Use of monthly collected milk yields for the early detection of vector-borne emerging diseases.

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Plan

1. Context
2. Data
3. Disease detection
4. Results
5. Conclusions

Context

- Emergence of 2 vector-borne diseases in ruminants in Northern Europe since 2006

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- Increased risk?
  - Global warming
  - Trade

Syndromic surveillance

- The next emergence
    - What?
    - When?
    - Where?

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- Need non specific methods of detection
  - $\Rightarrow$ Syndromic surveillance
- Milk production
  - High metabolic demand for the dairy cow
  - $\Rightarrow$ Non specific
  - $\Rightarrow$ Precocious

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Study design

1. Prediction of **expected milk productions**
2. Calculation of **Observed - Expected** productions
3. Detection of **clusters** of low milk production

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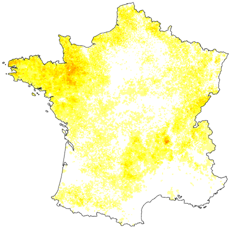
Period studied

- 2006: Before BTV-8 emergence
- 2007: During BTV-8 emergence

Milk recording data

- Milk recording:
  - Yields of all cows from a herd
  - Monthly basis
  - Herd location: municipality level
  - $\sim$ 60% of French dairy herds

Number of herds per km²



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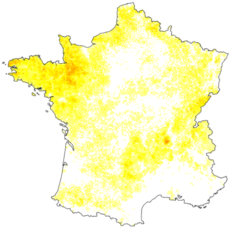

- For this project
  - All the data collected between 2003 and 2007

BTV notification data

- Emergence of BTV-8 in 2006 in Belgium/Germany/the Netherlands
- Disease expected in France in 2007
    - Notification of clinical suspicions mandatory
    - Serological tests on suspected animals
    - Active surveillance around the affected area

Prediction of expected milk production

- Prediction of expected herd test-day milk productions
- From 3 years of historical data
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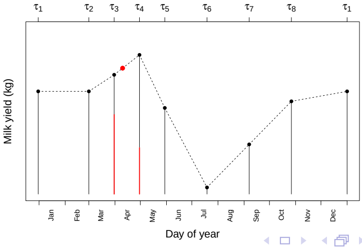
- Linear mixed models

$$Y_{ij} = \sum_{k=1}^{8} I_k \left[(\beta_k + \upsilon_k^j) \frac{d - \tau_k}{\tau_{k+1} - \tau_k} + (\beta_{k+1} + \upsilon_{k+1}^j)(1 - \frac{d - \tau_k}{\tau_{k+1} - \tau_k}) \right] + \varepsilon_{ij}$$

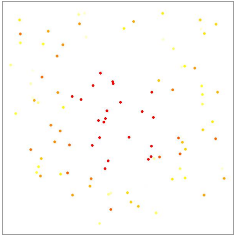
$$\upsilon_k^j \sim MVN(0, \Sigma_j)$$

$$\varepsilon_{ij} \sim (0, \sigma_{ij})$$



Scan statistic

- An area with potential disease clusters
- A normally distributed variable



Scan statistic

- An area with potential disease clusters
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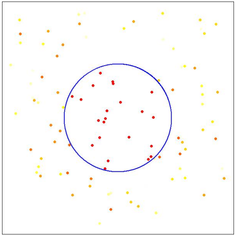
- A circle of random location and size is chosen
- H_0: The distribution of the variable is the same inside as outside of the circle
    - Likelihood of a measure given H_0?
    - Log likelihood ratio (LLR)



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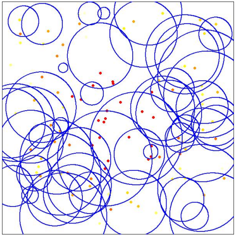

