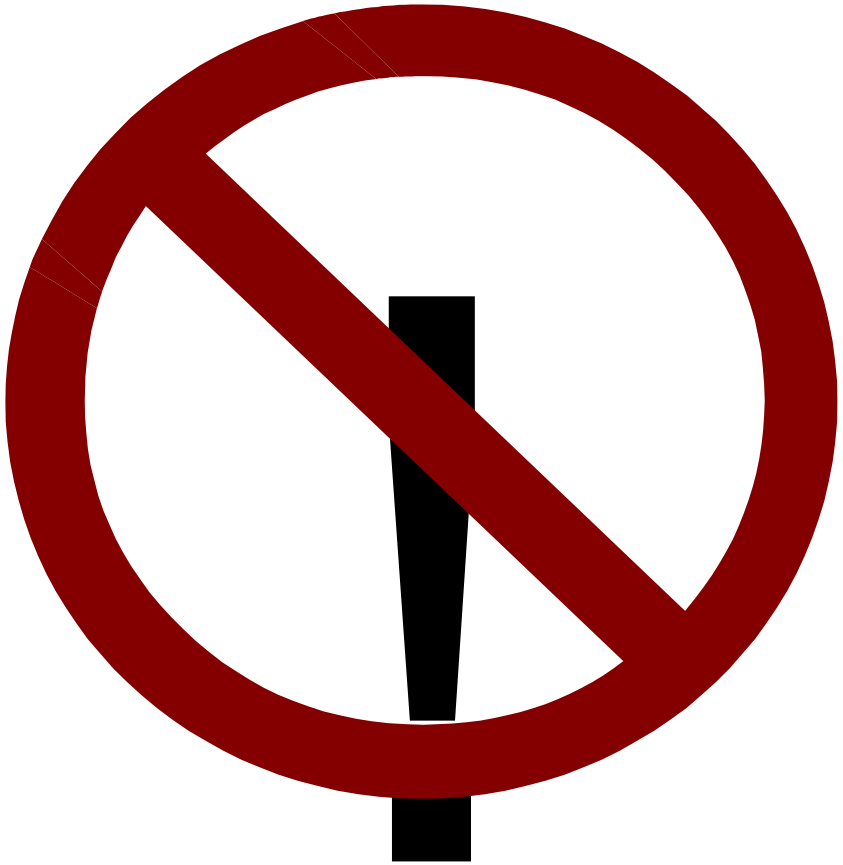

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Introduction

- Flash File Systems: Wear-leveling is achieved in a variety of ways by FFS
- Linux Offerings
  - JFFS & JFFS2
  - YAFFS & YAFFS2
  - UBIFS
  - Datalight FlashFX Pro + Any File System
  - Many others in development

Context:

- File System
- Not XiP
- We’re talking about NAND
- Dynamic read/write data storage
- Dynamic wear-leveling

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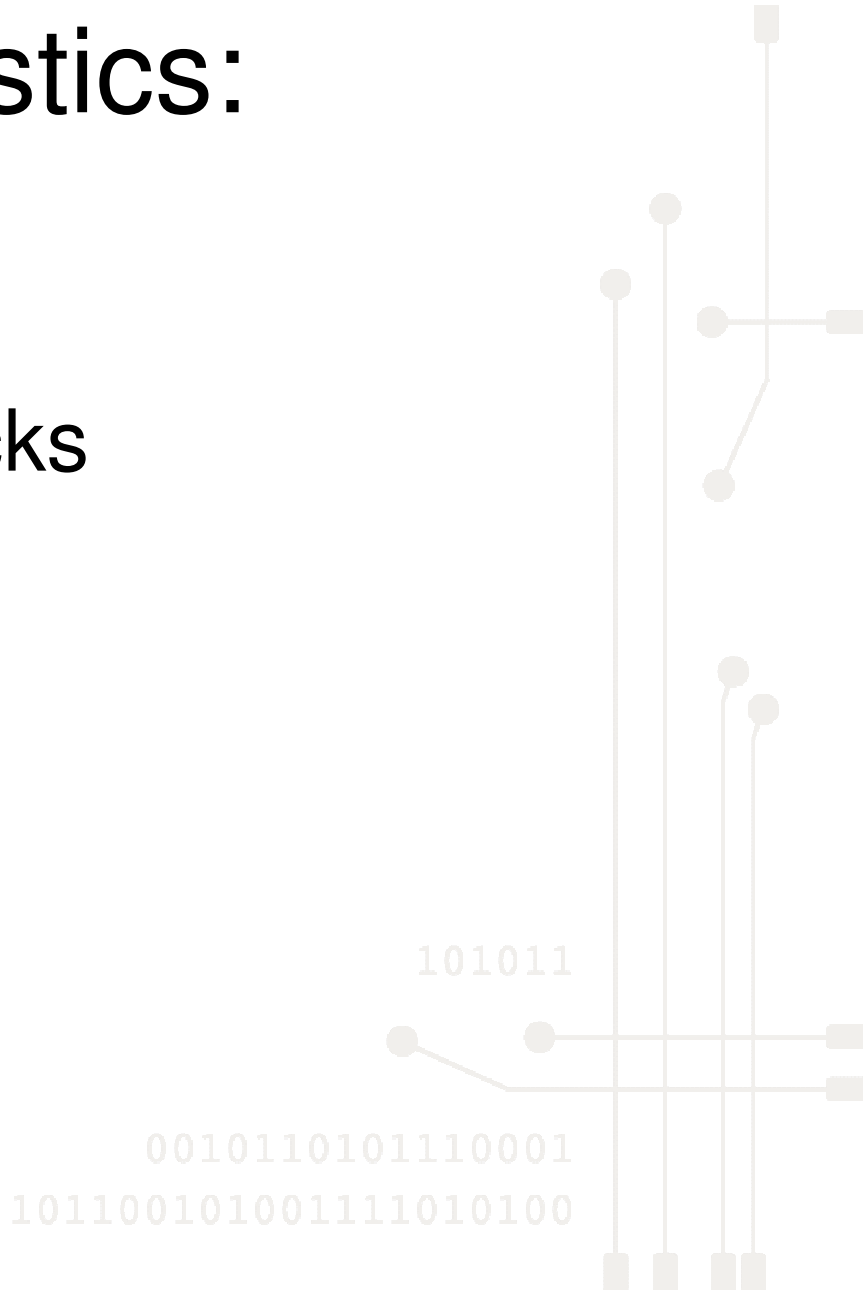
Flash Characteristics:

- Must erase large blocks
- It wears out



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Conventional File System on Flash

- Inefficient
- Not interruption-safe
- Hot spots
- Usable for read-only

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Conventional File System on Flash

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FIFO

- Original JFFS used this strategy
- Strictly linear
- “Perfect” wear-leveling

FIFO

Immediately after erasing

Erase Block

FIFO

A file is written

Erase Block

FIFO

Data in the file is modified

Erase Block

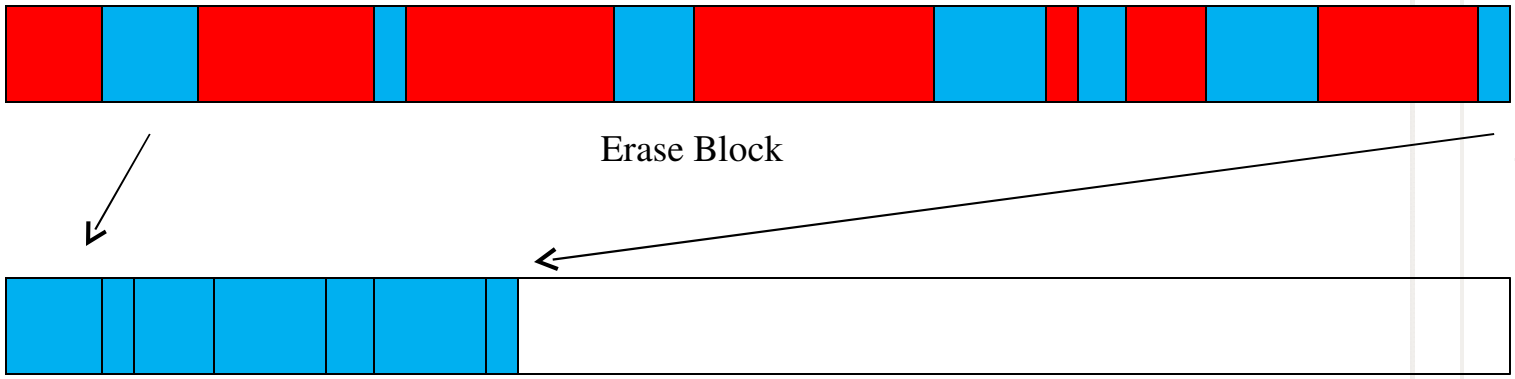
FIFO

More files are created, modified, deleted

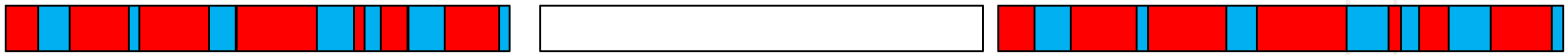
Erase Block

FIFO

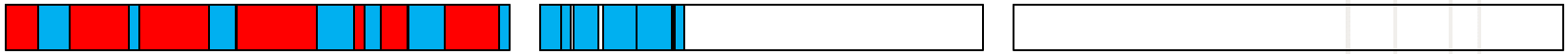
When the entire erase block is used, compact valid data into a free block



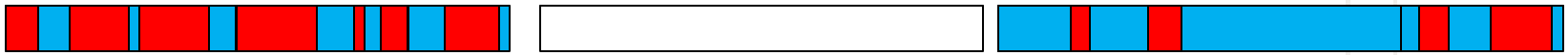
FIFO



Becomes



FIFO



Becomes

Effect of FIFO on flash life

$$\text{actual life} \approx \text{specified life} \cdot \left(1 - \frac{\text{static data size}}{\text{total flash size}}\right)$$

Balance “perfect” wear leveling against efficiency by occasionally moving static data.

64 MiB Simulated Flash

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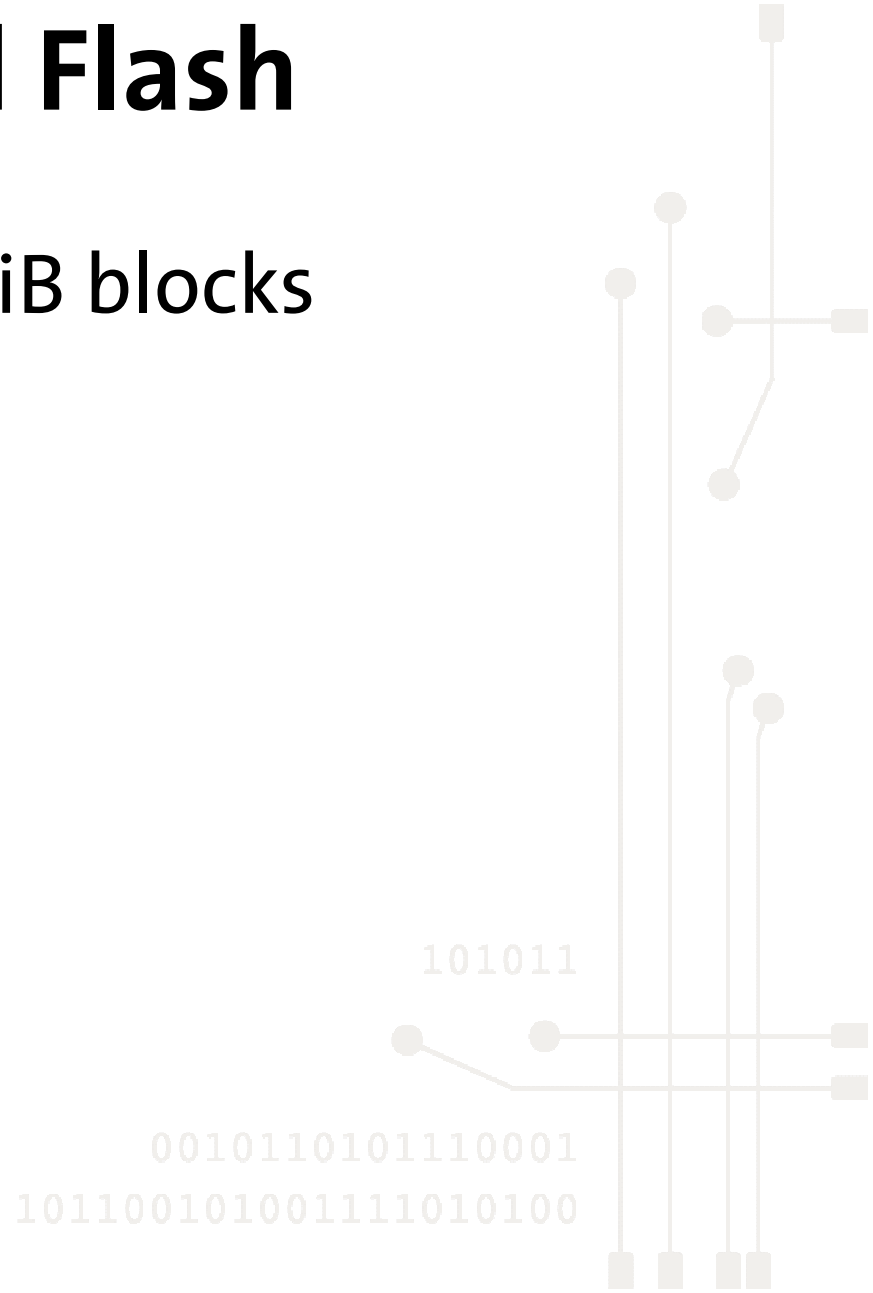
64 MiB Simulated Flash

- Small block: 4096 16 KiB blocks



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64 MiB Simulated Flash

- Small block: 4096 16 KiB blocks
- Large block: 512 128 KiB blocks

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10,000 is ...

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10,000 is ...

- A really big number!

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10,000 is ...

- A really big number!
- 10,000 days = about 27 years

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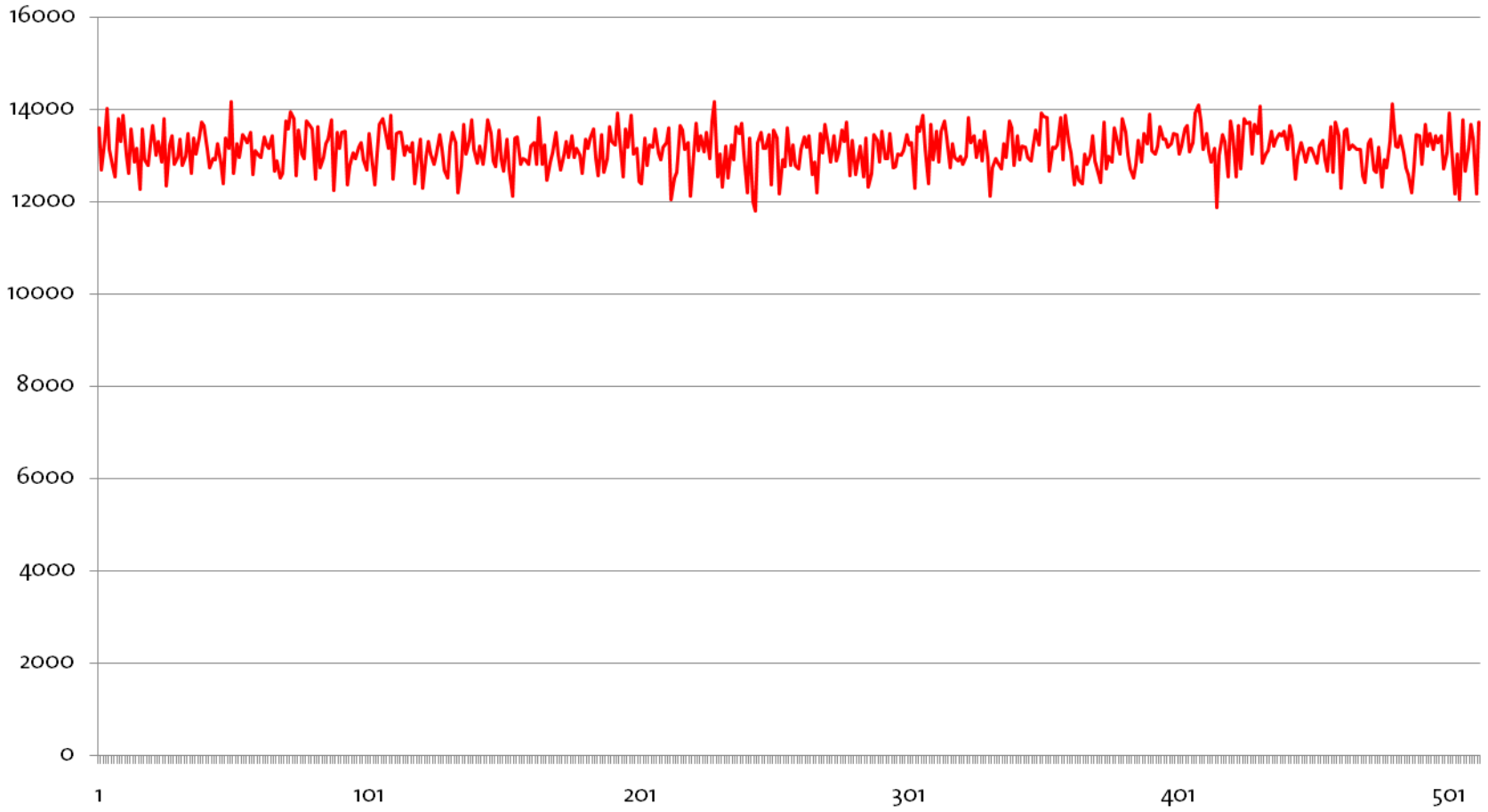
JFFS2 Large block 10% Static



