

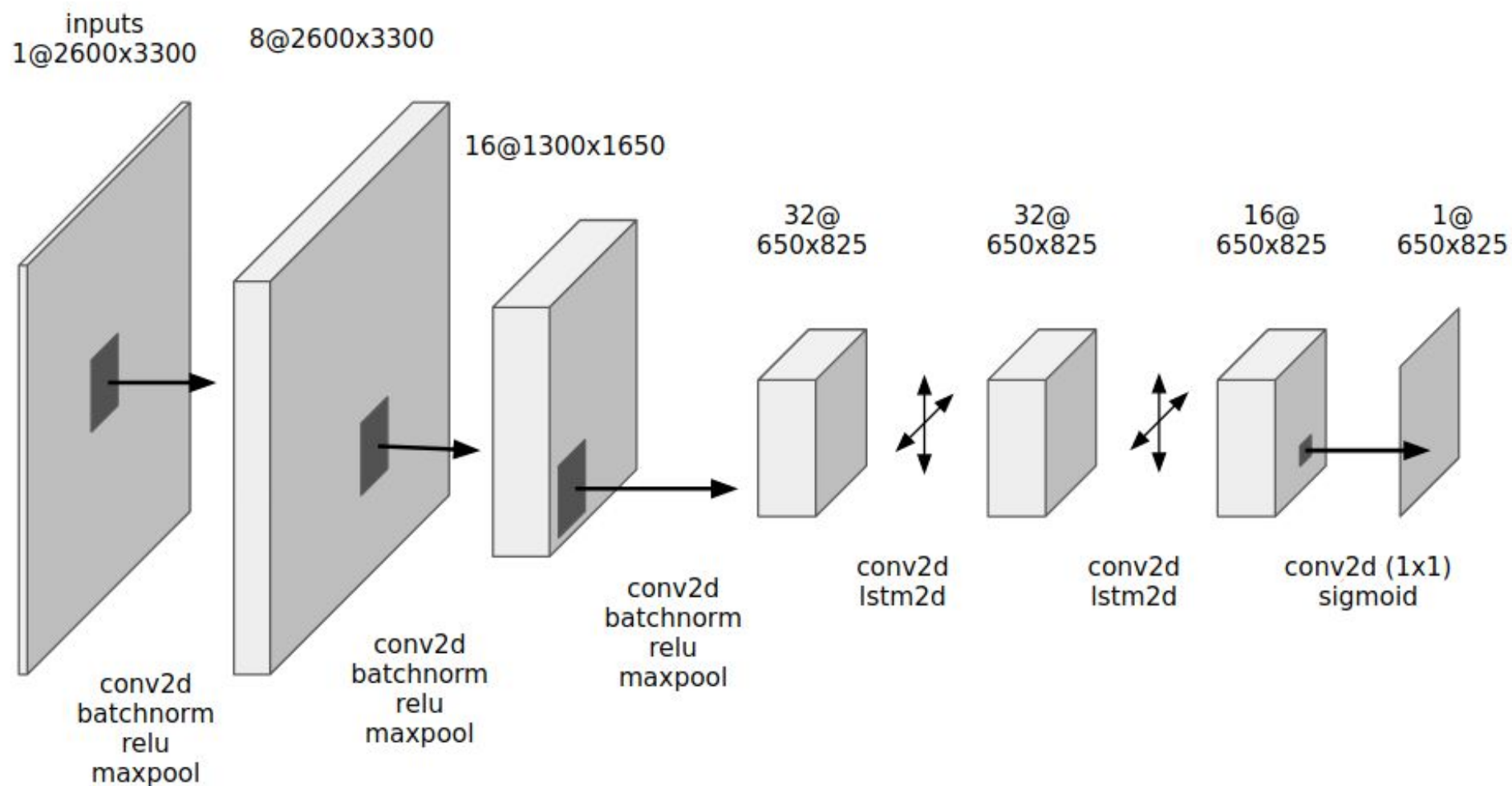
Robust, Simple Page Segmentation using Hybrid Convolutional MDLSTM Networks