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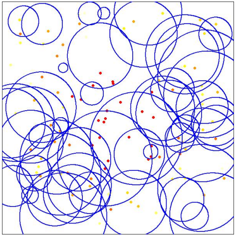
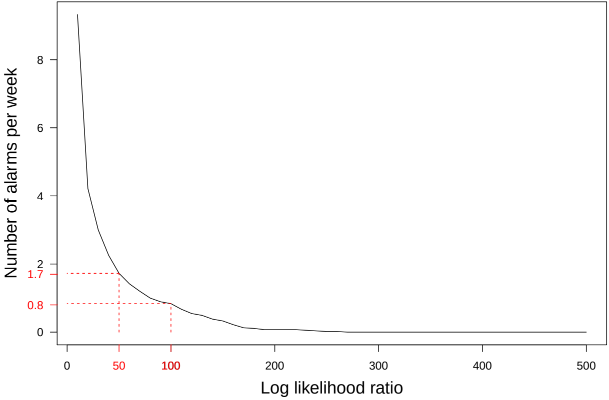
- Algorithm implemented in **SaTScan**™

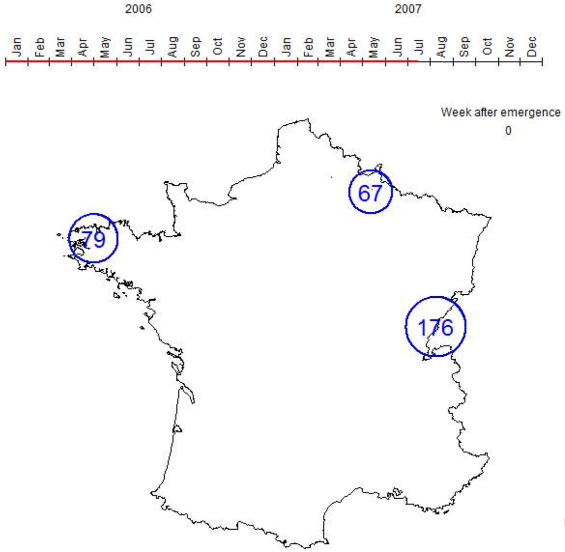


LLR threshold-False alarms

- Clusters detected before the 1st March 2007



Clusters detected during the emergence



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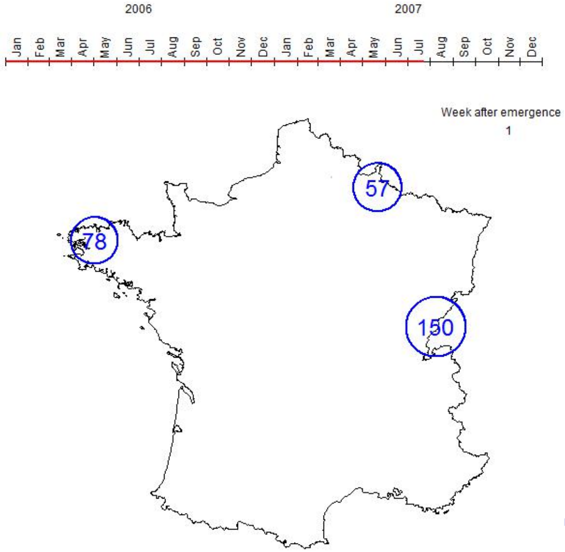

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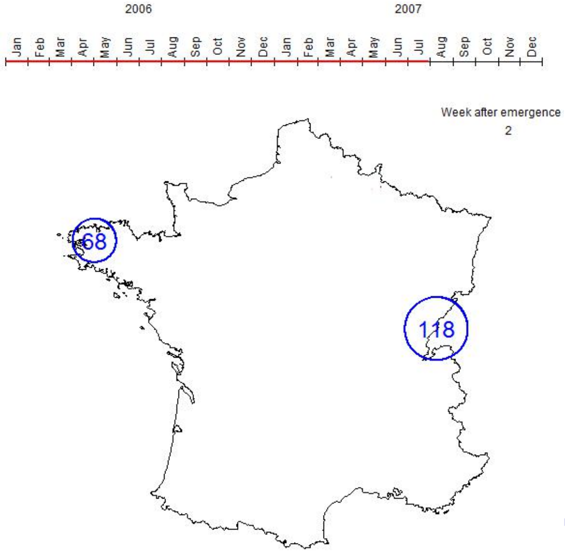