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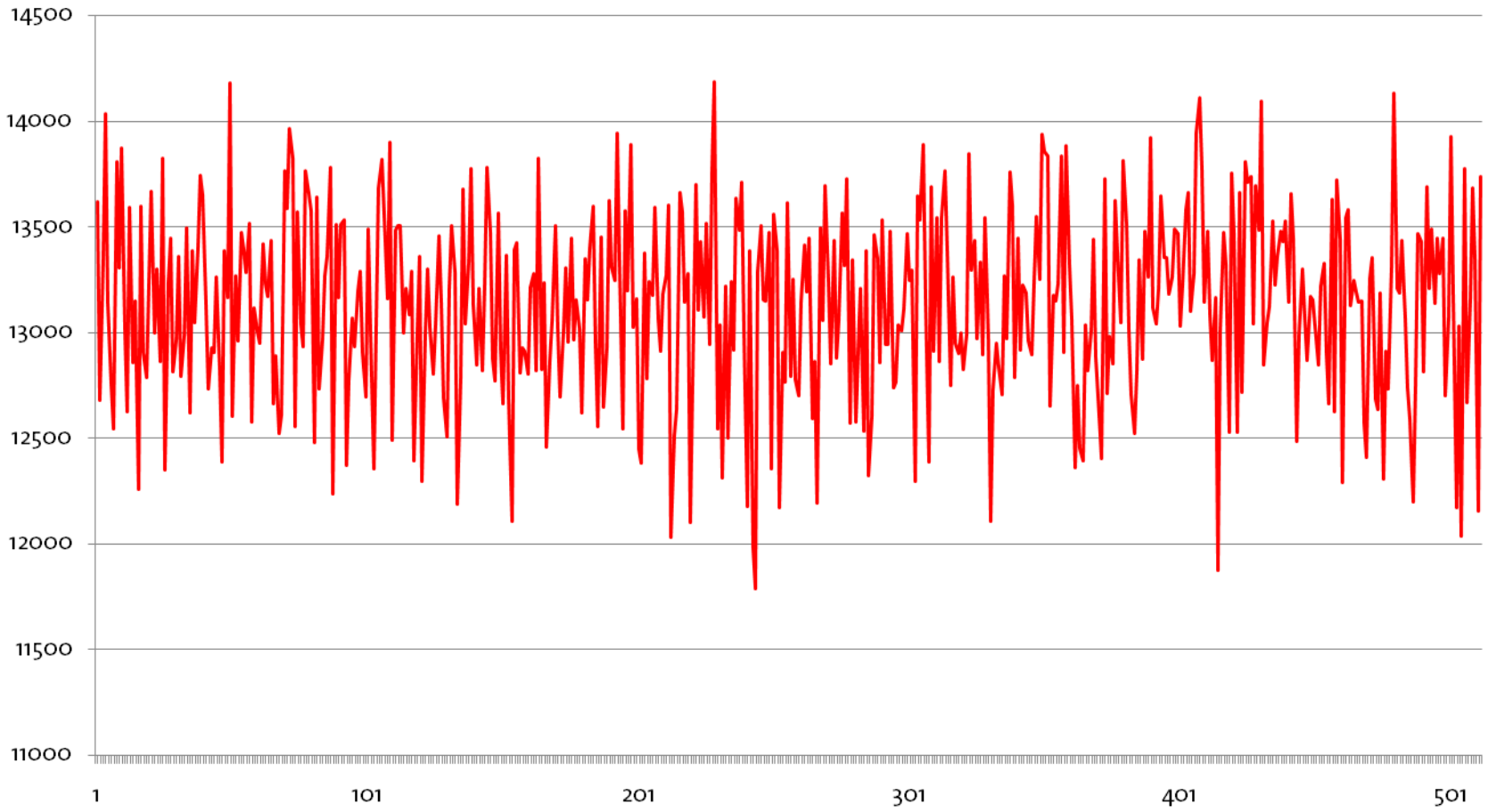

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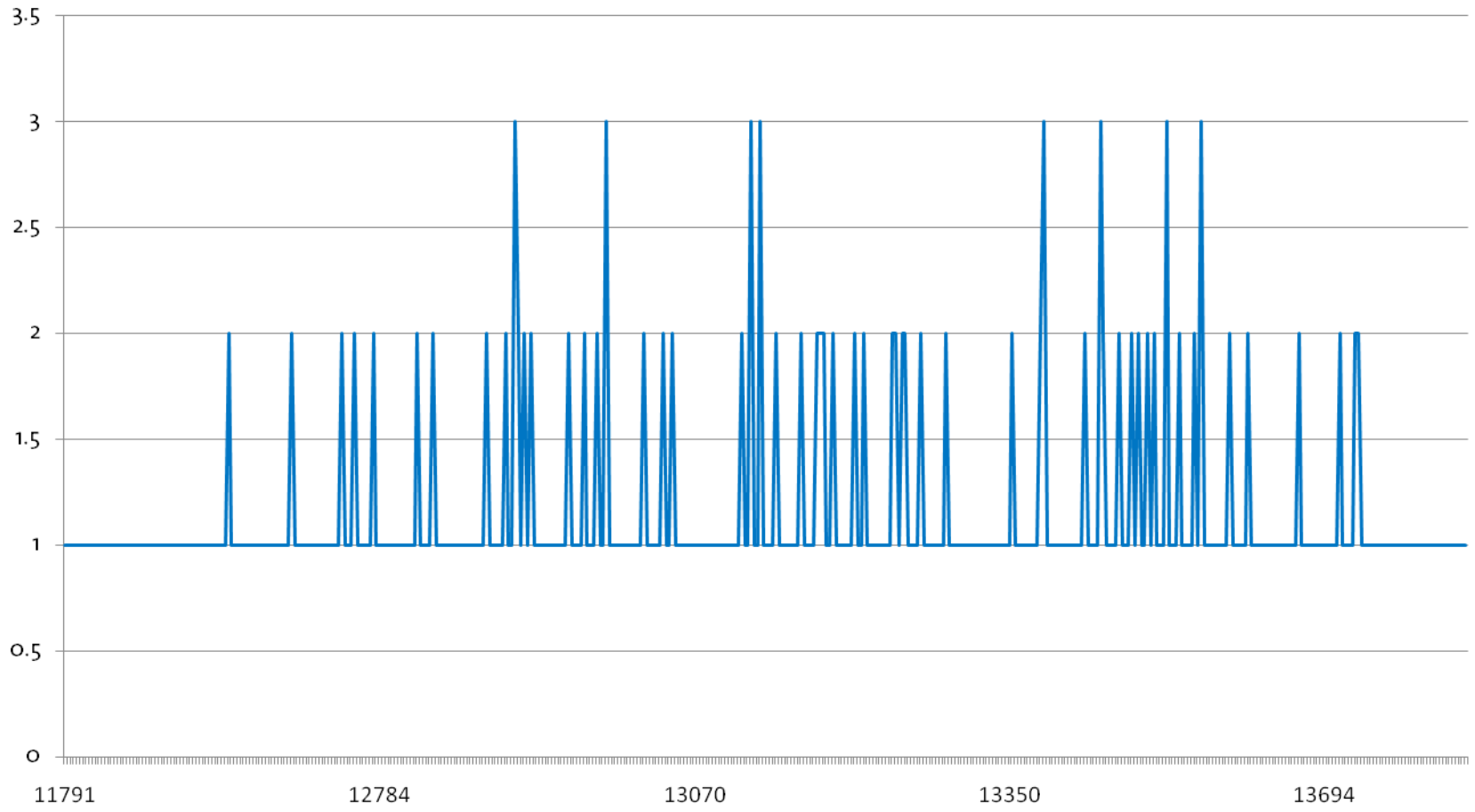

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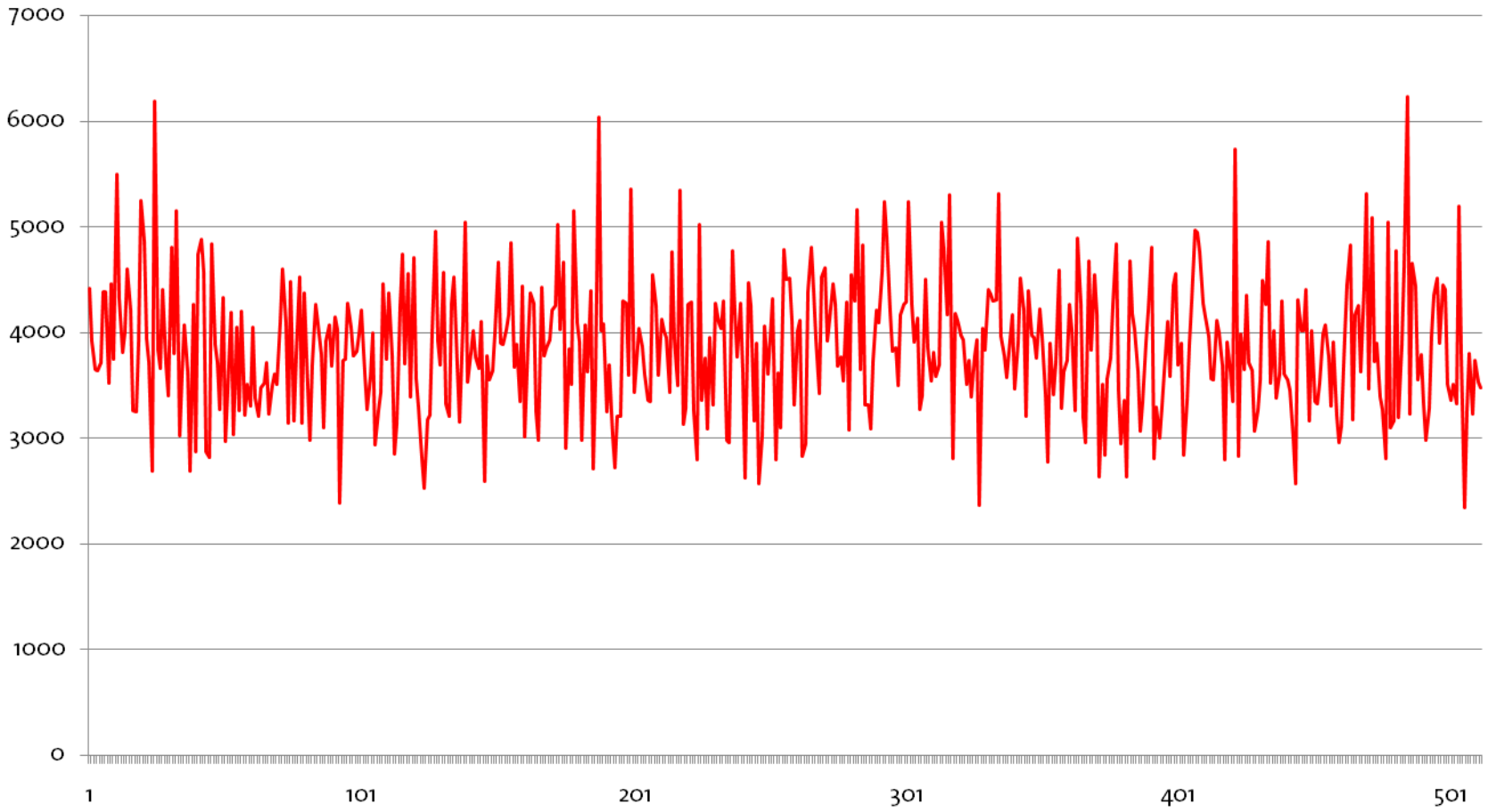

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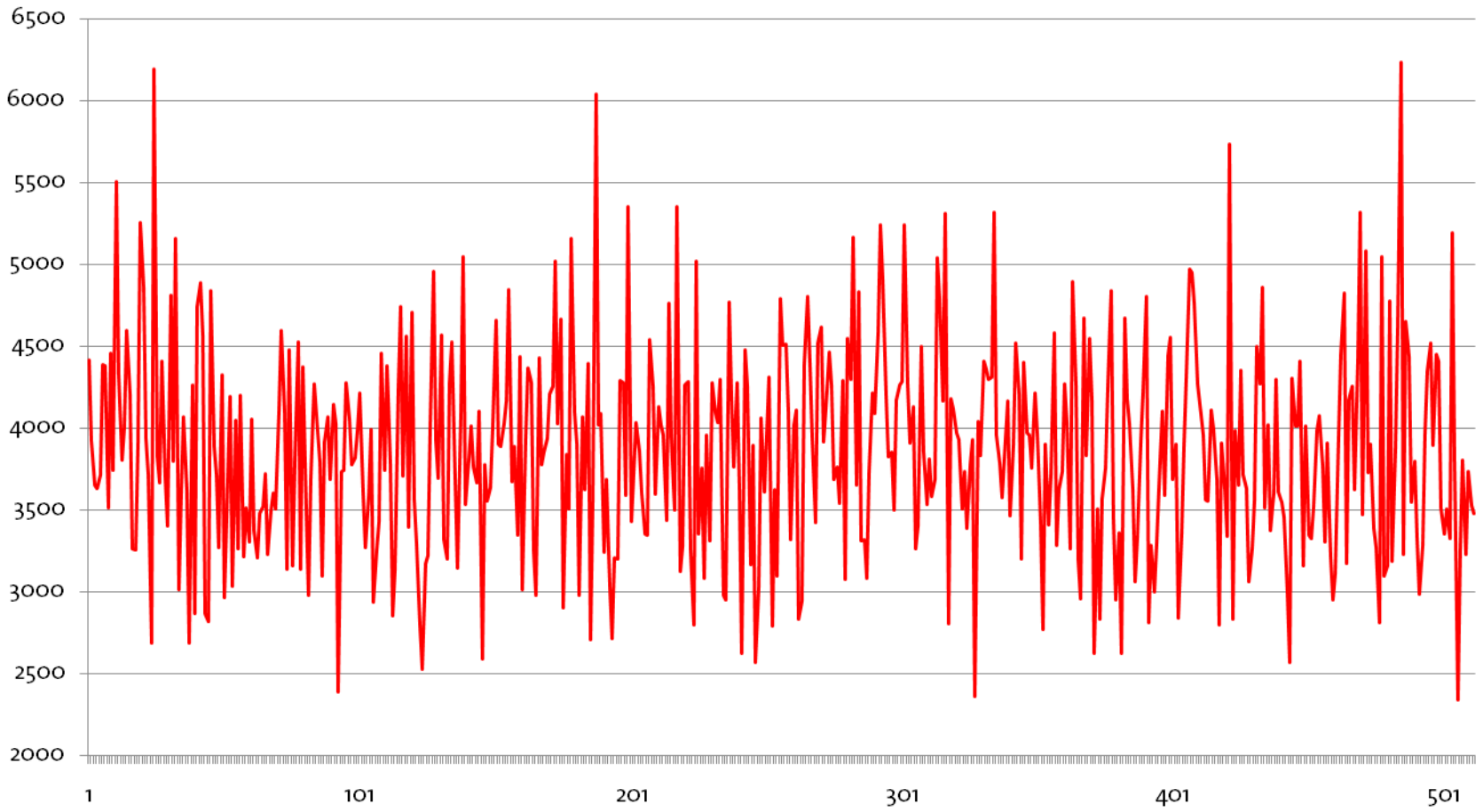

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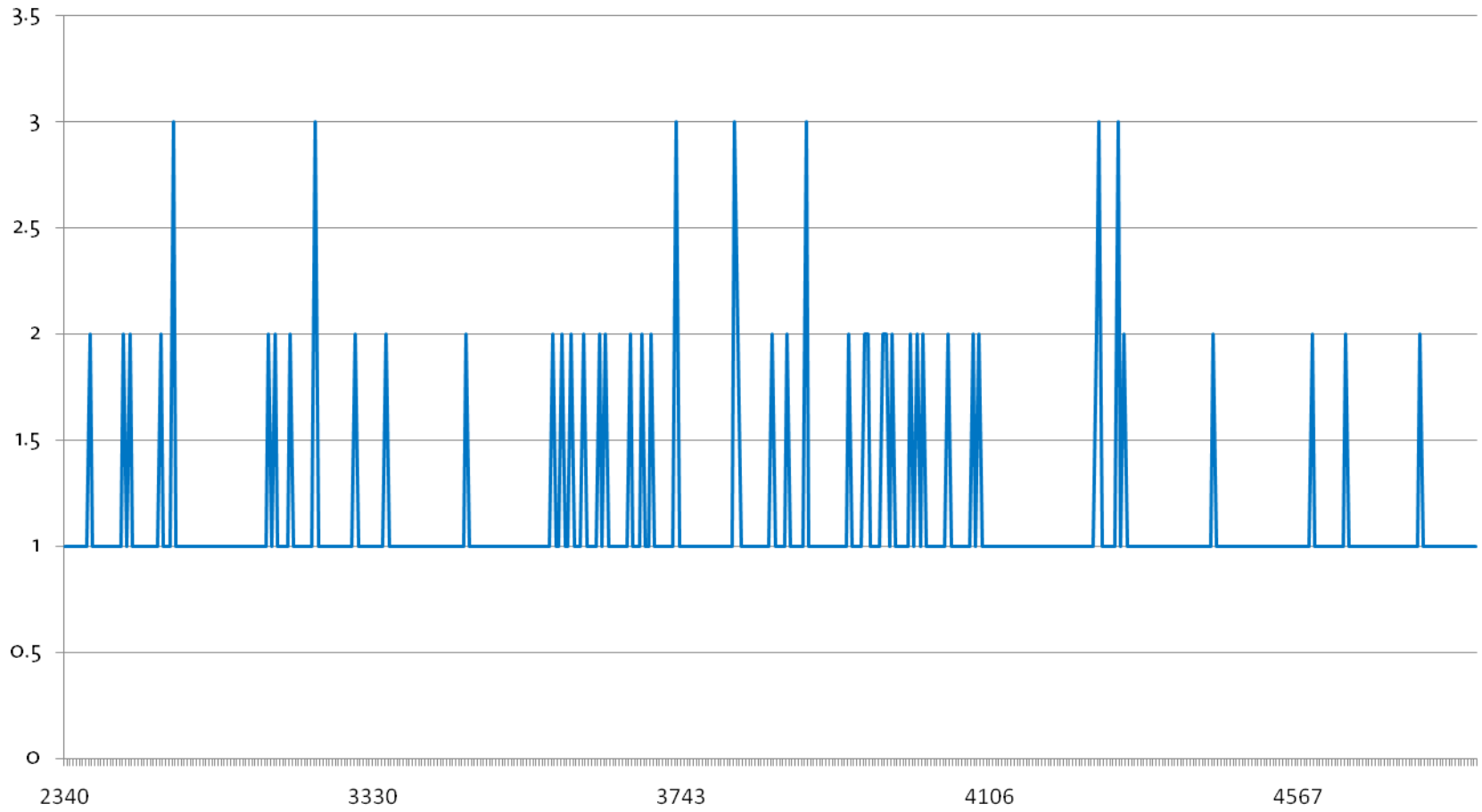

