



Optimizing multi-layered screening

Defence-in-depth or statistical folly?

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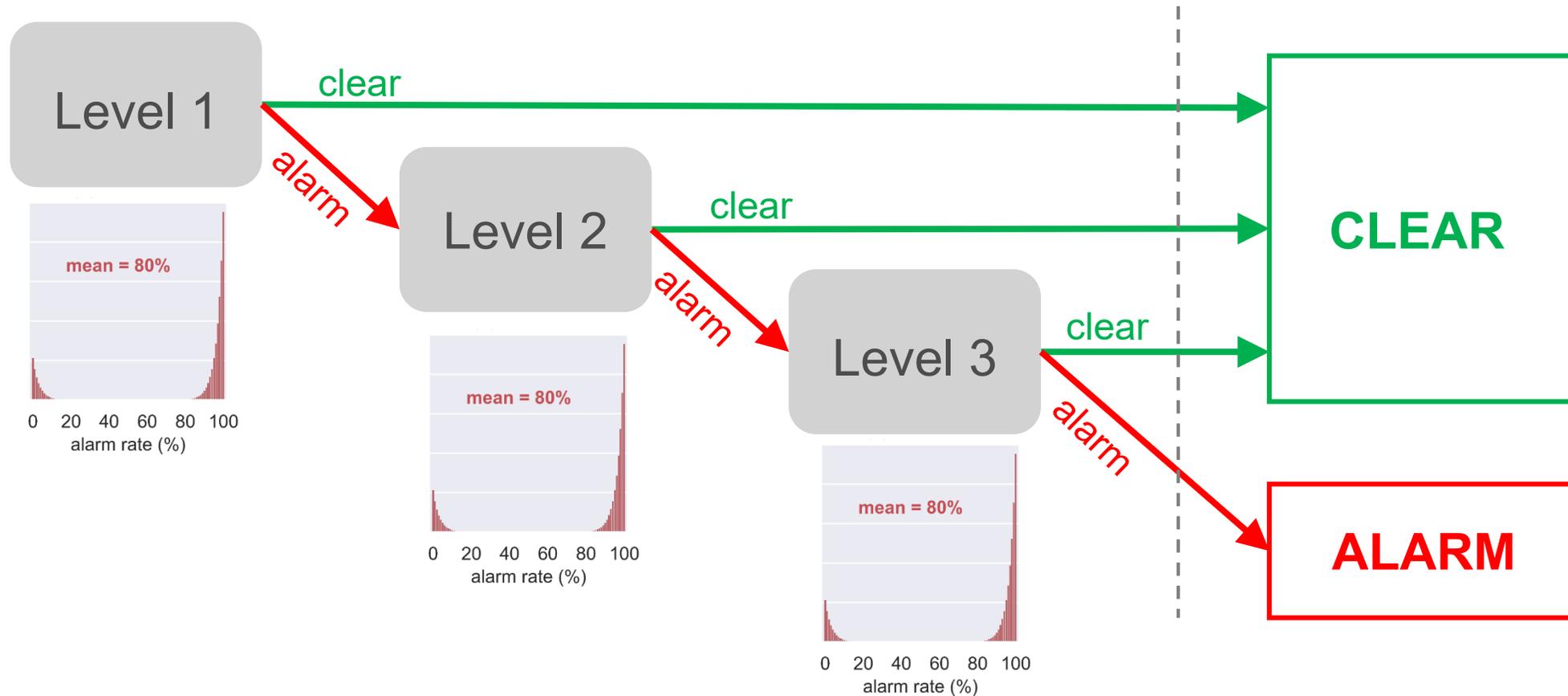
ADSA-25, 4 May 2022

So what? Who cares?

- ❑ **Space:** Almost all security screening processes are **multi-layered**.
- ❑ **Problem:** We rarely *regulate* or *test* **system-level performance**.
- ❑ This presentation summarises a software model of multi-layered screening (Jupyter notebook available upon request).
- ❑ **System-level performance** depends on i) how correlated / orthogonal the layers are, and ii) how we combine the outputs of each layer.
- ❑ **Solution:** Cumulative screening architecture can significantly outperform cascading screening architectures. (For cumulative screening, the more orthogonal the layers the better.)