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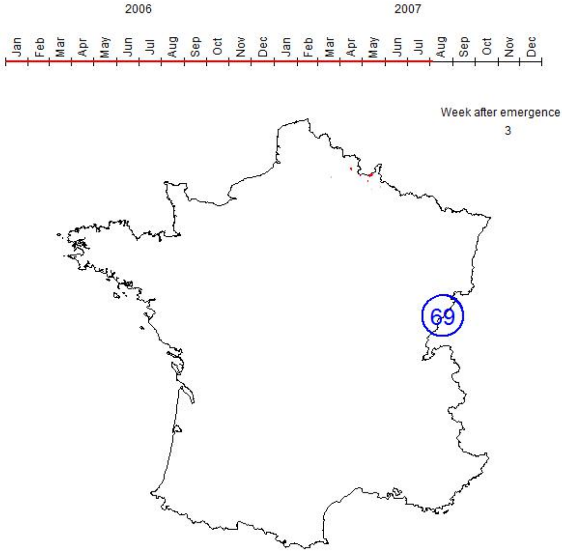

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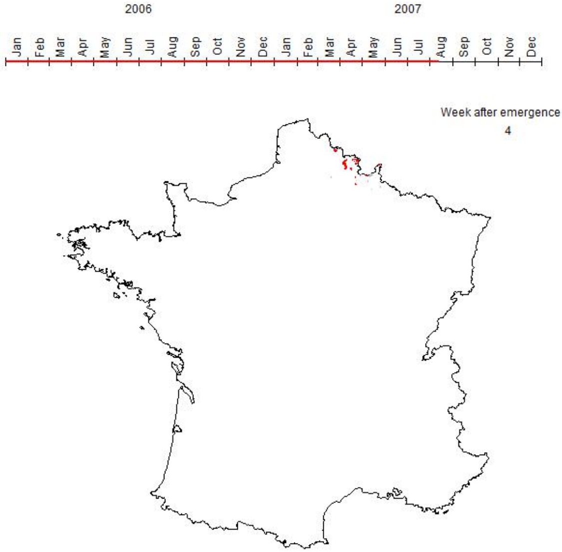

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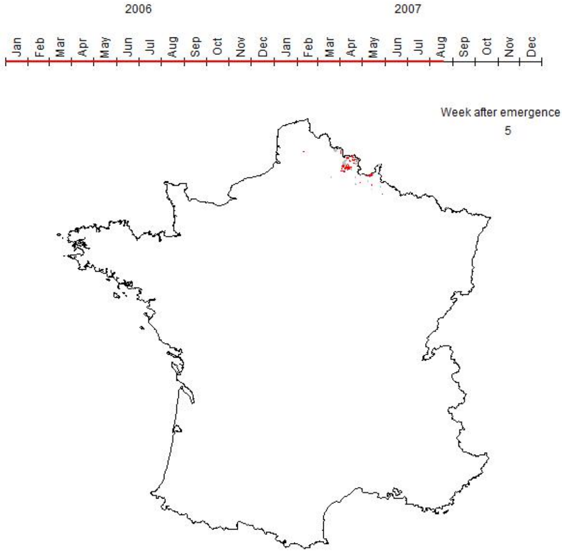