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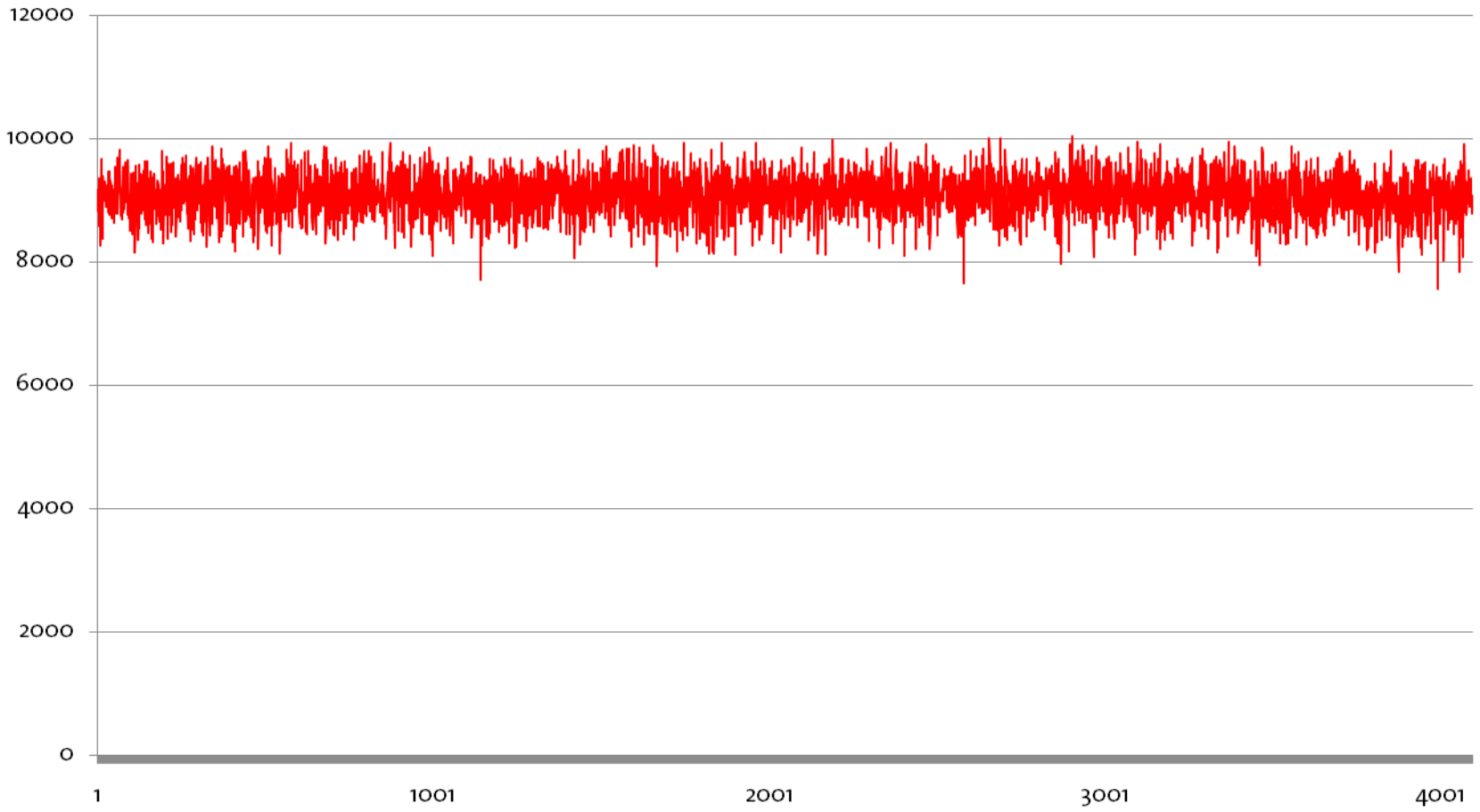

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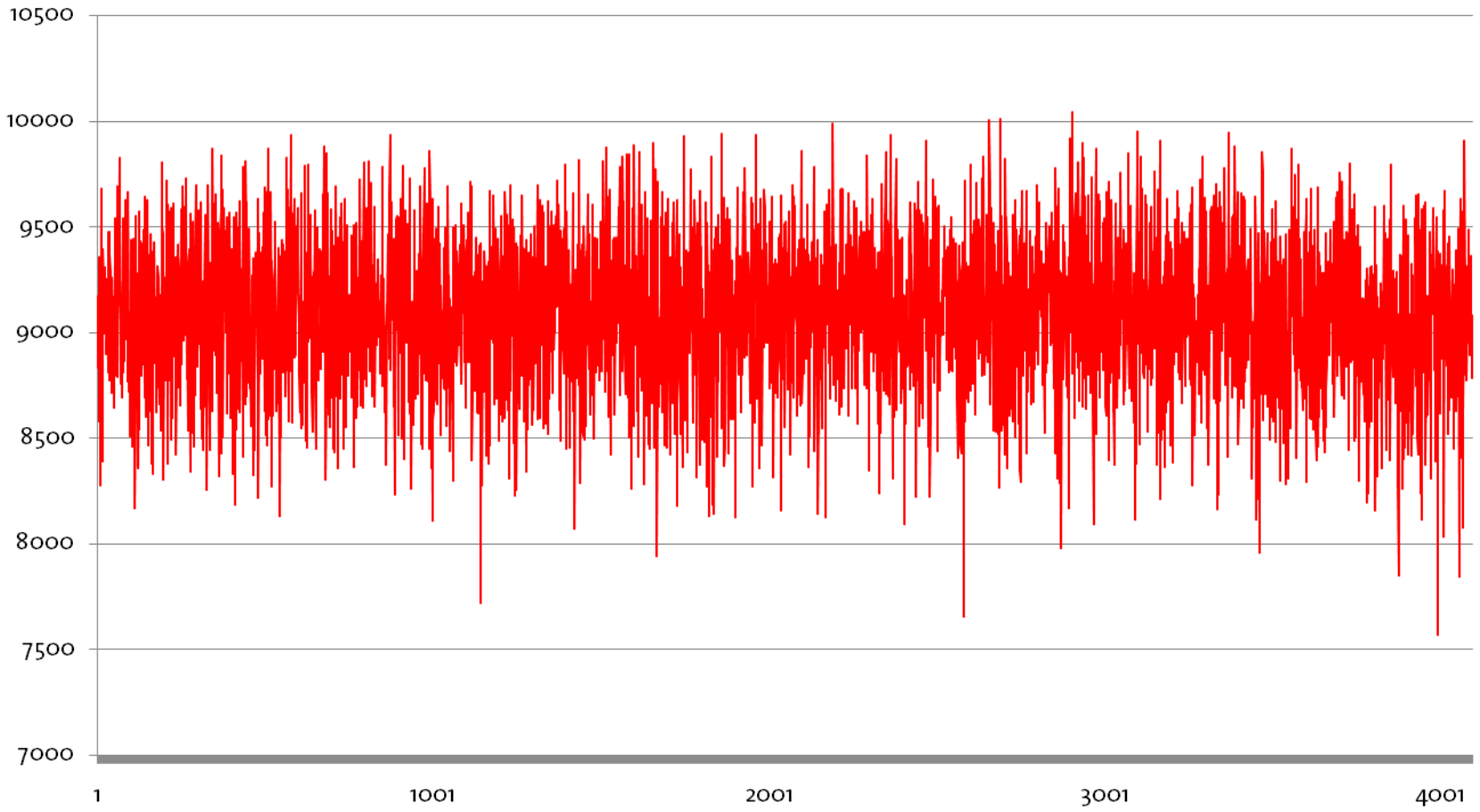

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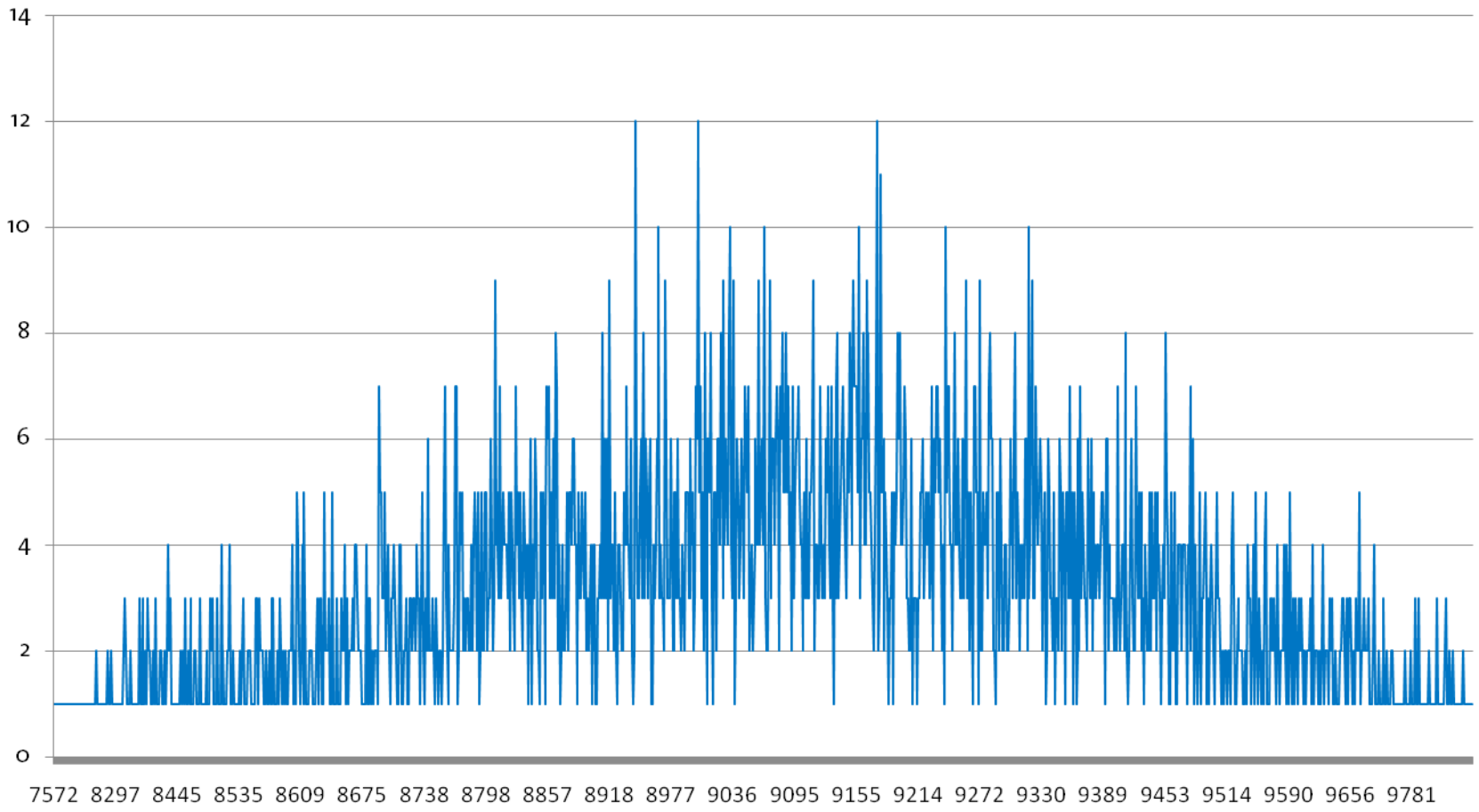

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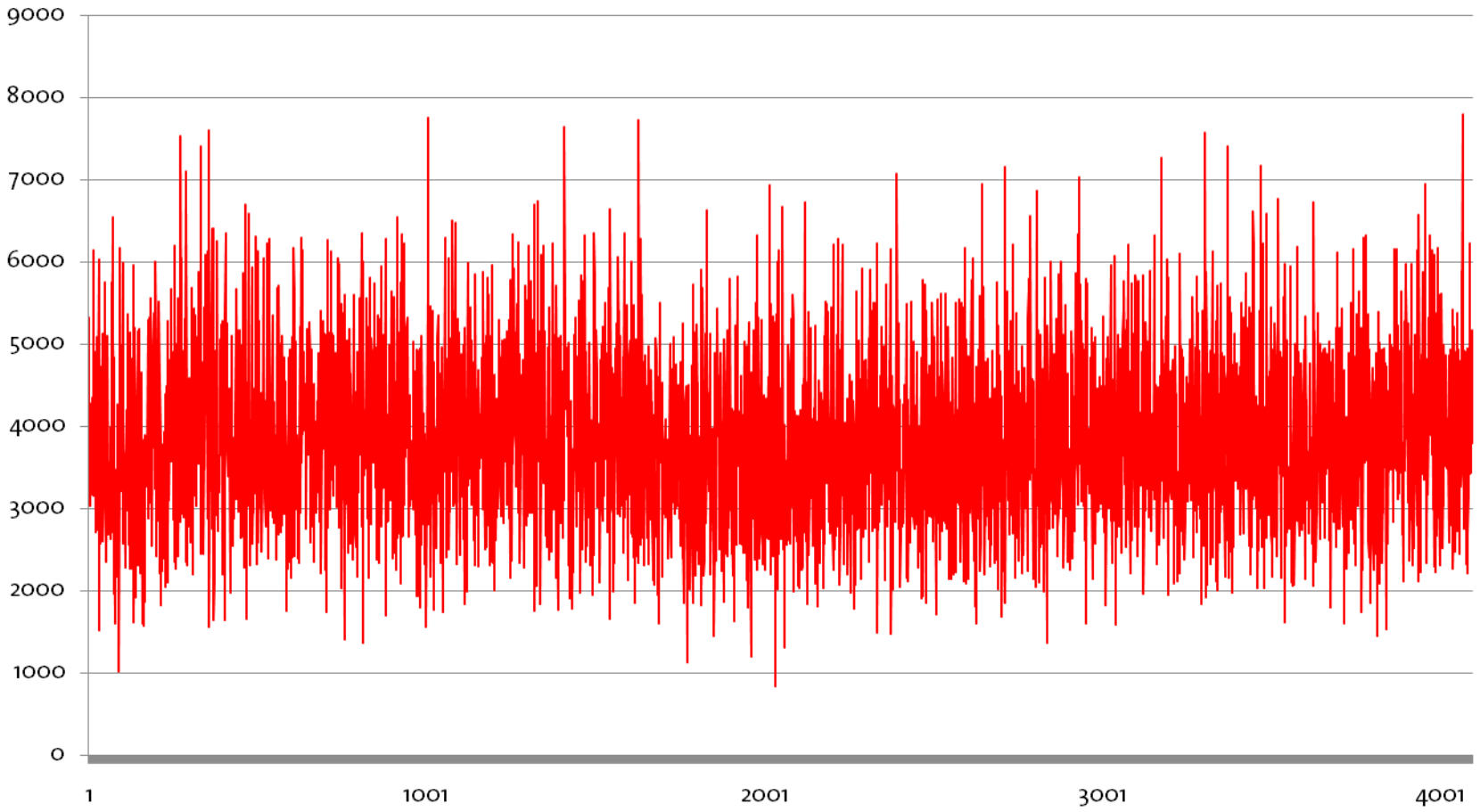

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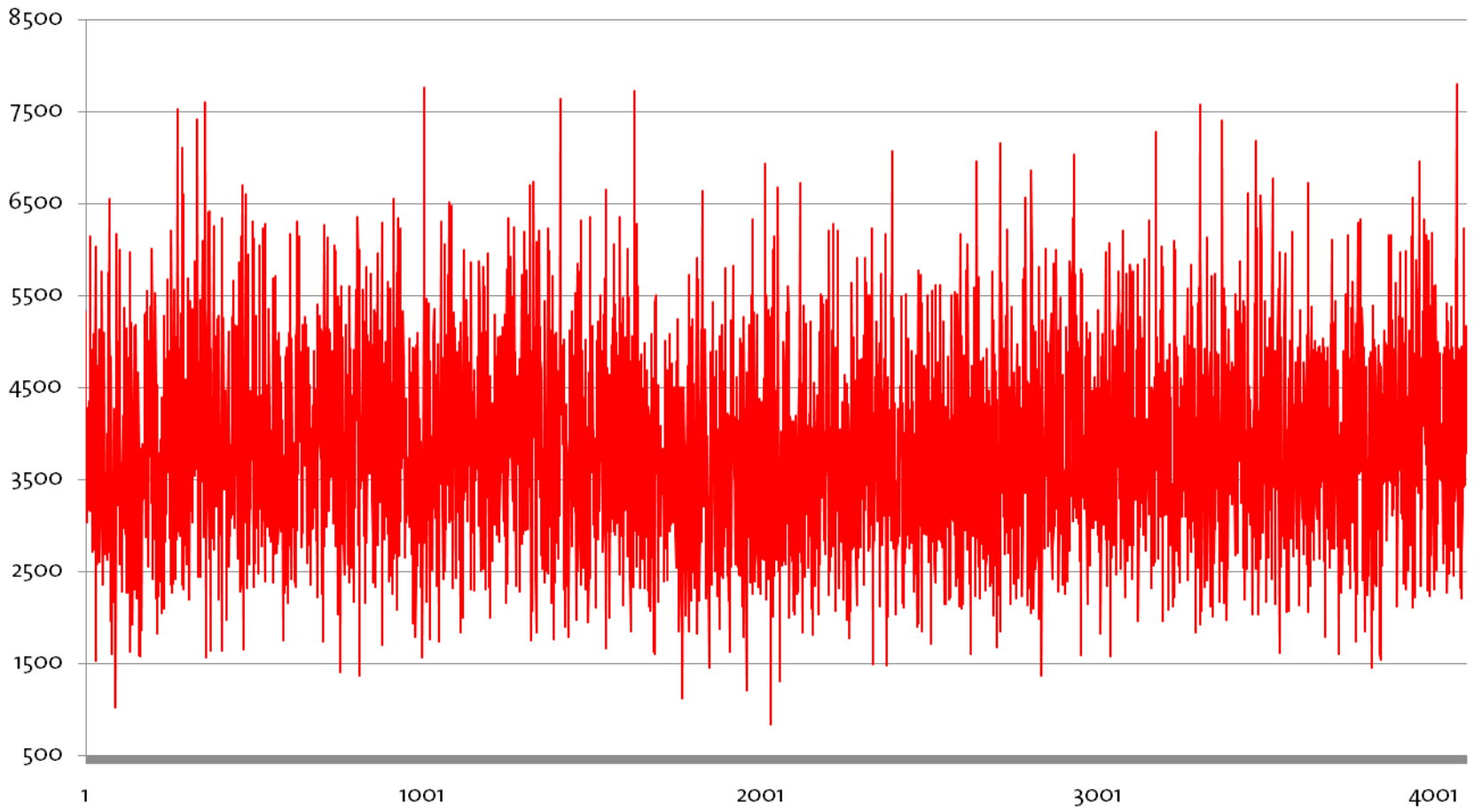