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Single Step Deep Learning Layout Analysis

- simple deep learning approach
- convolutional layers + MDLSTM layers
- trainable, adapts to document databases
- simultaneously performs: text/image segmentation, border noise removal, text/math segmentation, text line detection
- robust to noise
- can be applied directly to grayscale, photographic images
- runs on GPU (1 sec / page)
- comparable performance to existing layout analysis systems using just 1600 training pages

Deep Learning Architecture for Layout Analysis



Single Step Border Removal, Multicolumn Textline Finding

Sublogarithmic and Algorithmic Time

In case of 138 mg, 138 mg were set as initial dose
and in the case of 138 mg, 138 mg were set as
initial dose of 138 mg.

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Figure 2. Sample response to question 1. Both participants indicated that the current research was not relevant to their understanding of the role of the agent in the system. The participant on the left was a first-year student, and the participant on the right was a second-year student. — 19.12.17 and 19.12.17.2. — The first participant is a first-year student.

[illegible][illegible]

He took his usual daily precautions against poisoning, but the doctor told him that he was not eating enough. He had to eat a lot of food, and he had to eat it all at once.

*The author and his group have been awarded a grant by the National Science Foundation to study the effects of the environment on the development of the brain.

[illegible]

Spain's role in internationalizing the legacy of the dictatorship is not the only one. In many ways, Spain is not the only country that has experienced a similar process. In fact, the process of internationalizing the legacy of the dictatorship is a global phenomenon. In many ways, the process of internationalizing the legacy of the dictatorship is a global phenomenon. In many ways, the process of internationalizing the legacy of the dictatorship is a global phenomenon.

[illegible]

The 4 subject design

The degree of variation in the exposure of the two
sides of the head is small.

Table 1 shows the mean values of the parameters of the model for the two groups. The mean values of the parameters of the model for the two groups are shown in Table 1. The mean values of the parameters of the model for the two groups are shown in Table 1.

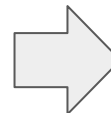
When a high concentration of a species is added to a degraded or degraded-like sample, the degradation rate of that species is often faster than in a sample of similar composition. This is called the "enhancement effect" and is a well-known phenomenon in the study of biodegradation. The enhancement effect is thought to be due to the presence of a "seed" population of the species in the sample, which is able to degrade the substrate more rapidly than a fresh population of the same species.

[illegible]