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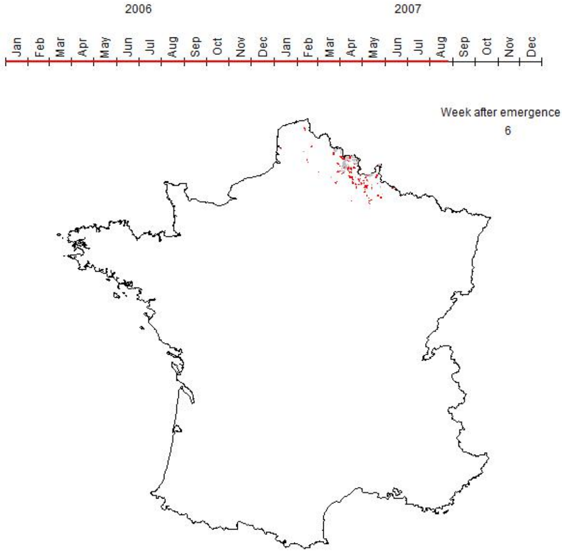

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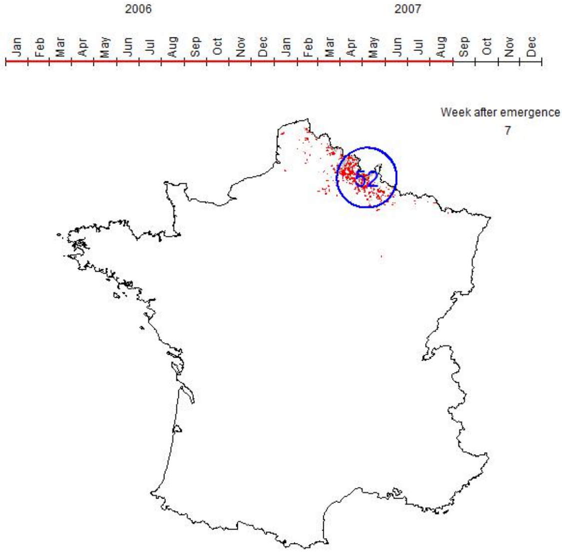

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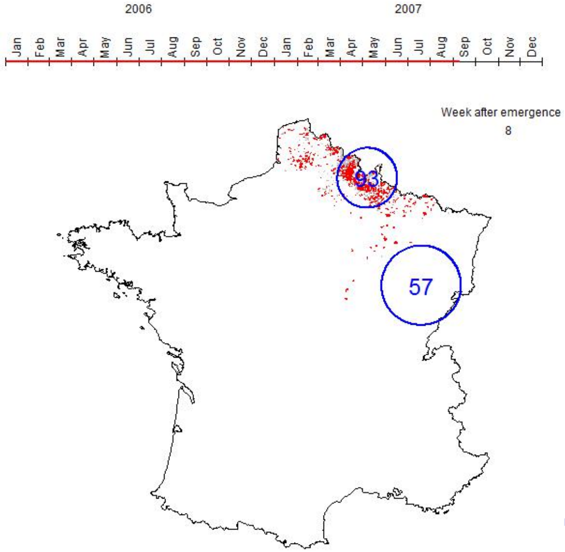

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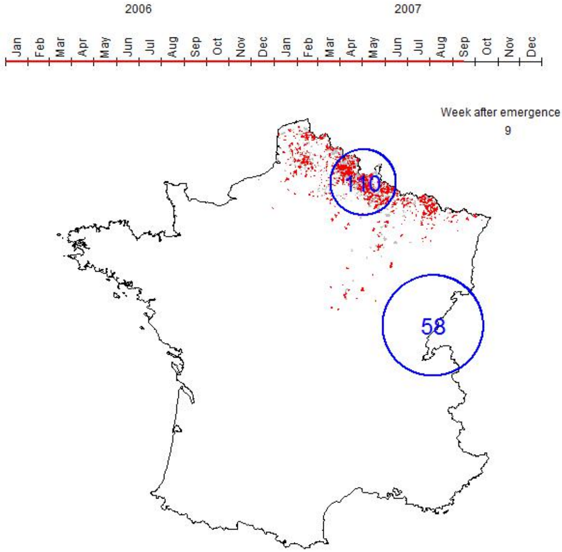