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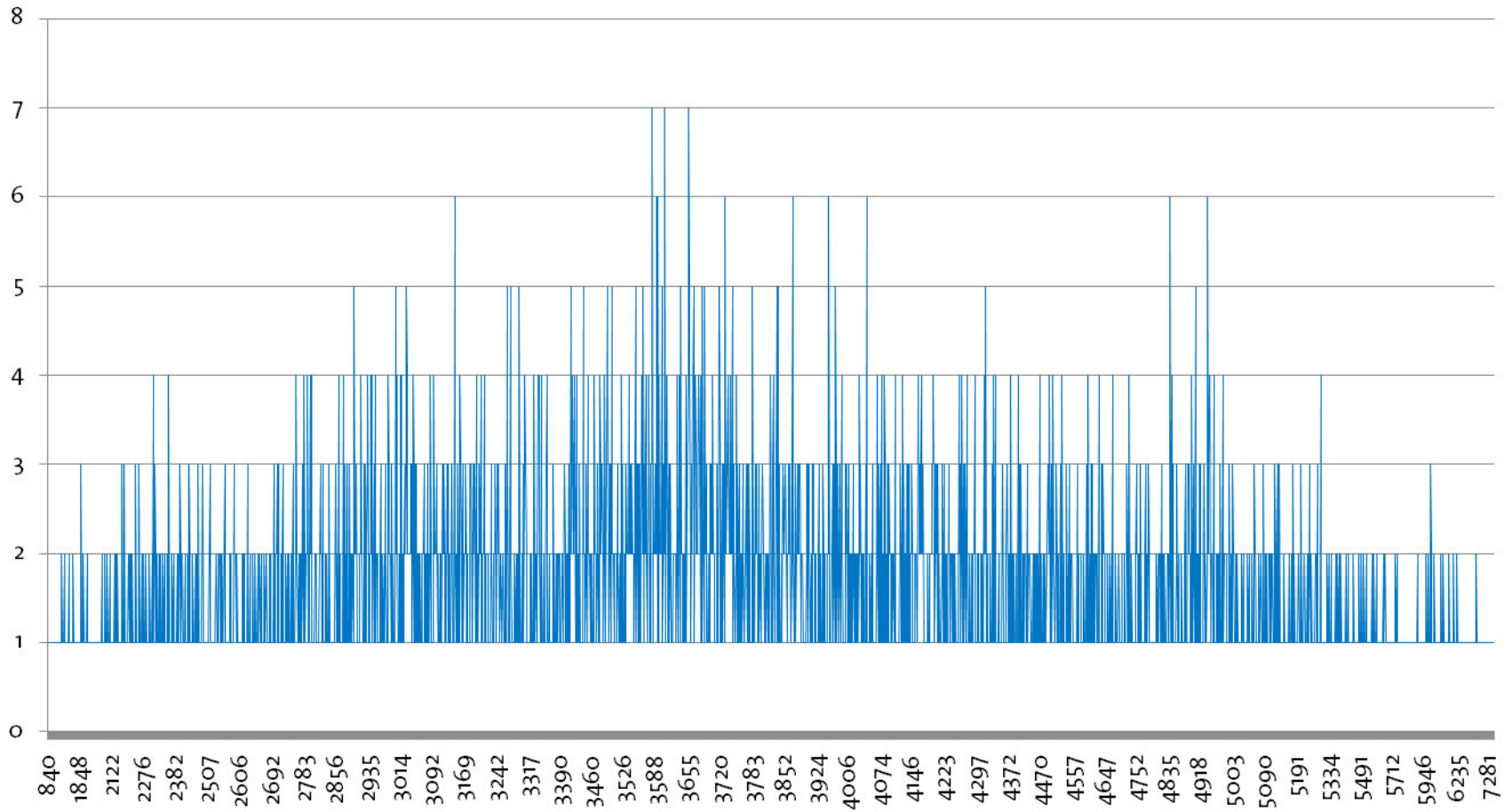

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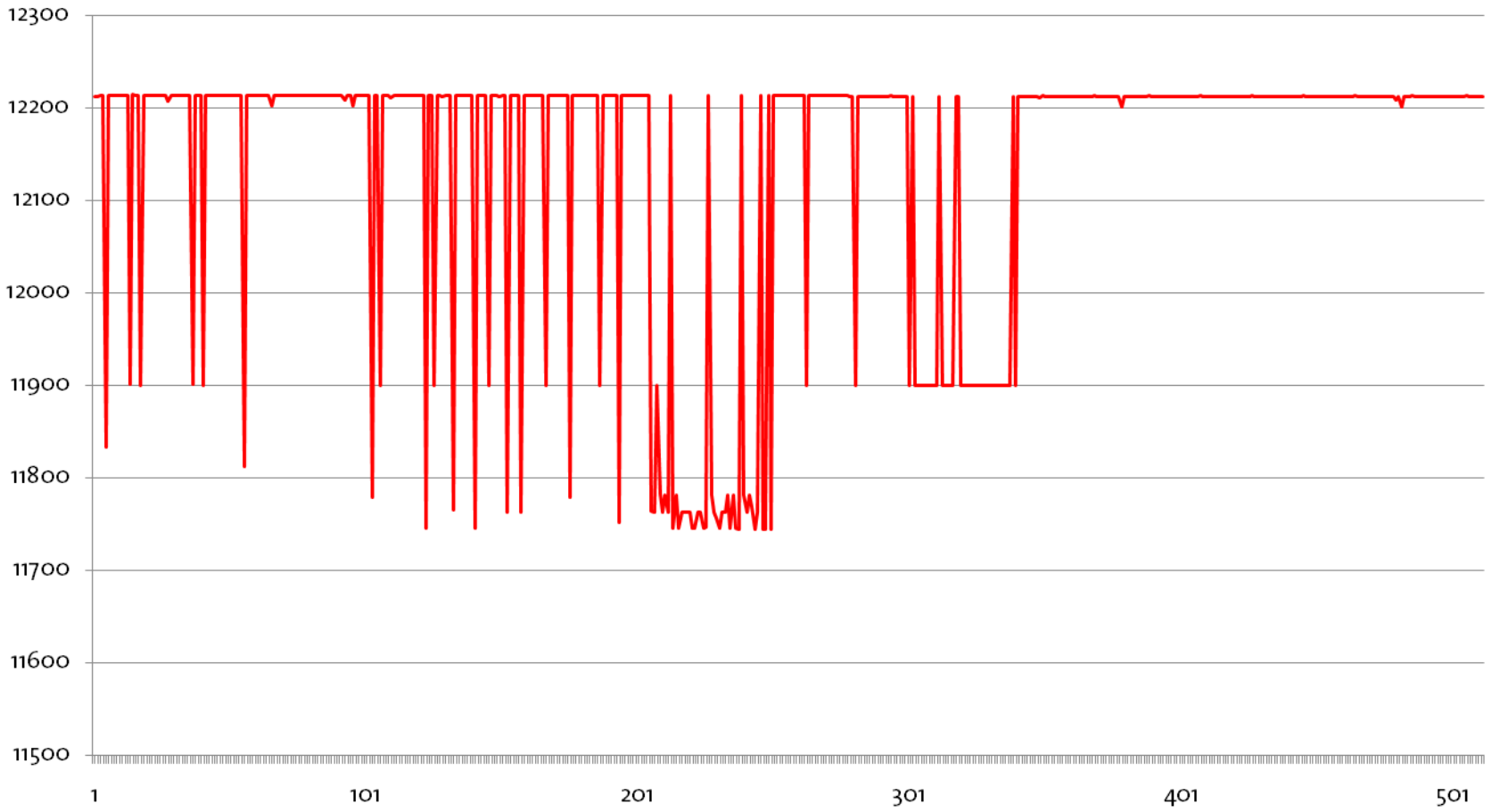

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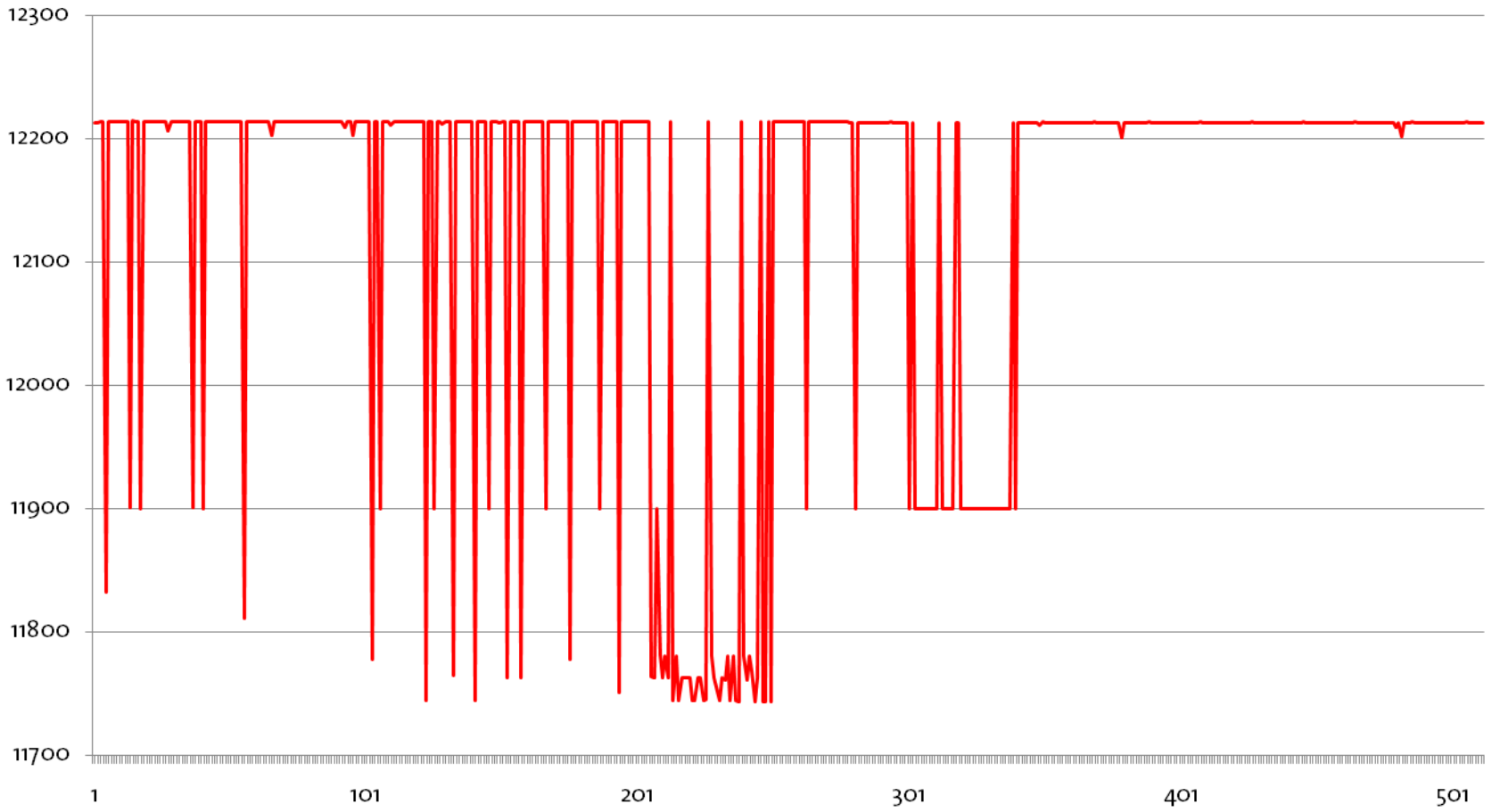

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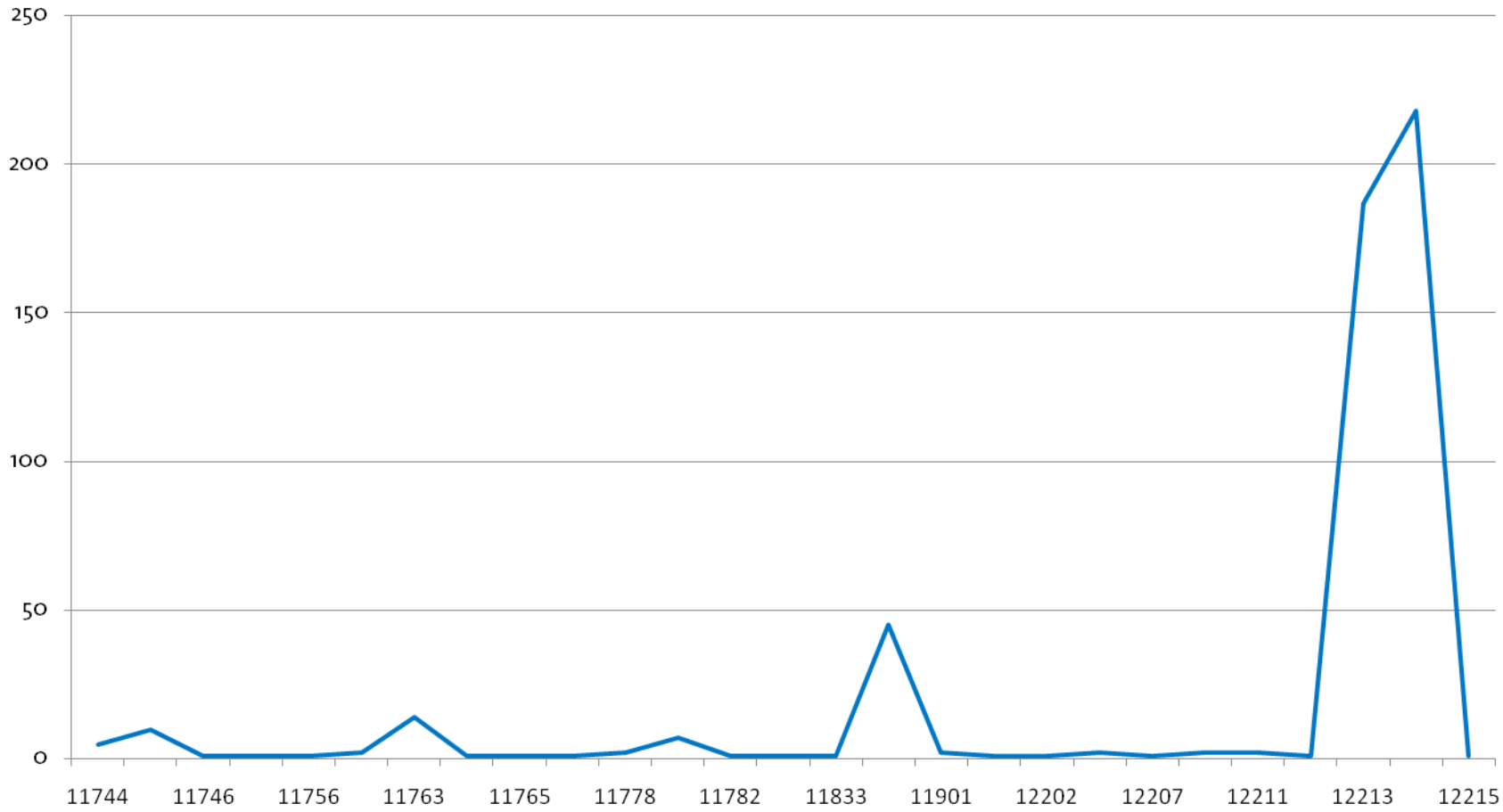

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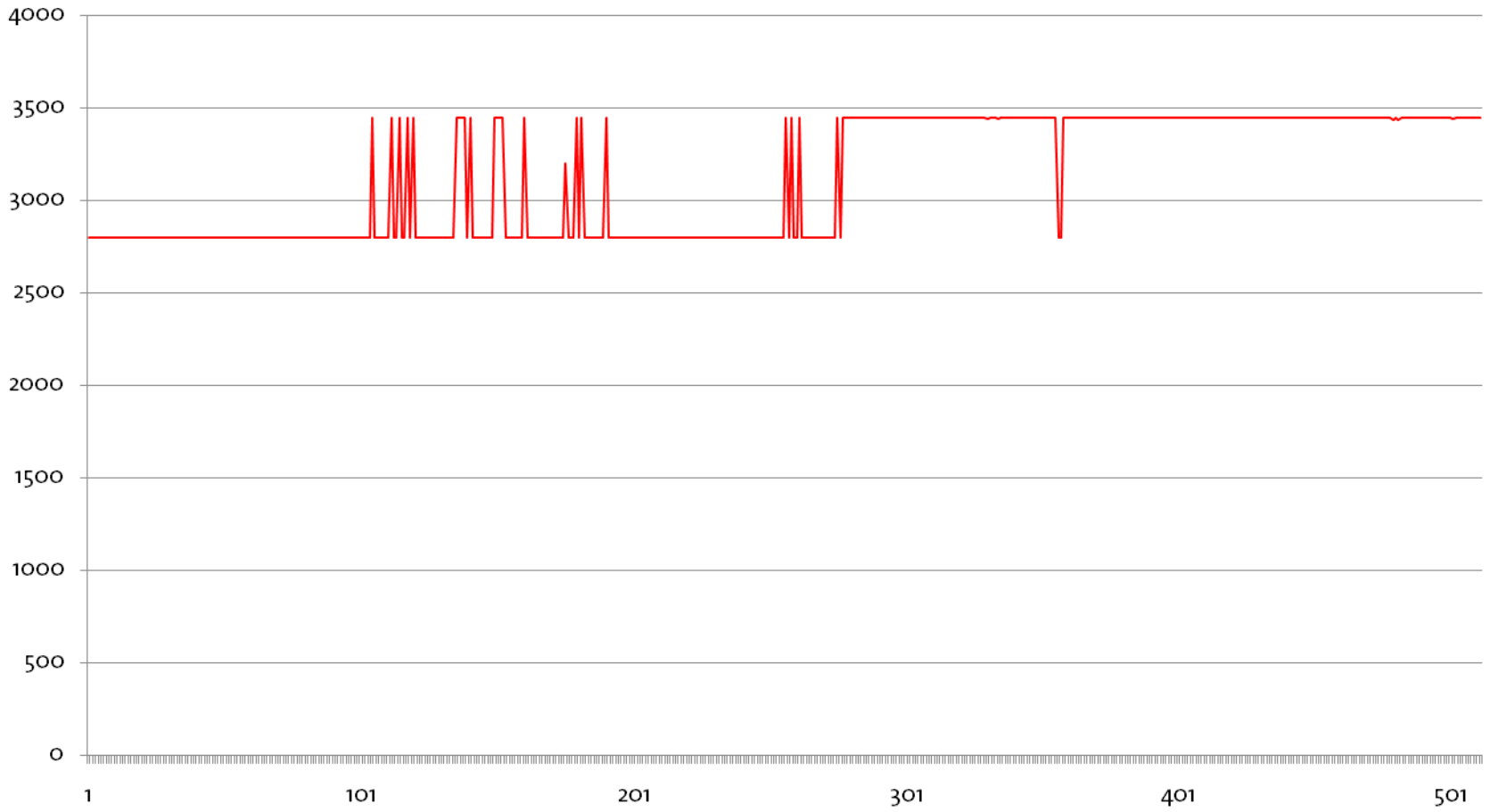