Multi-layered screening: “cascading”

What is the system performance?



Multi-layered screening: orthogonal vs correlated

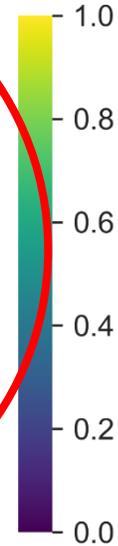
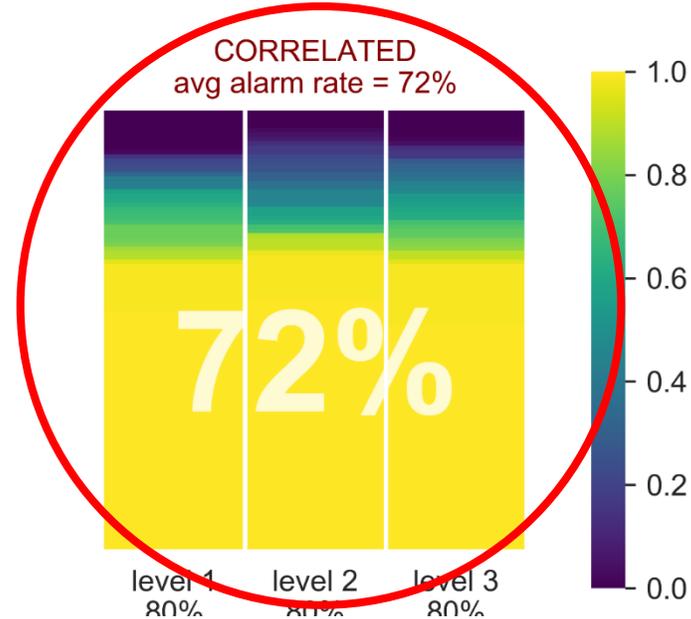
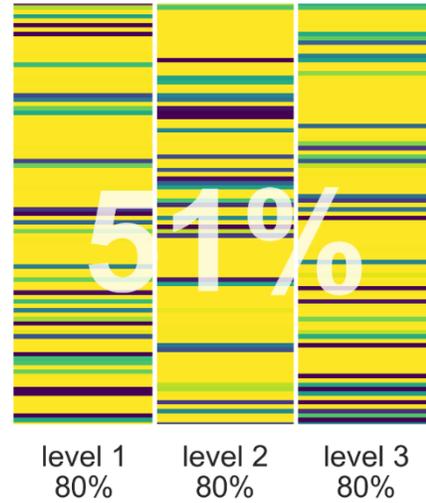
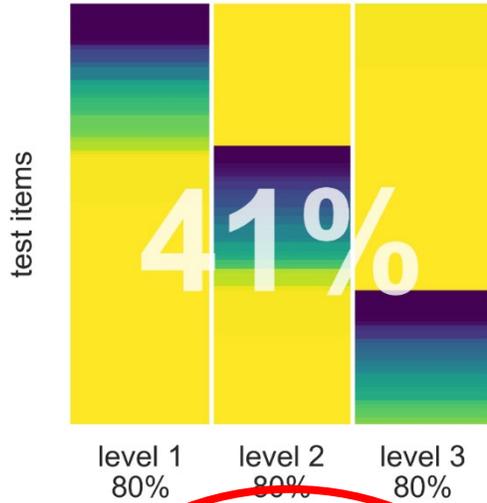
true

positives:

ORTHOGONAL
avg alarm rate = 41%

RANDOM
avg alarm rate = 51%

CORRELATED
avg alarm rate = 72%



Conflicting requirements!

TPR: correlated
FPR: orthogonal

We need a new screening architecture...