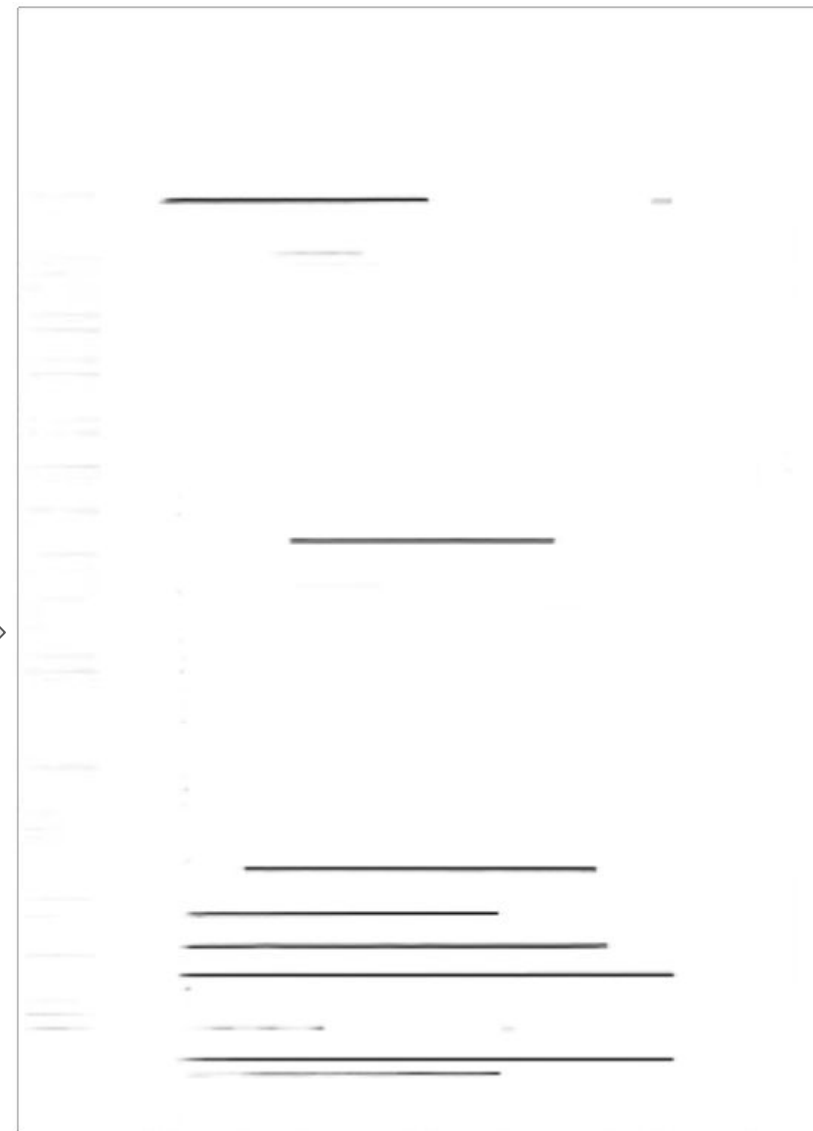
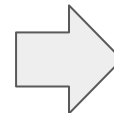
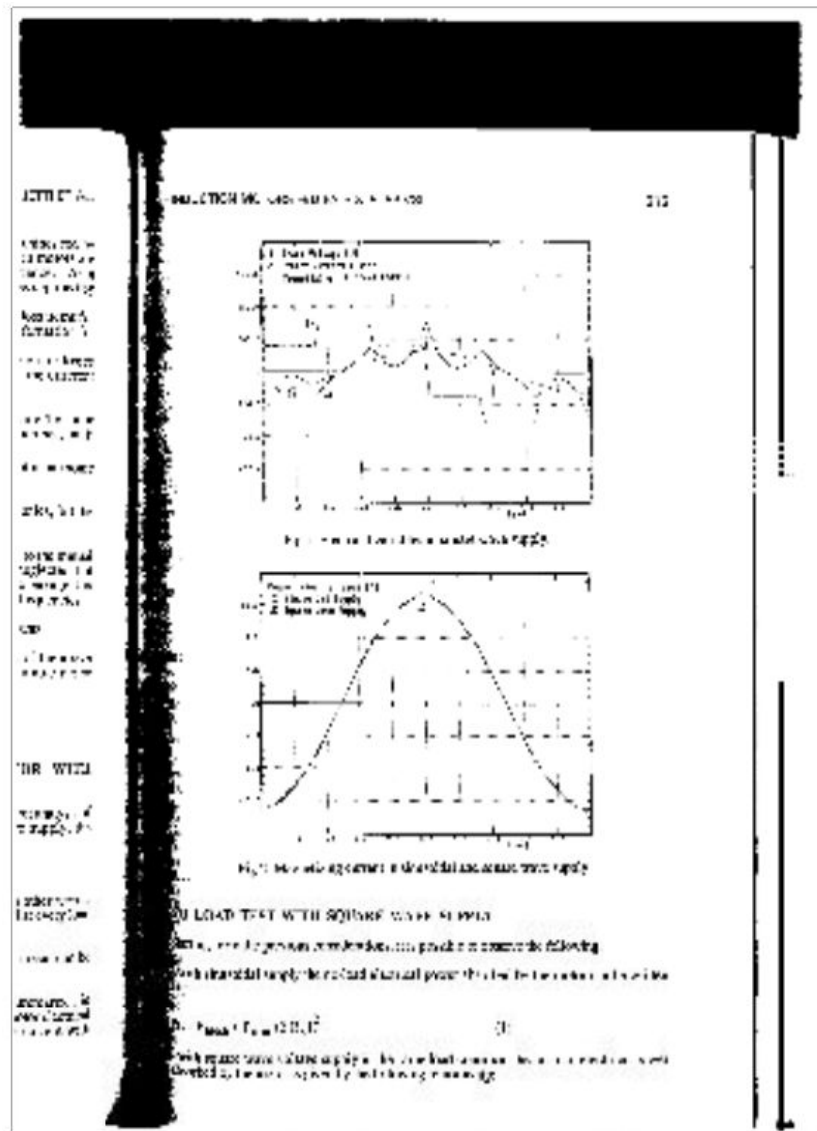
1991: 258