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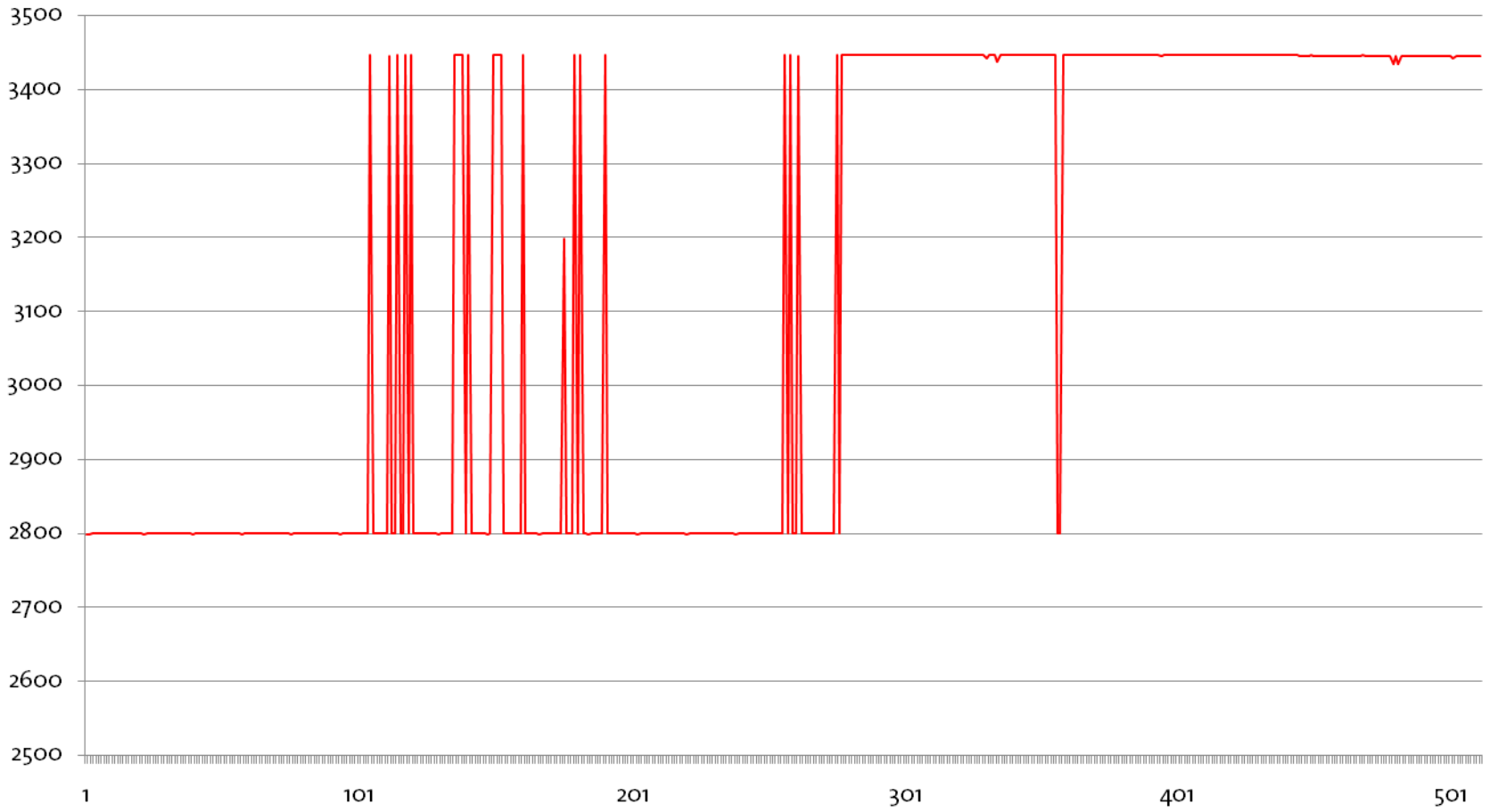

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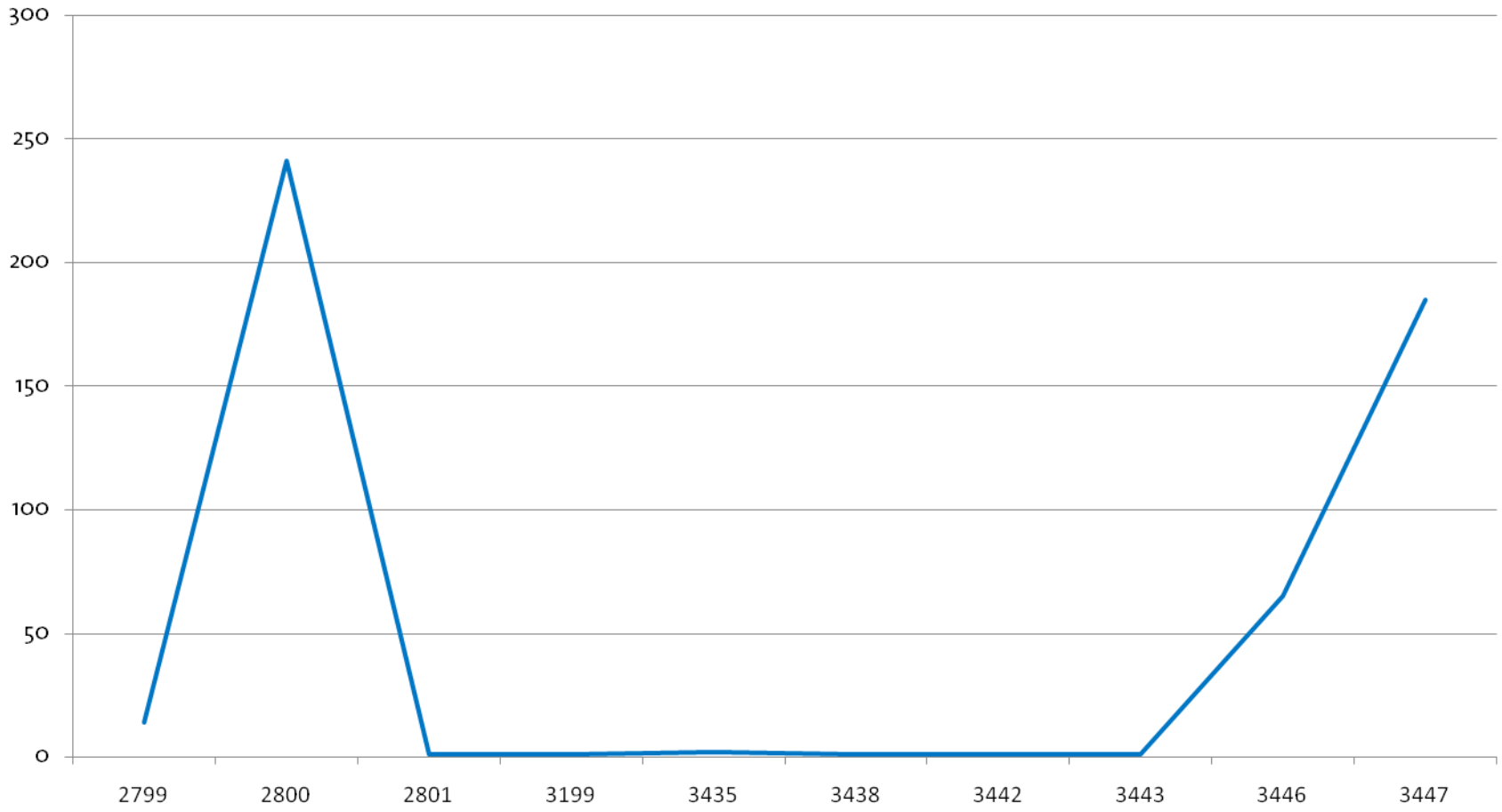

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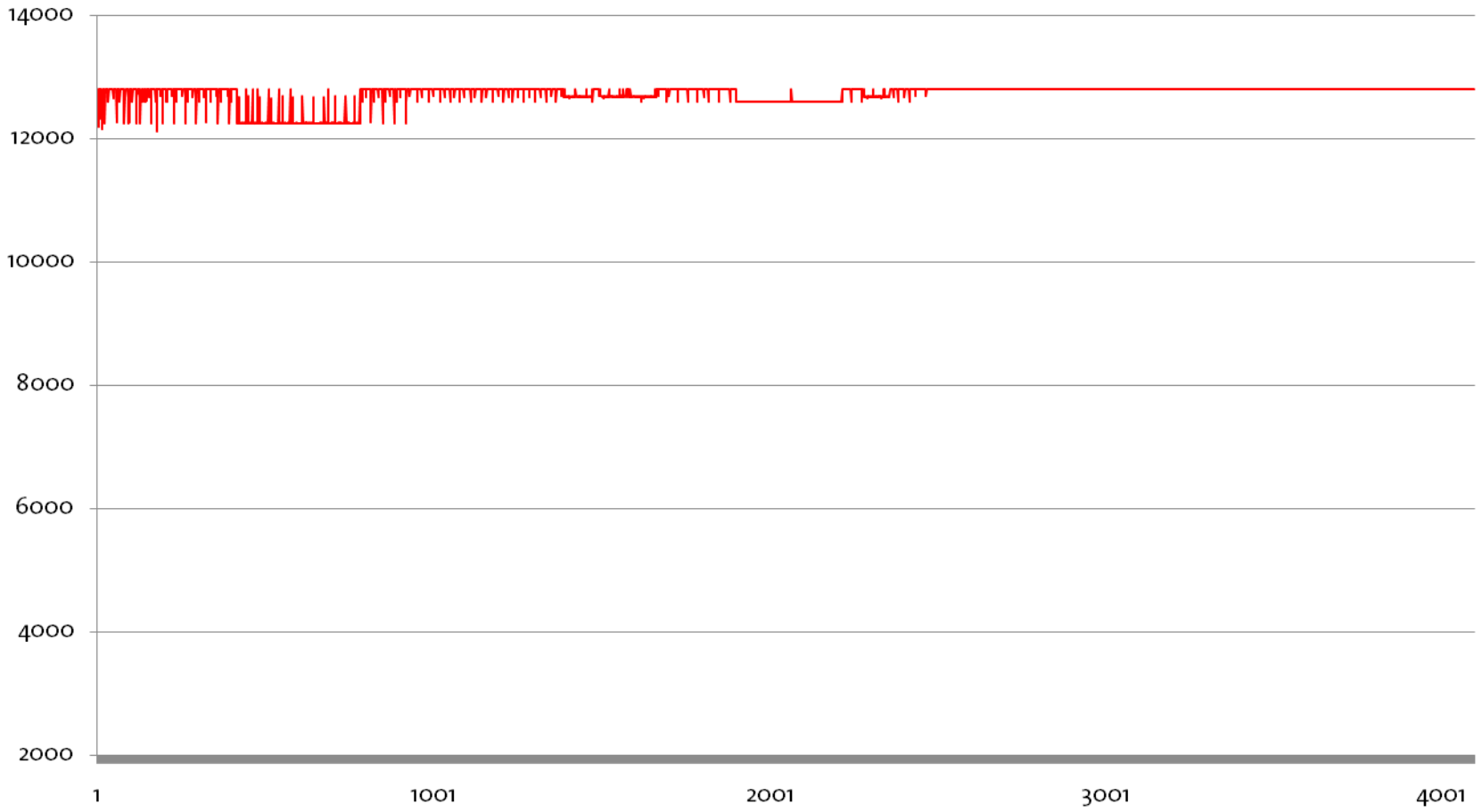

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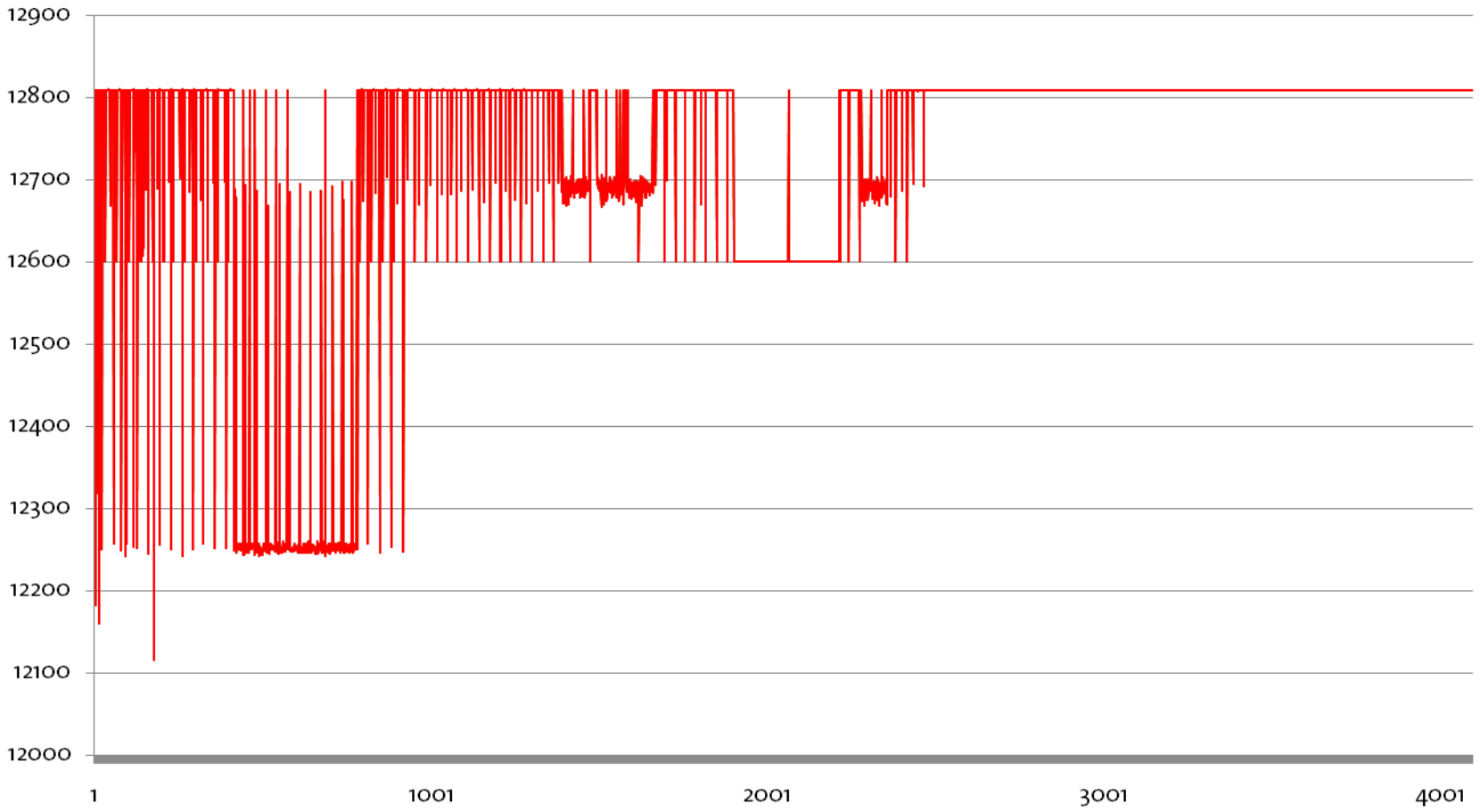

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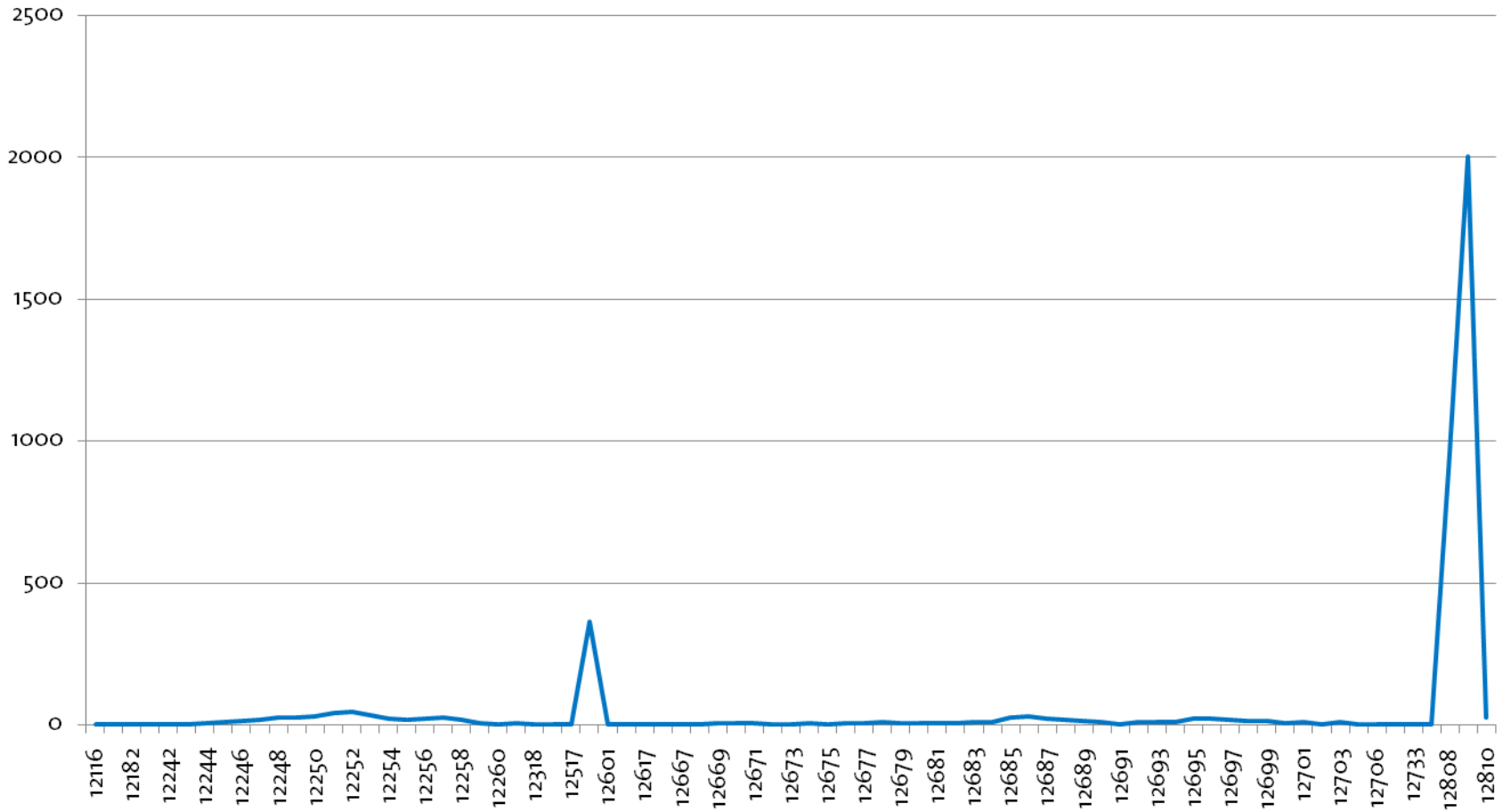