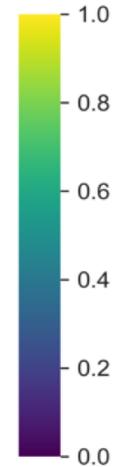
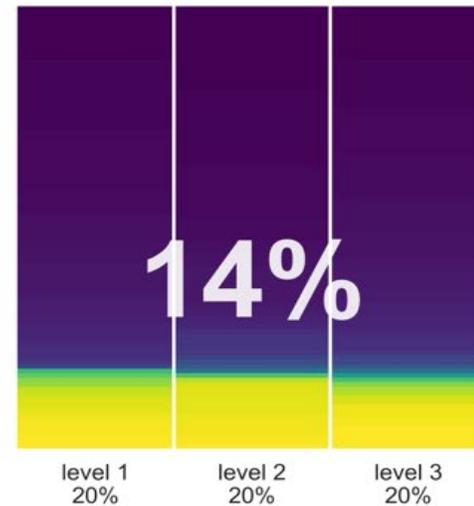
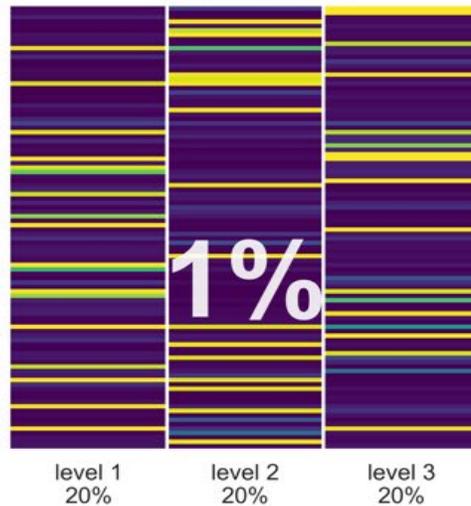
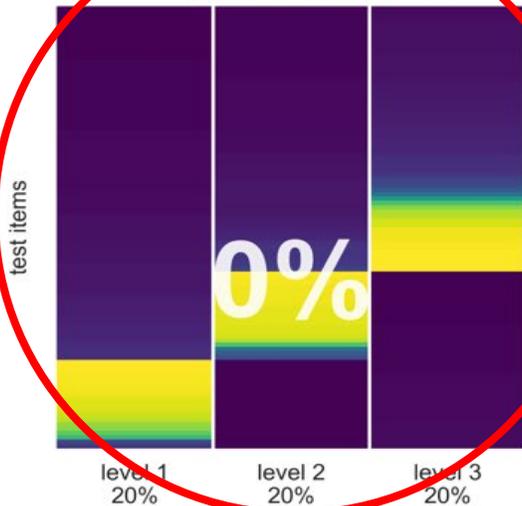
false

positives:

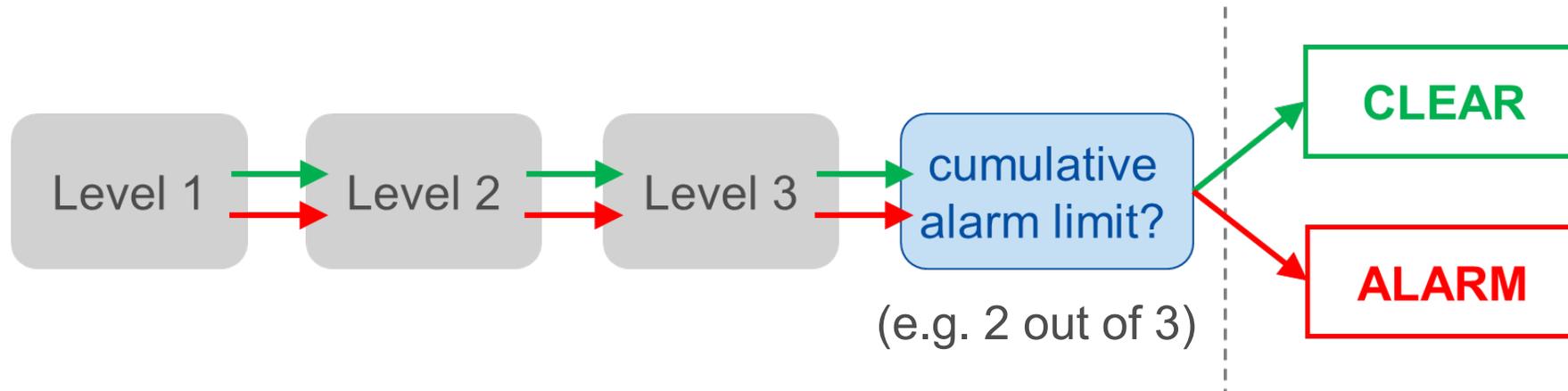
ORTHOGONAL
avg alarm rate = 0%

RANDOM
avg alarm rate = 1%

CORRELATED
avg alarm rate = 14%



A different design: “cumulative” screening



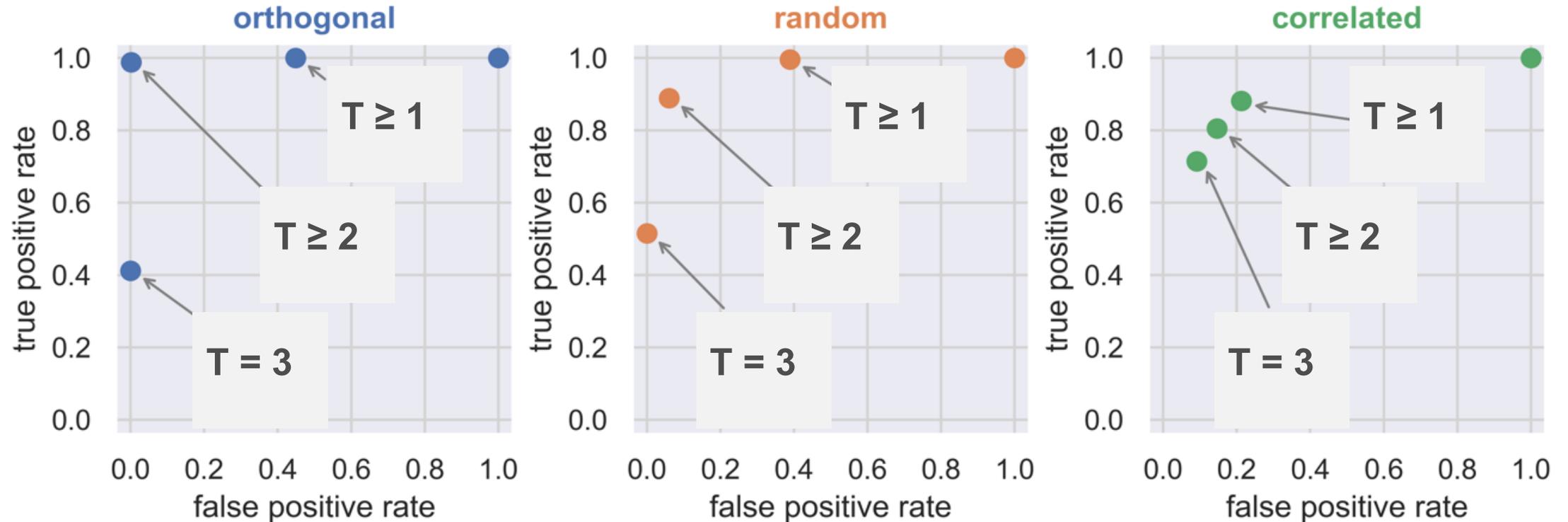
Scan with all layers regardless of individual outputs “alarm” or “clear”. Weaknesses of one layer can be complemented by strengths of other layers.

Requirements for cumulative screening:

- ❑ High-throughput (< 5 secs) screening technologies
- ❑ Orthogonal screening technologies
- ❑ Data fusion

System-level performance: cumulative screening

Showing different thresholds, T , required to generate a system-level alarm



Key message: we should move from $T=3$ to $T \geq 2$
(and as orthogonal as possible)

Optimizing multi-layered screening

Recommendations

- ❑ Move from **equipment-based thinking** to **systems thinking**
- ❑ Move from **cascading screening** to **cumulative screening**
- ❑ Prioritise **orthogonal, high-throughput detection** technologies
- ❑ Embrace testing of **system-level performance**
- ❑ Promote **open architecture** to enable data fusion

Thank you for your attention.

For more details...

Anderson, D. Optimising multi-layered security screening.
J Transp Secur **14**, 249–273 (2021).