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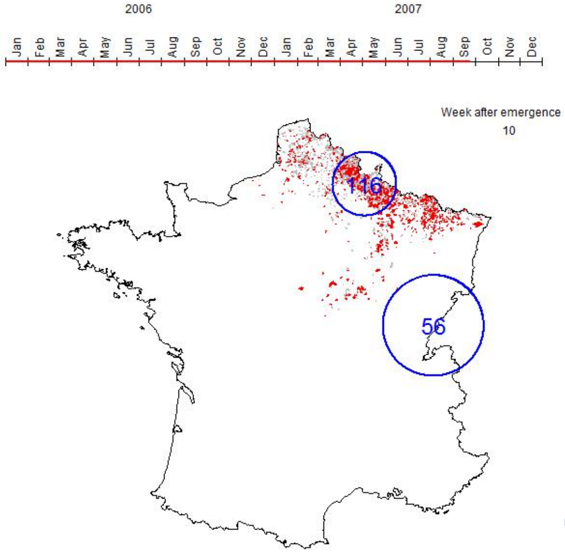

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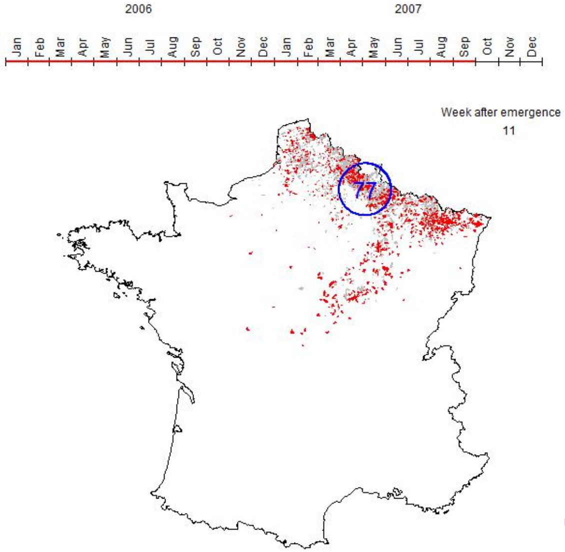

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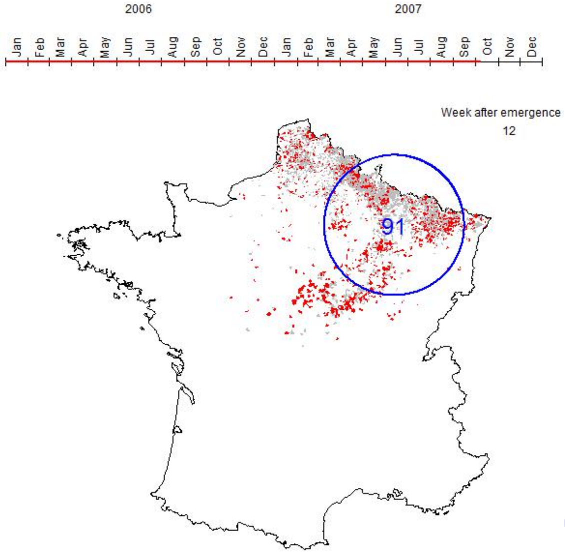

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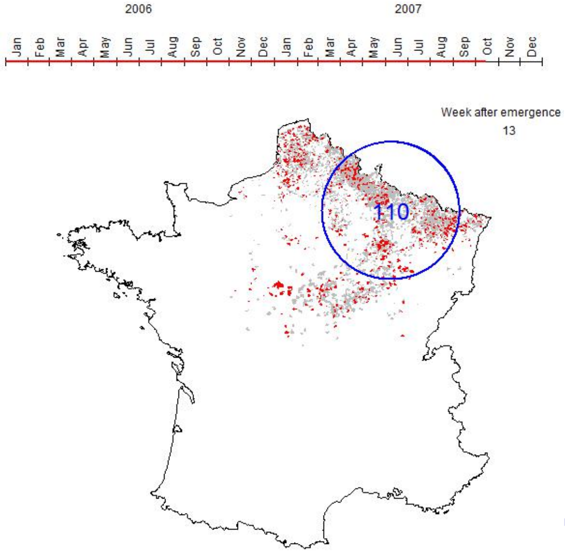