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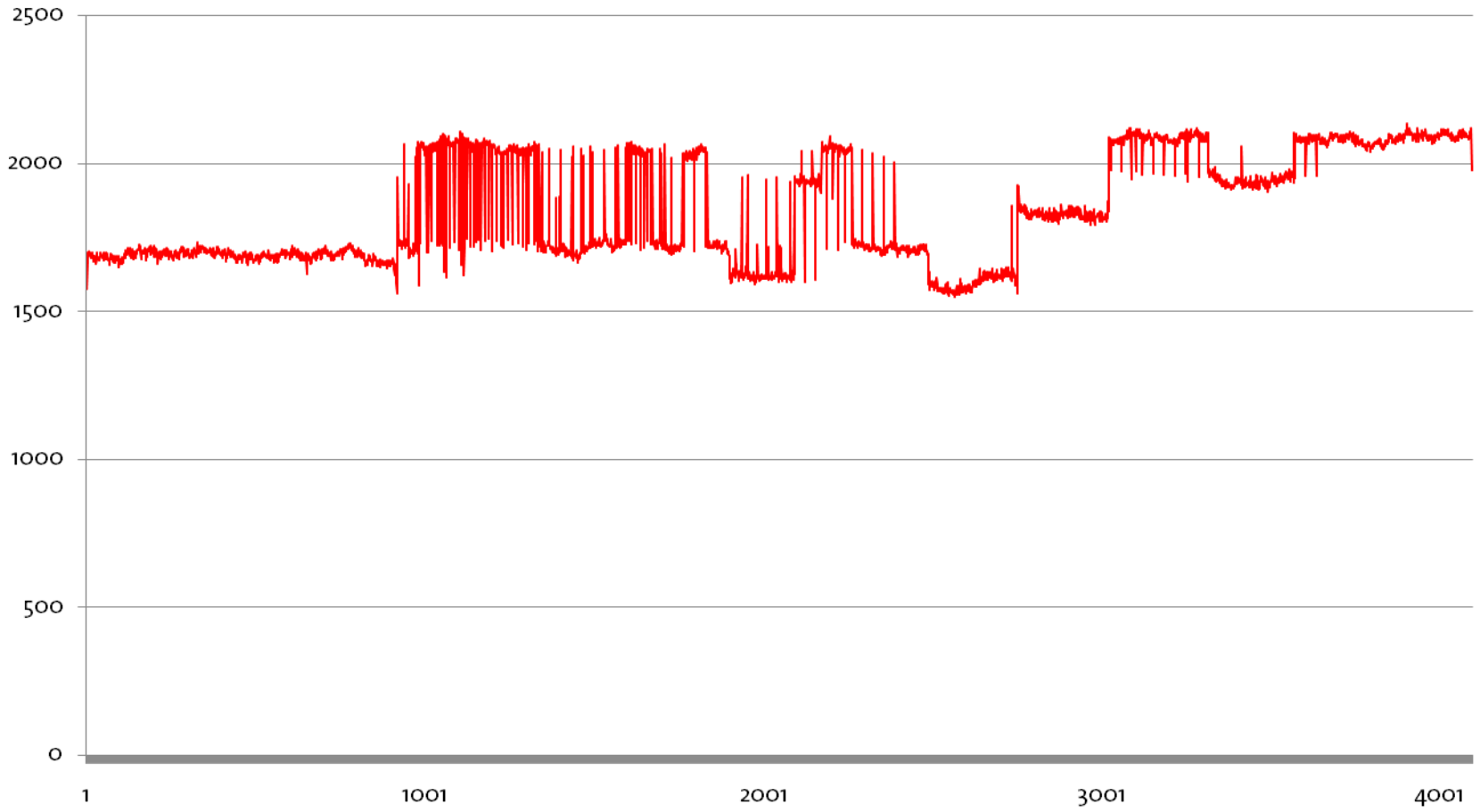

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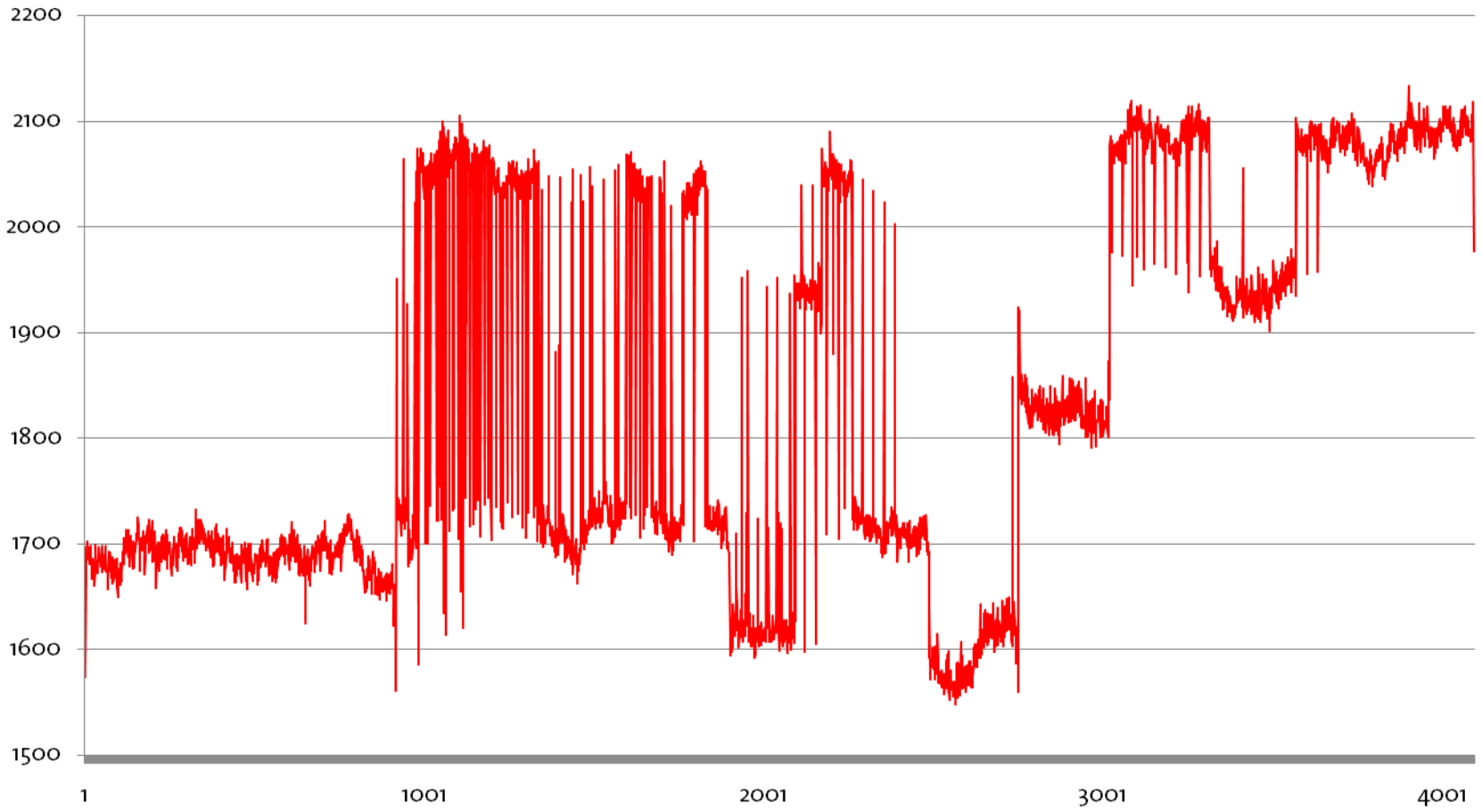

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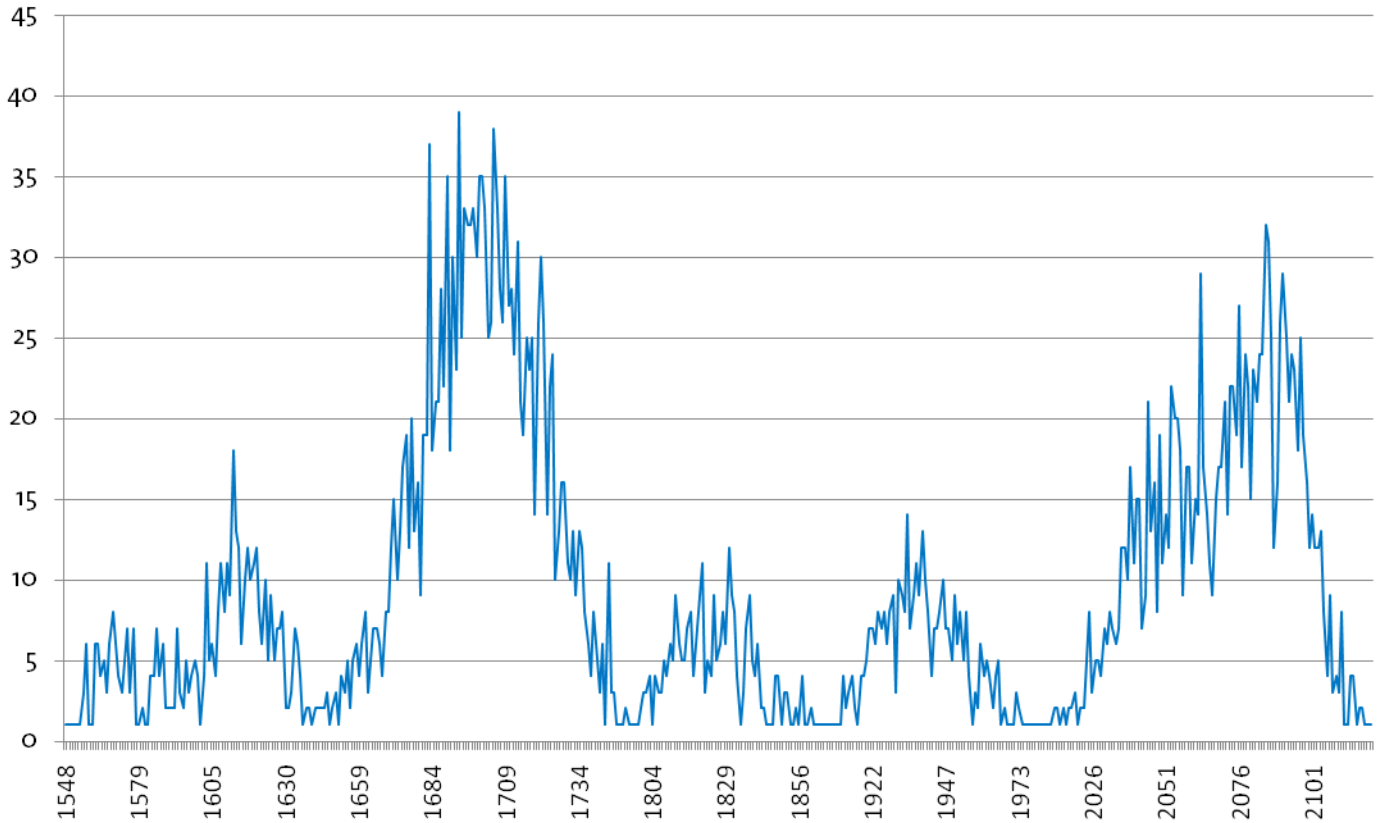

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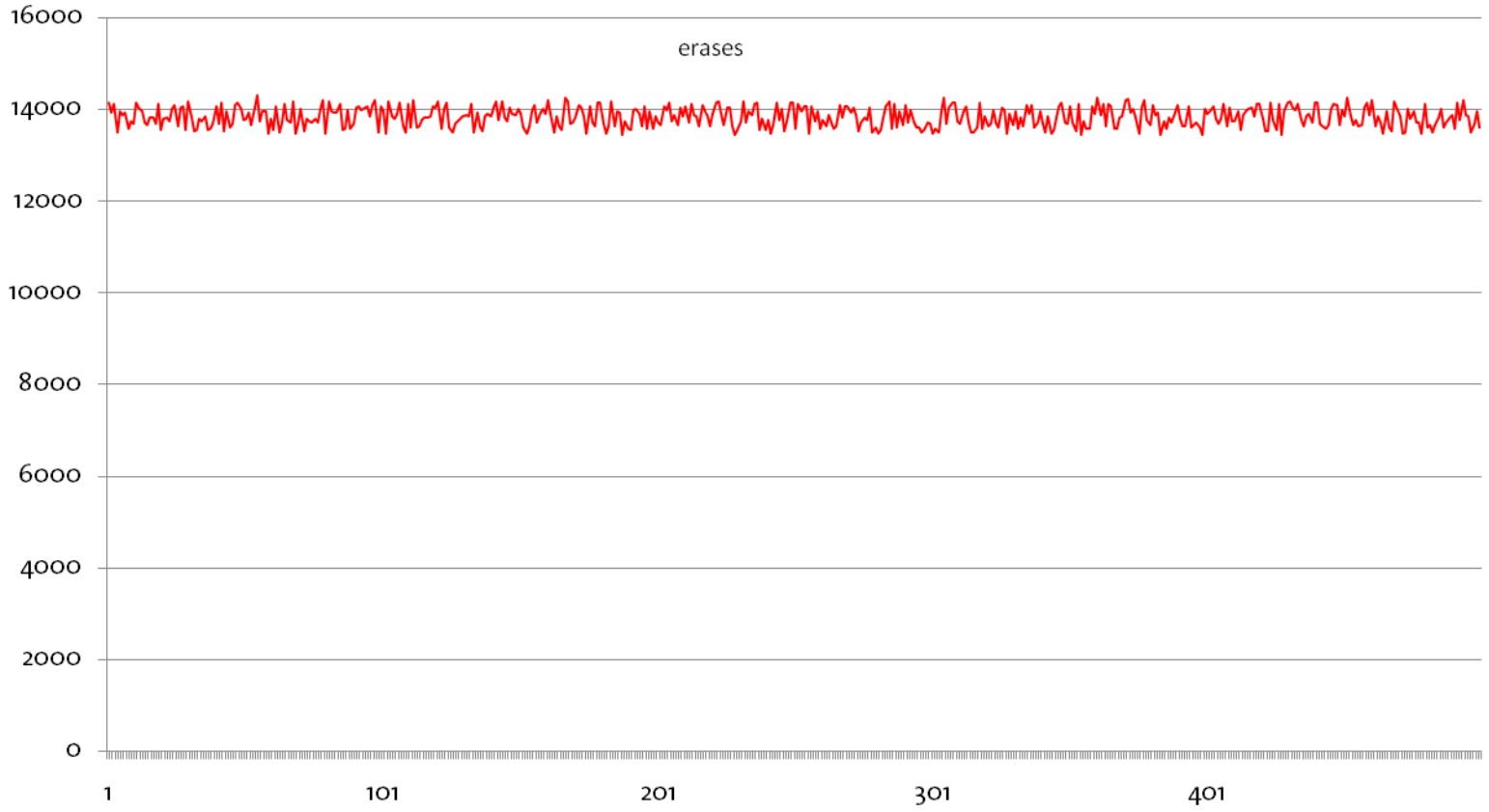
Large block 10% Static



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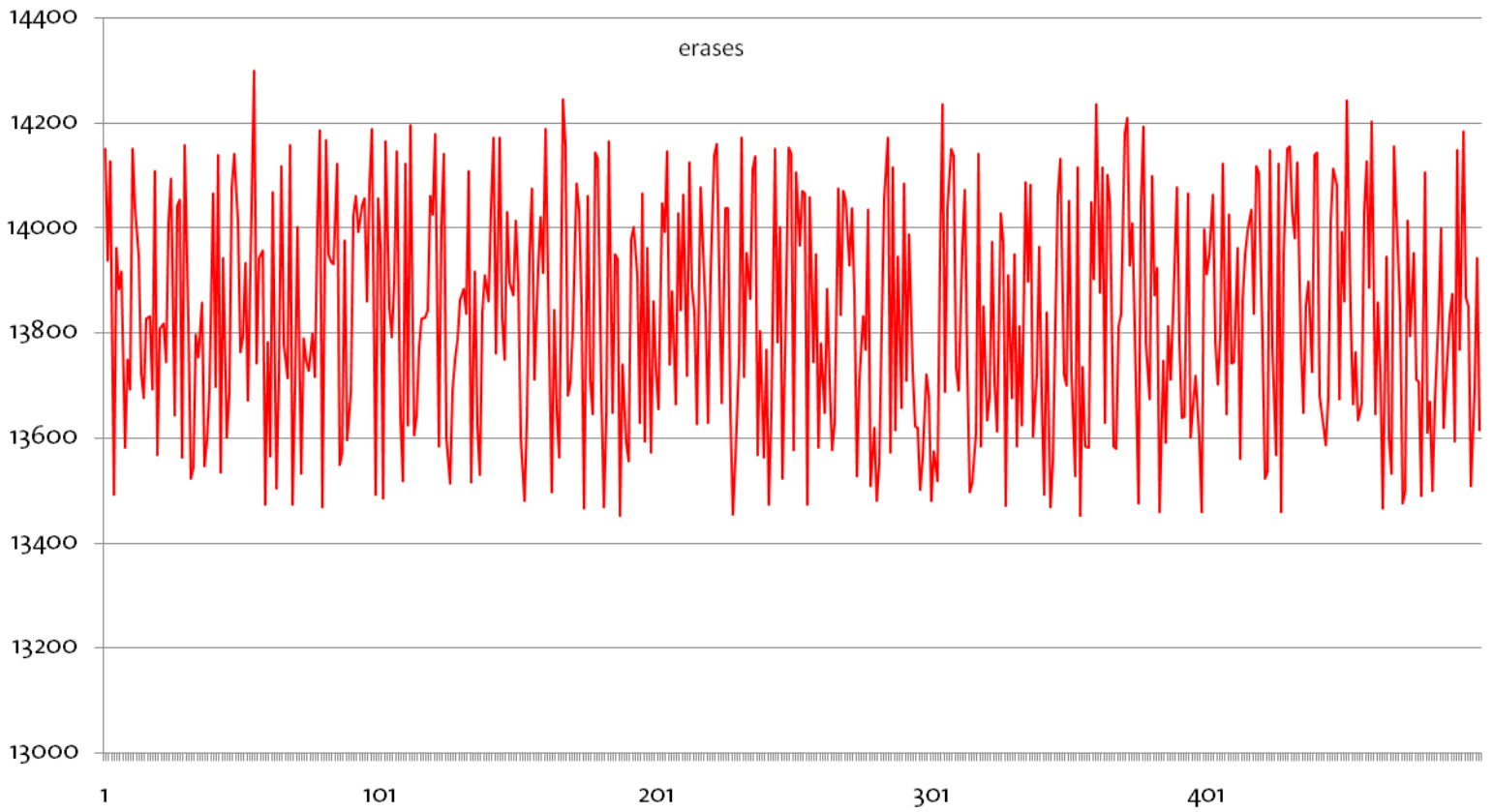