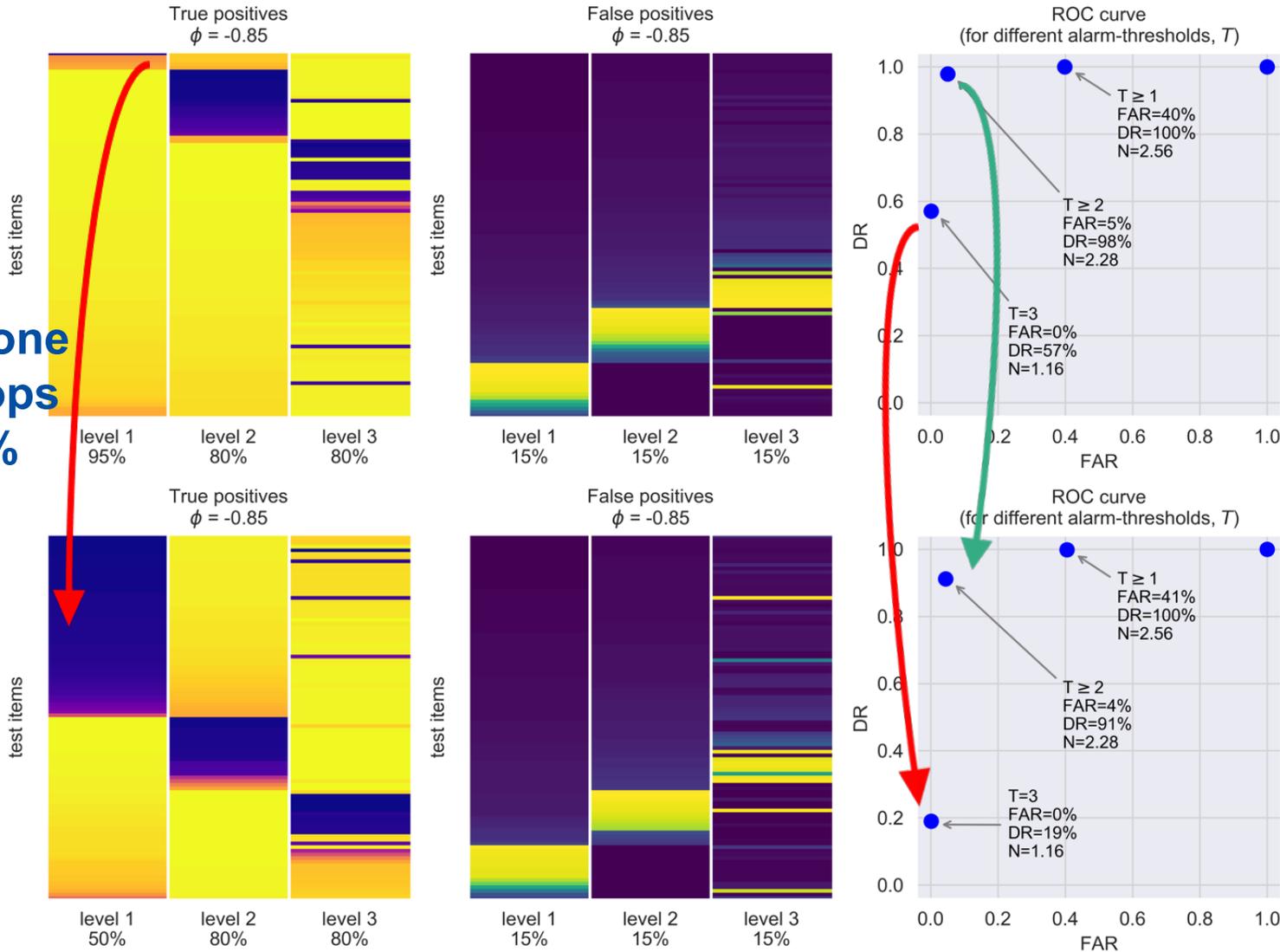
<https://doi.org/10.1007/s12198-021-00237-3>

Note: Software model (interactive dashboard) of multi-layer screening available as Jupyter notebook upon request.

Back-up slide

Cumulative screening is more **resilient** than cascading

If DR of one layer drops from 95% to 50%



$T \geq 2$: from 98% to 91%

$T=3$: from 57% to 19%