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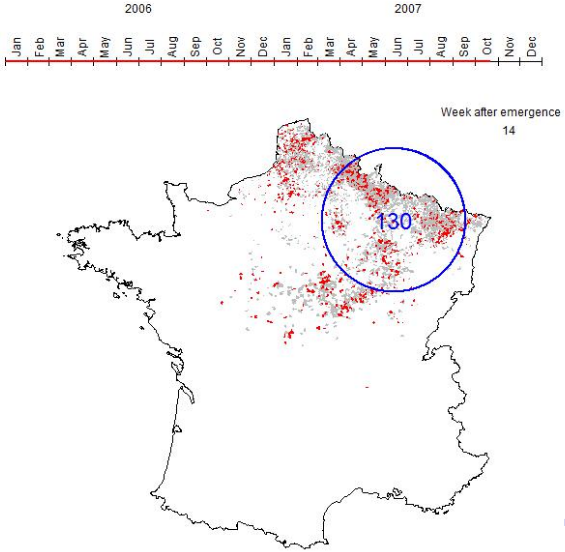
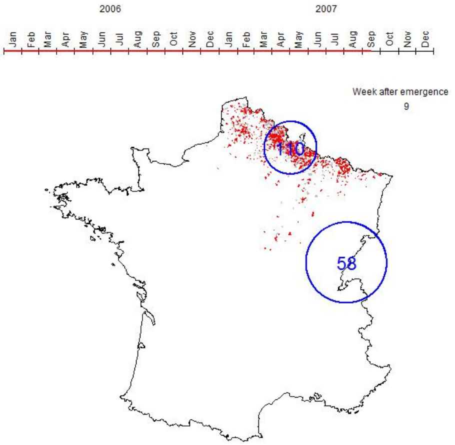


Milk production in the affected area

First true alarm with LLR > 100



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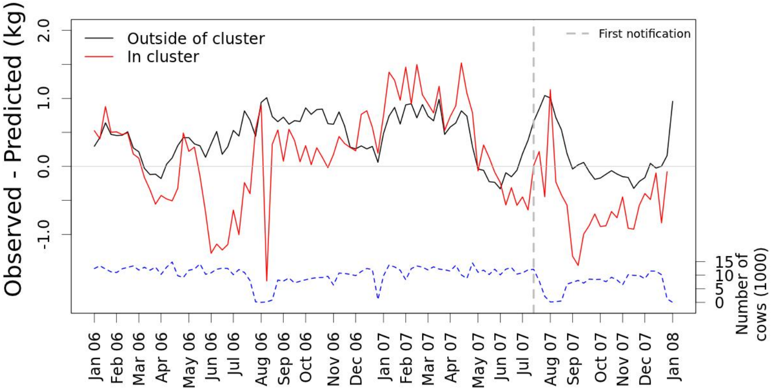

Conclusions

- Milk production dropped when the disease emerged
  - Deviation from expected $\sim$ 1 kg at the maximum
  - Deviation of the same magnitude between May and July 2006
  - Very low number of recordings at the beginning of the outbreak
- Main limitation: difficulty to predict milk production in the absence of disease
  - $\Rightarrow$ False positives
  - Is it possible to improve prediction?
    - Prediction at the cow-level: computationally intractable
    - Different model?
    - Incorporate more information: Climate, feed price, ...

Thank you!

EMIDA ERA-NET

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CODA - CERVA

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