He also worked in the group, ONI, during the 1970s. He is currently working in the Los Angeles office of a private consulting firm, and is a member of the Los Angeles County Board of Supervisors.

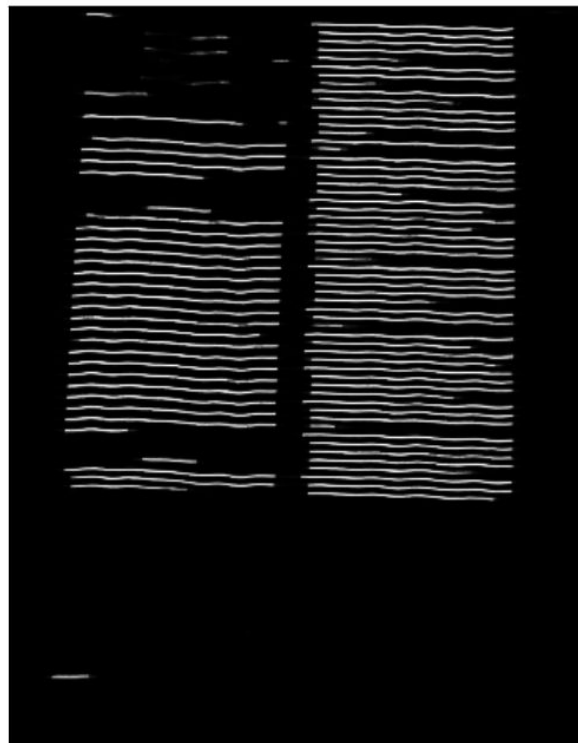
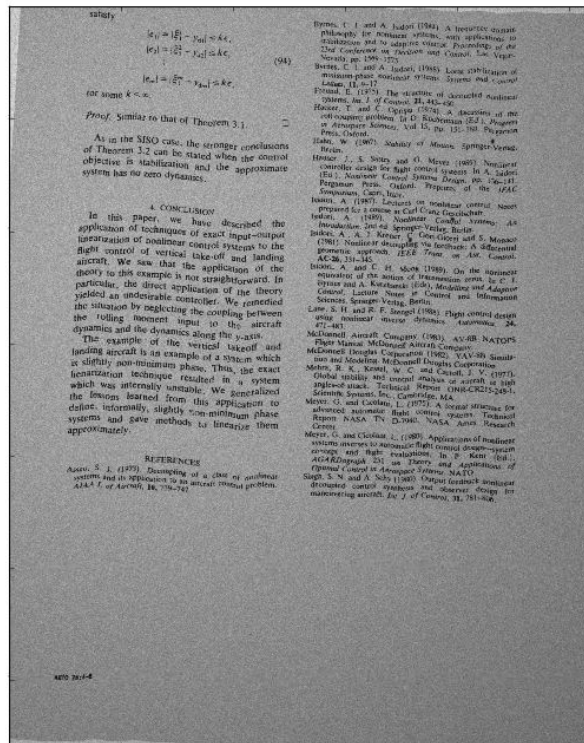
¹ For a detailed study of the asymptotic behavior of the eigenvalues of the Laplacian on a Riemannian manifold, see the book by B. Gruber and J. Jost [1987].