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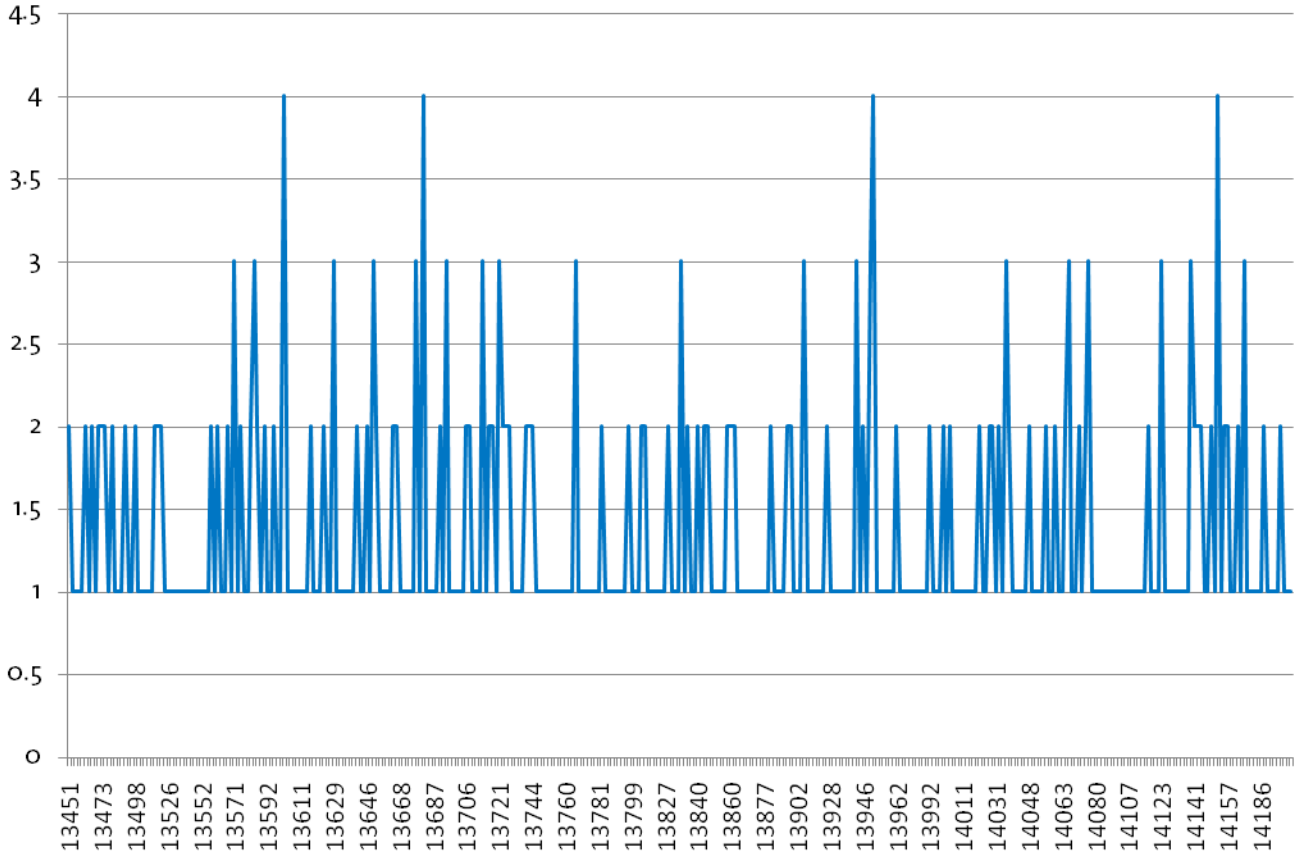

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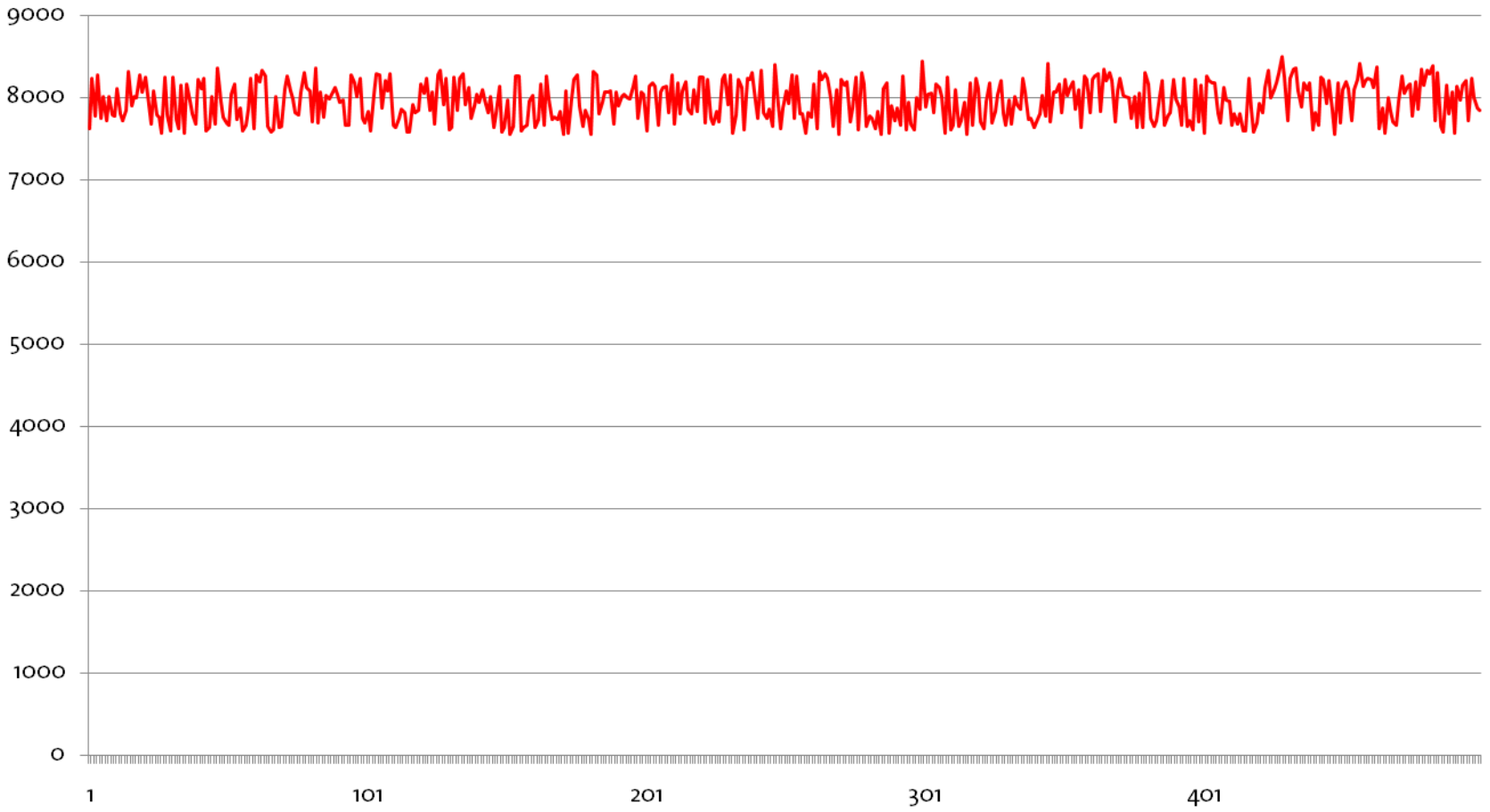

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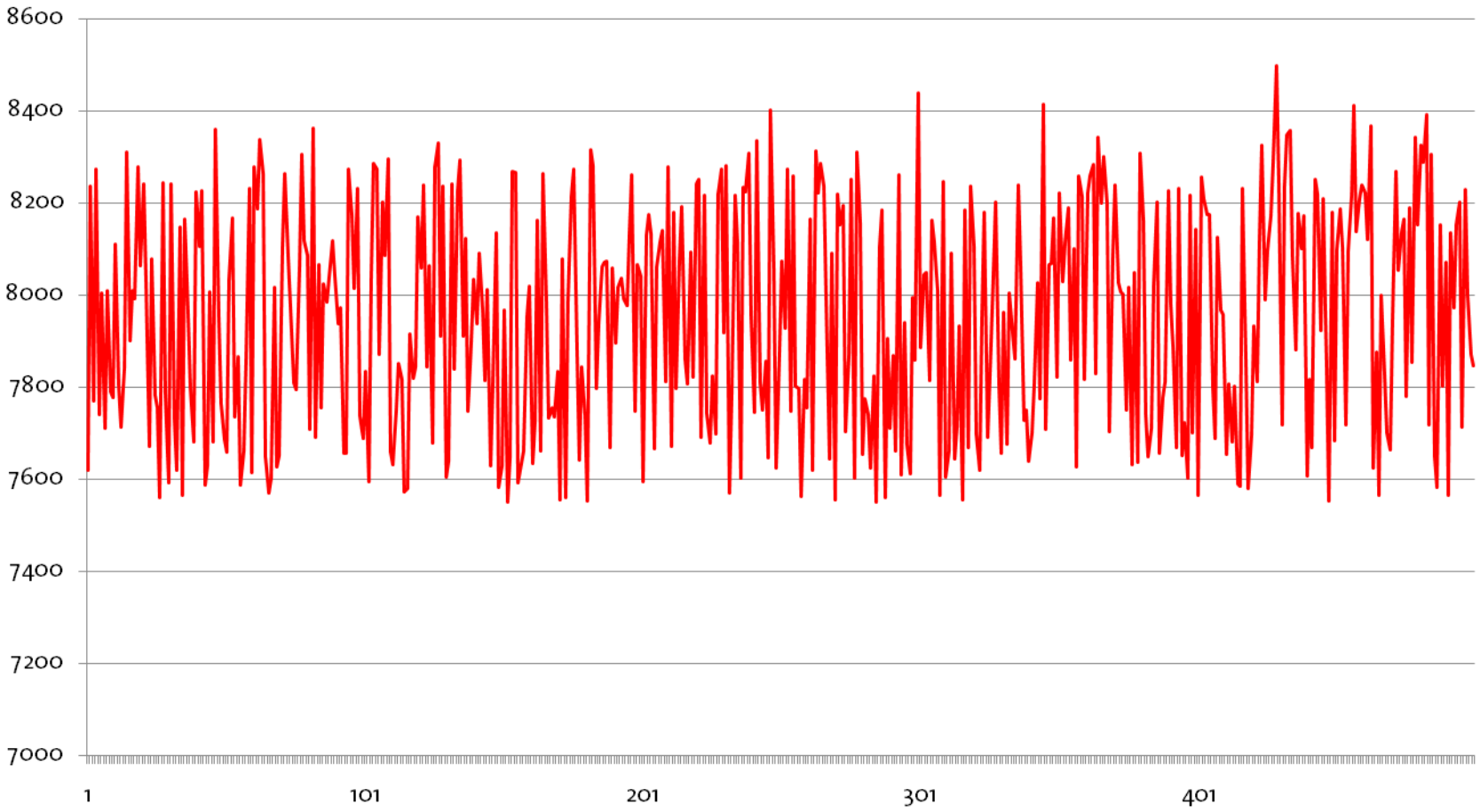

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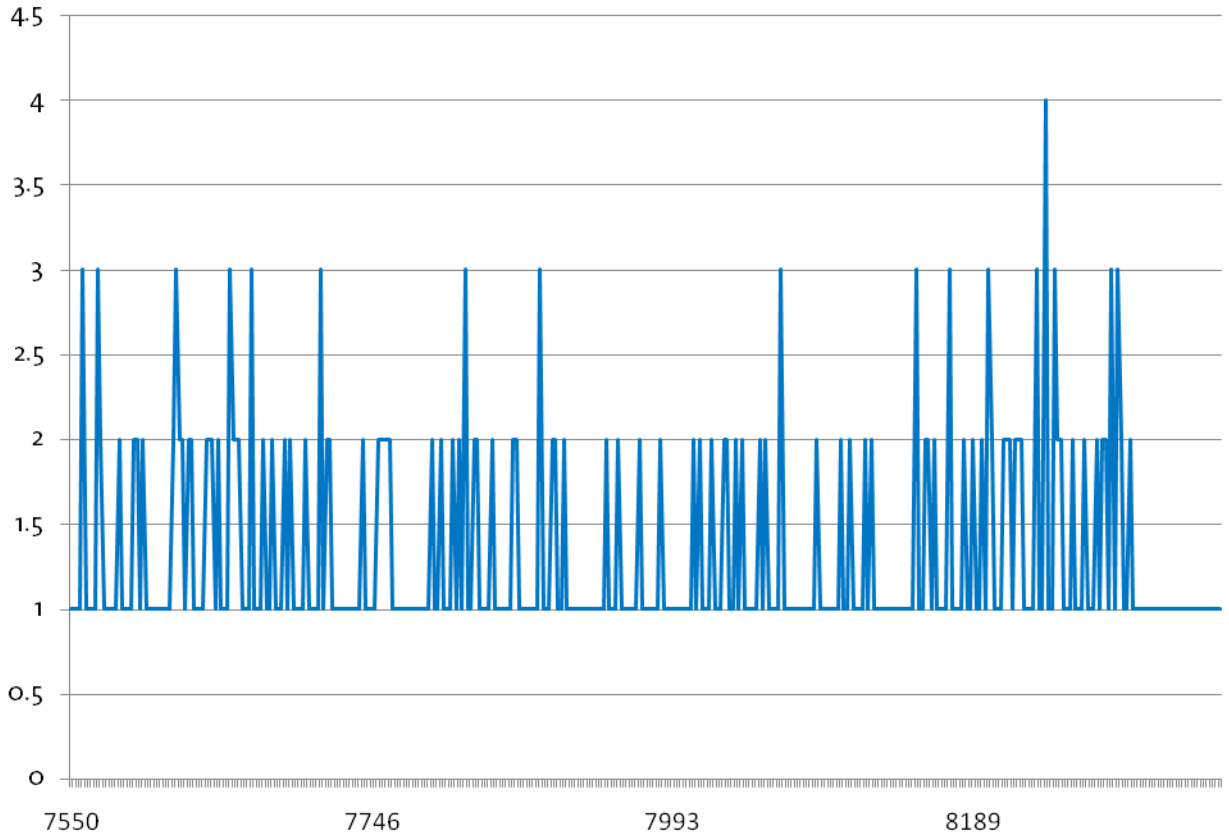

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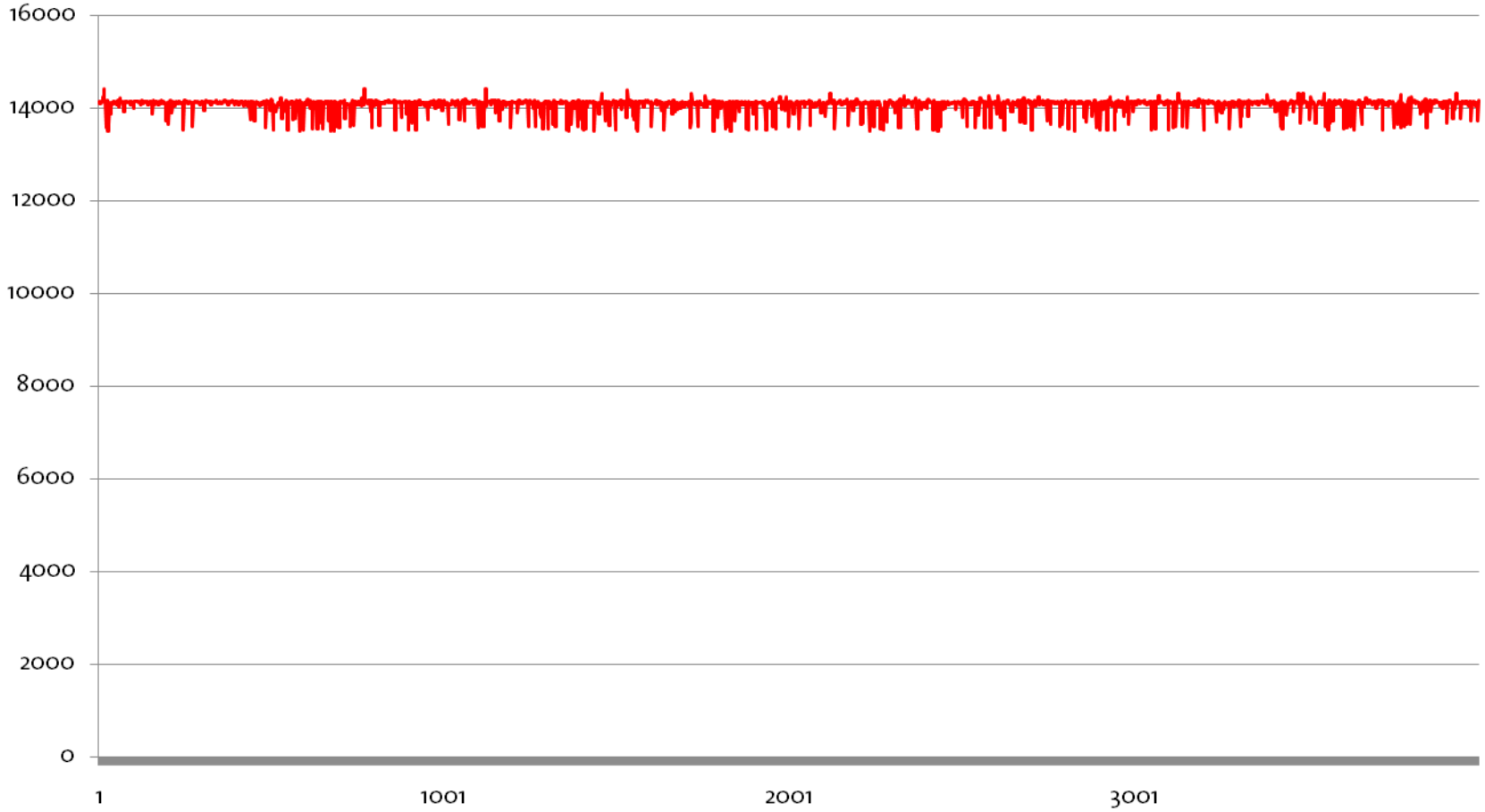

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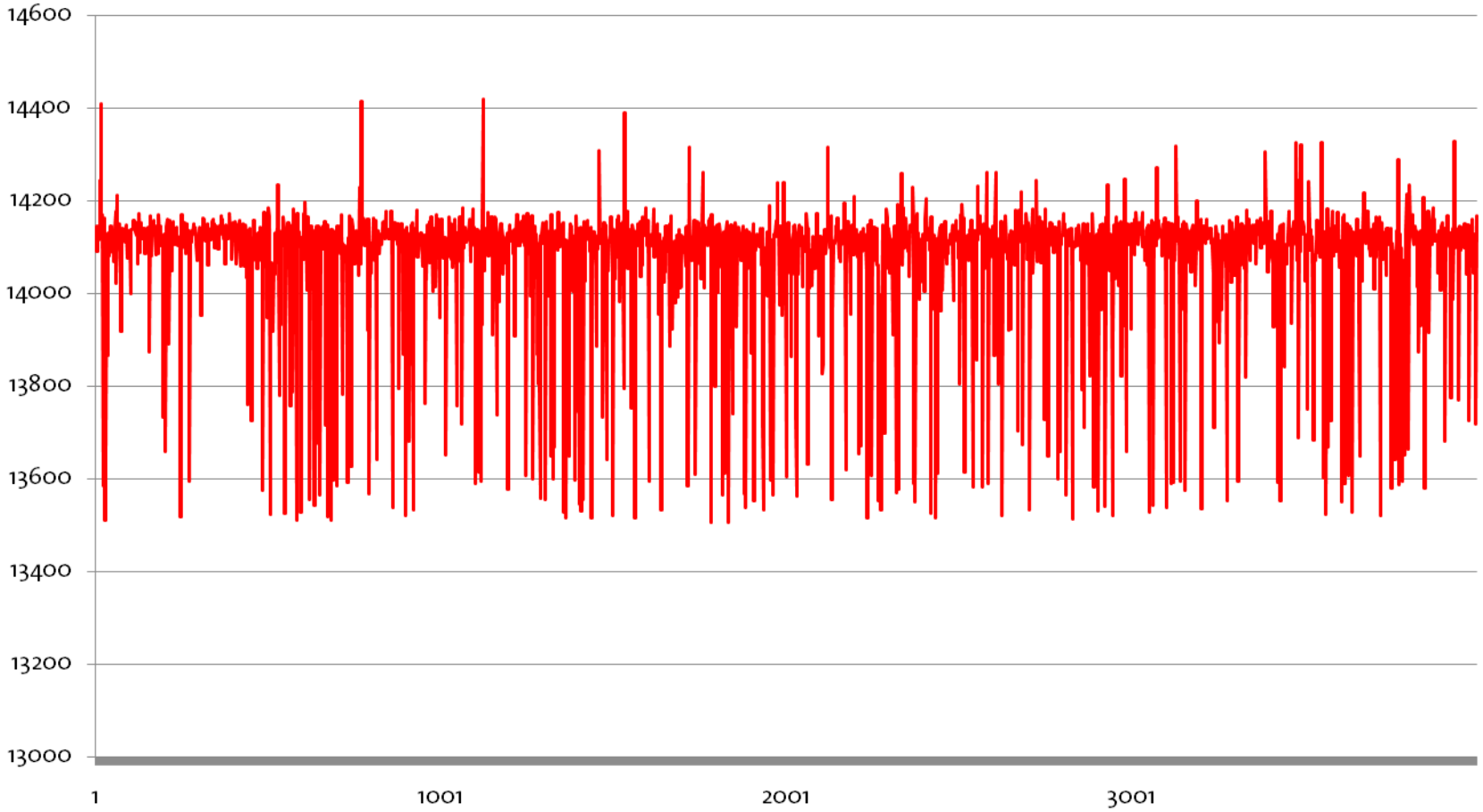