[illegible]

Single Step Border Removal, Math Removal, Figure Removal, Text Line Detection



Direct Application to Grayscale Input



Freund, E. (1975). The structure of nonlinear systems. *Int. J. of Control*, 21, 1-10.

Hacker, T. and C. Oprea (1978). The roll-coupling problem. In D. H. Stokich (Ed.), *Advances in Aerospace Sciences*, Vol. 15. Pergamon Press, Oxford.

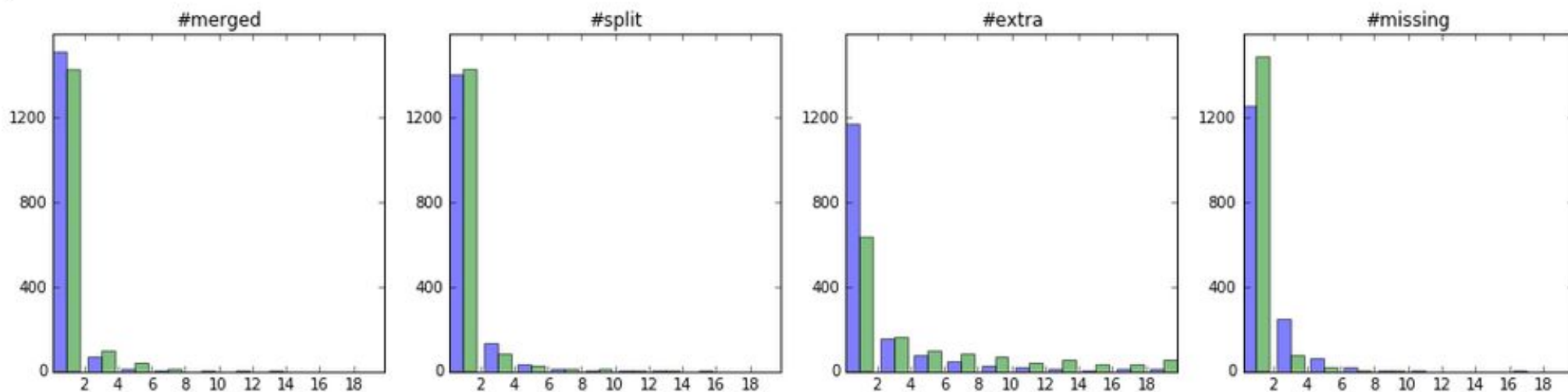
Hahn, W. (1967). *Stability of Motion*. Berlin.

Hauser, J., S. Sastry and G. Meyer (1987). Nonlinear controller design for flight control systems. In A. Isidori (Ed.), *Nonlinear Control Systems*. Pergamon Press, Oxford.

Symposium, Capri, Italy.

Isidori, A. (1987). *Lectures on nonlinear control*. Notes prepared for a course in Control Engineering, Stanford University, Stanford, CA.

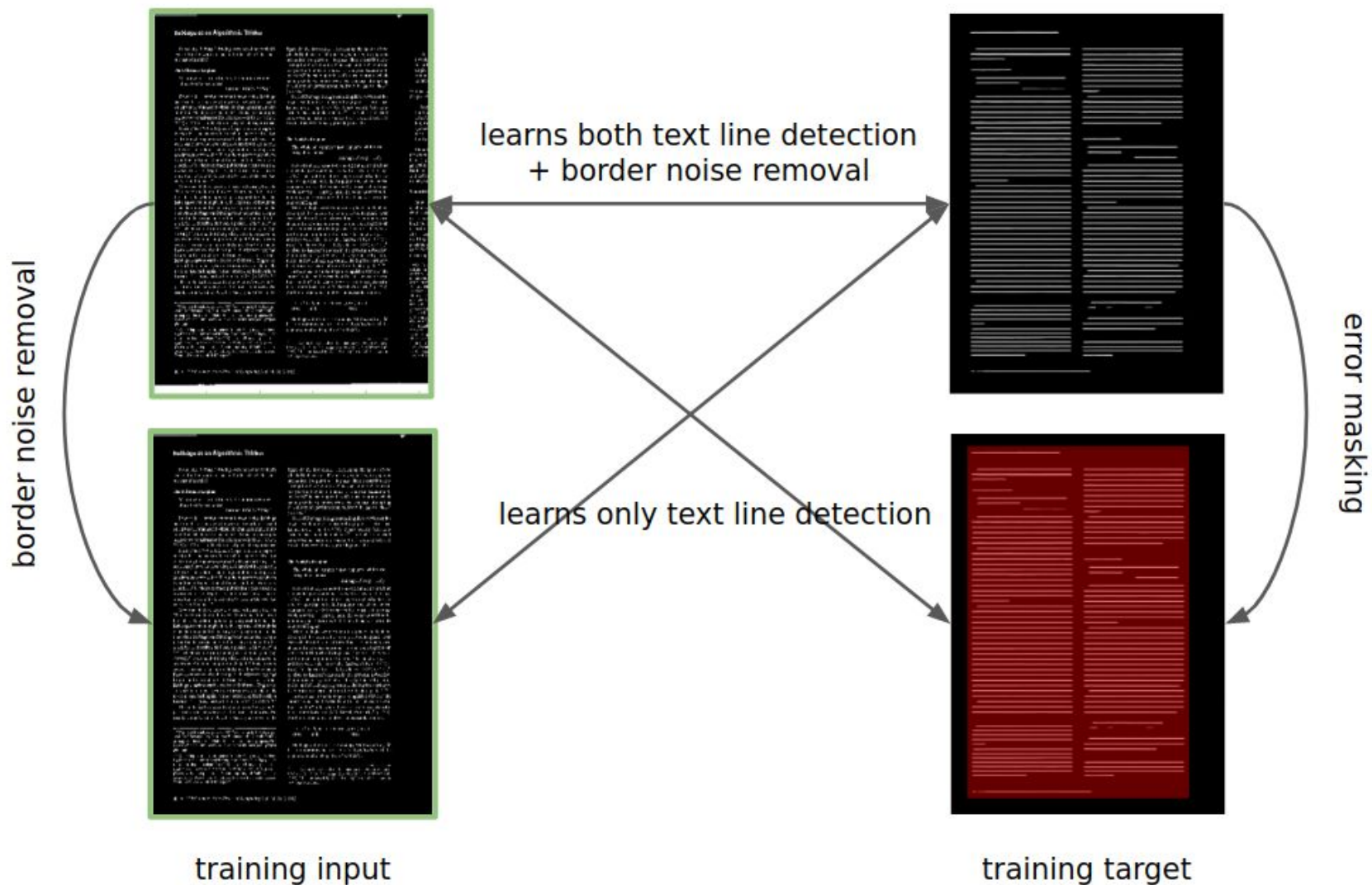
Deep Segmenter vs Tab Segmenter



The Deep Segmenter performs comparable to, or slightly better than, the Tab Segmenter.

Results on page frame only (border noise removed).

Ground Truth Prep vs Layout Analysis Training



Training for Different Detection Tasks



original page

body text
detection

text detection

text frame
detection

border noise
detection

Line Extraction from Text Center Lines

processor simulator and a detailed memory simulator for the Dash prototype. Vers
Tango allows a parallel application to Wa
the

- *The text center lines identified by the DNN are used as seeds for identifying the connected components belonging to the actual text line.*
- *Each connected component within a halo around the text center line seed is assigned to the closest seed.*

Layout Analysis with Deep Learning

processor simulator and a detailed memory simulator for the Dash prototype. Tango allows a parallel application to vers
Was
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processor simulator and a detailed memory ~~simulator for the Dash prototype.~~ vers
Was
the

Deep Neural Network computes text line centers from binary or grayscale document image. Images, math, etc. are implicitly removed.

For each identified text line center, all the closest connected components within a halo are assigned to the line.