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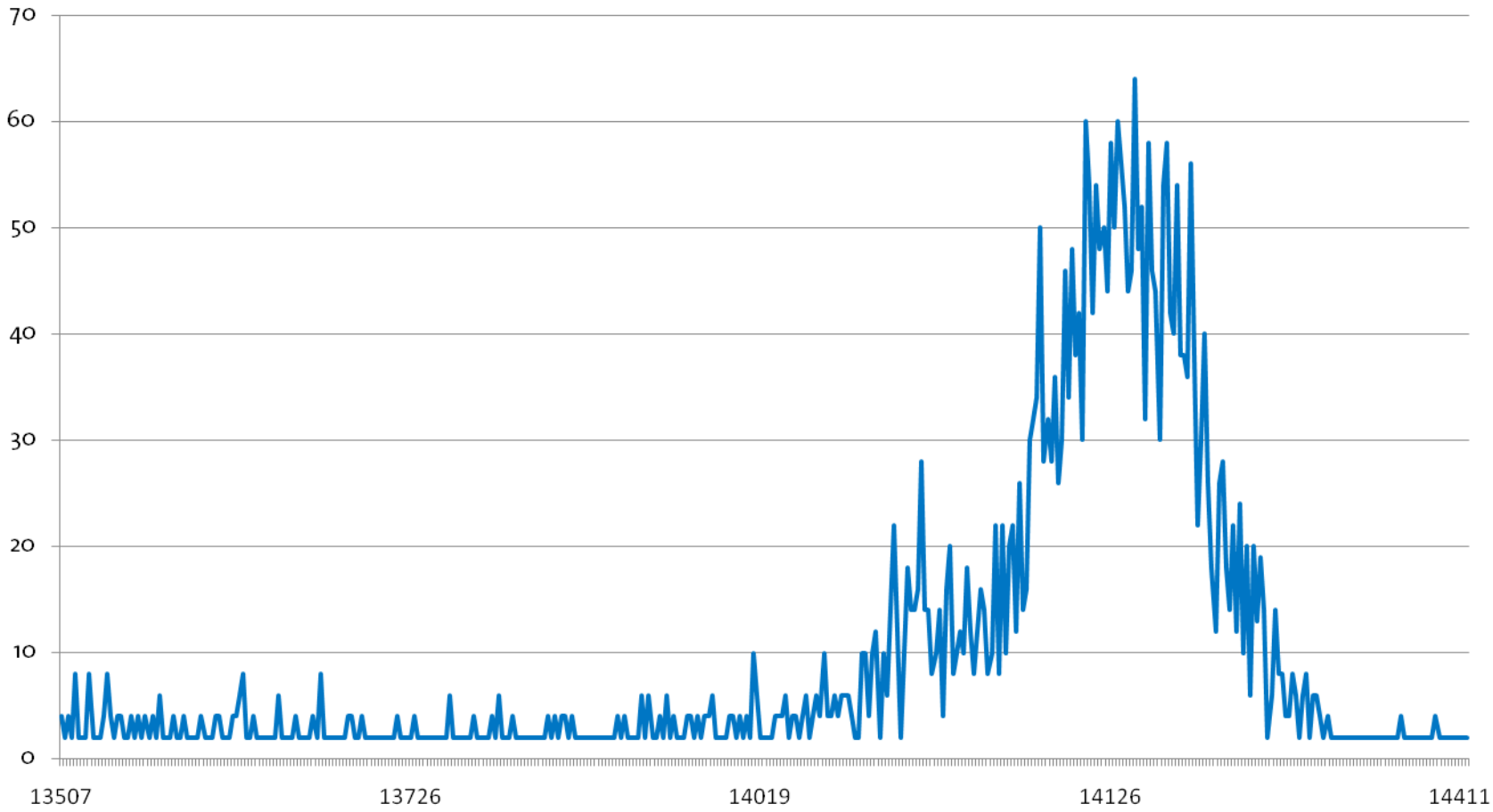

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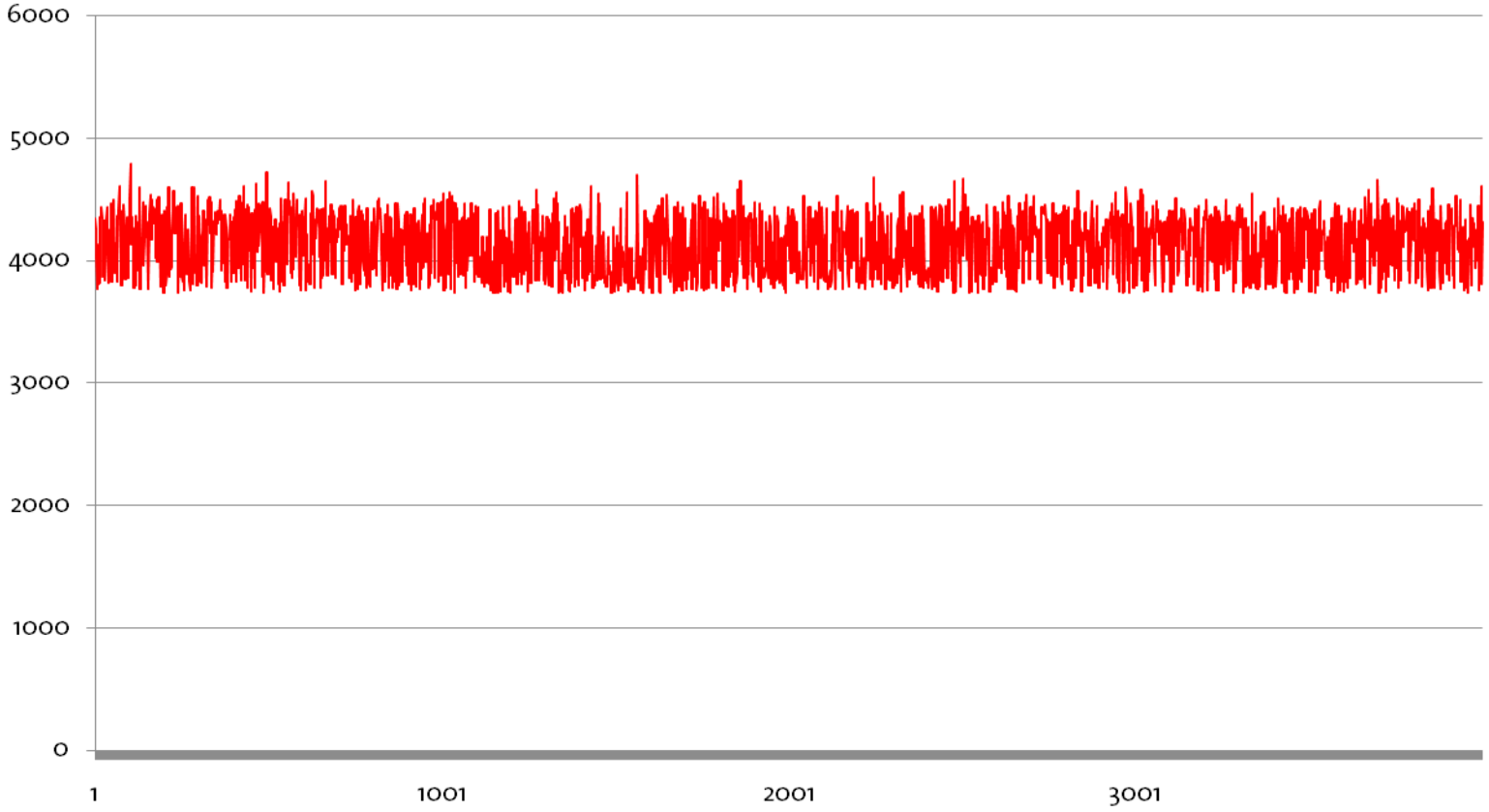

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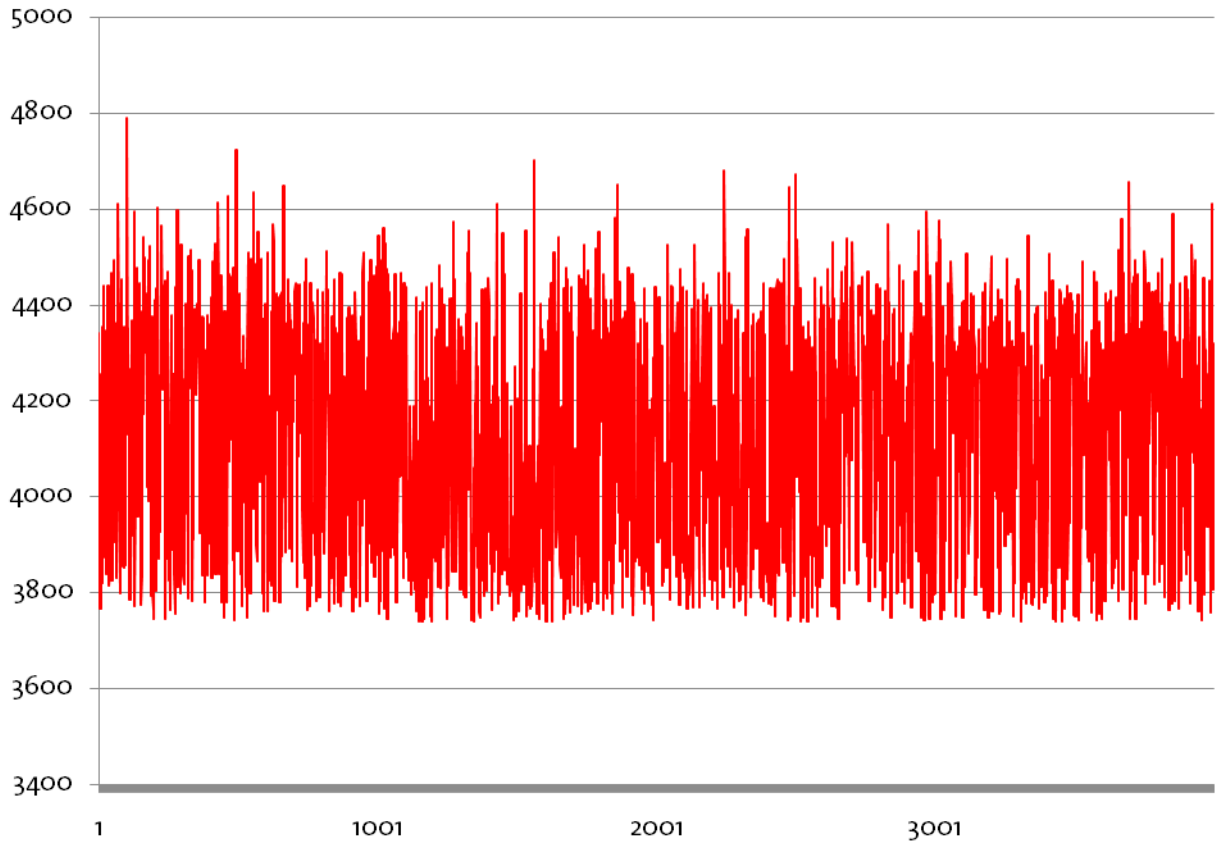

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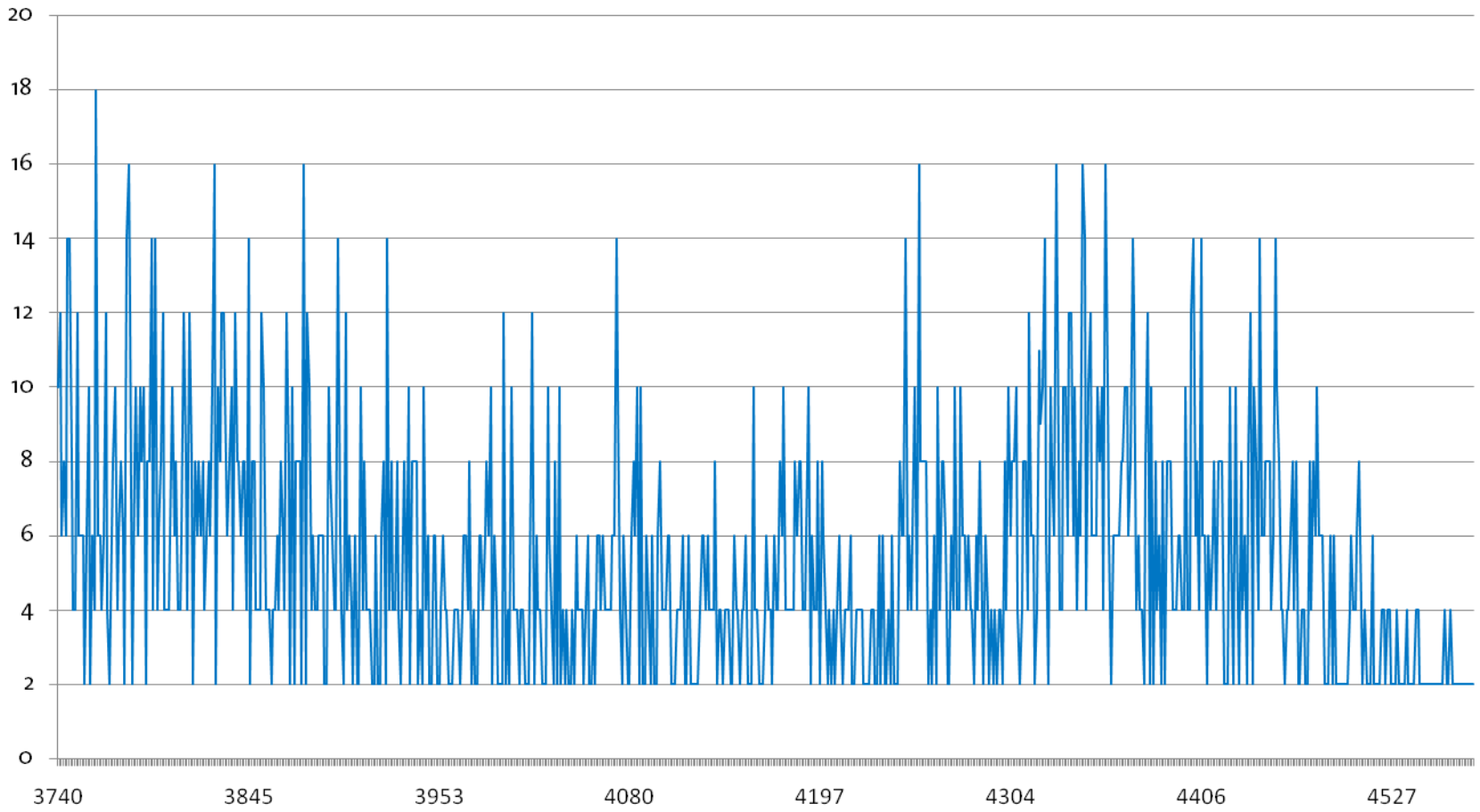

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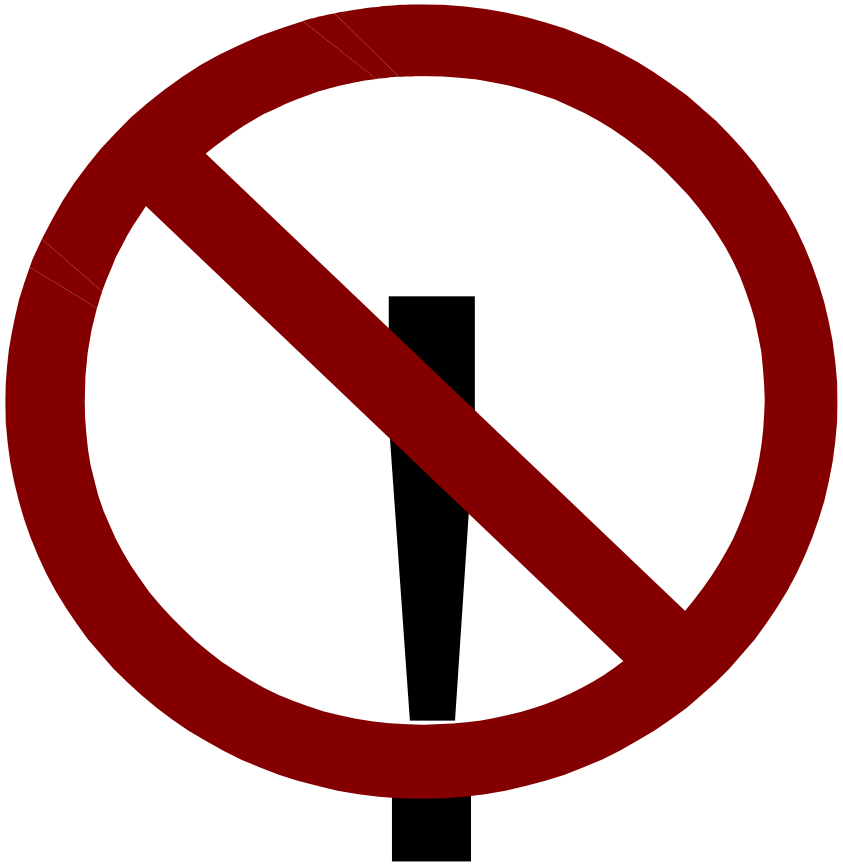

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