LayoutDETR: Detection Transformer Is a Good Multimodal Layout Designer

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https://ningyu1991.github.io/projects/LayoutDETR.html

Motivations

- Graphic designs are at the foundation of communication between marketers and target audience.
- Graphic designs require designers' thoughtful understanding of multimodal inputs:
  - Background images
  - Multiple foreground texts
  - Multiple foreground product images
- Graphic designs require reasonable and aesthetically appealing compositions.
- Manual graphic designs are skill-demanding, time-consuming, and not scalable.

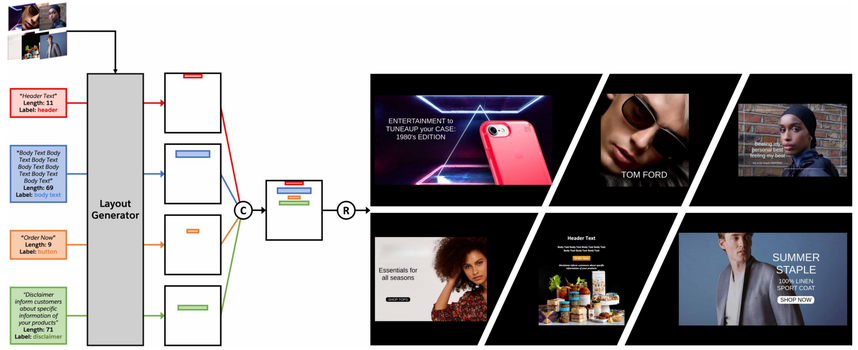
Goal

- Automate the multimodal layout design process by learning a layout generator.

Contributions

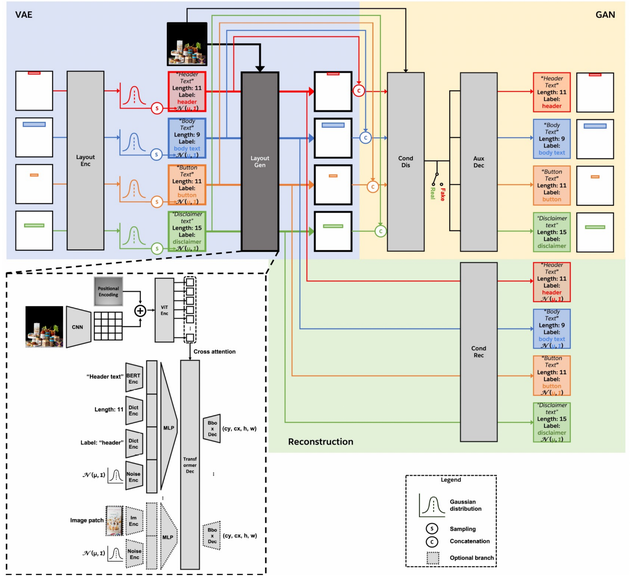
- **Method**: We bridge layout generation and visual detection into one framework that solves multimodal graphic layout design.
- **Dataset**: A large-scale multimodal ad banner dataset with 7,196 samples.
- **State-of-the-art performance** in six evaluation metrics, which measure the realism, accuracy, and regularity of generated layouts
- **Graphical system and user study**: Scales up layout generation and facilitates user studies. Users prefer our designs by significant margins.

Pipeline



Framework

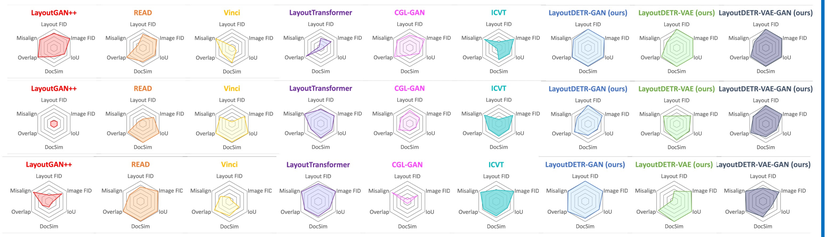
- GAN+VAE
- Unconditional/condition discriminators
- Auxiliar reconstructor
- DETR-based multimodal architecture
- BERT text encoder; ViT image encoder



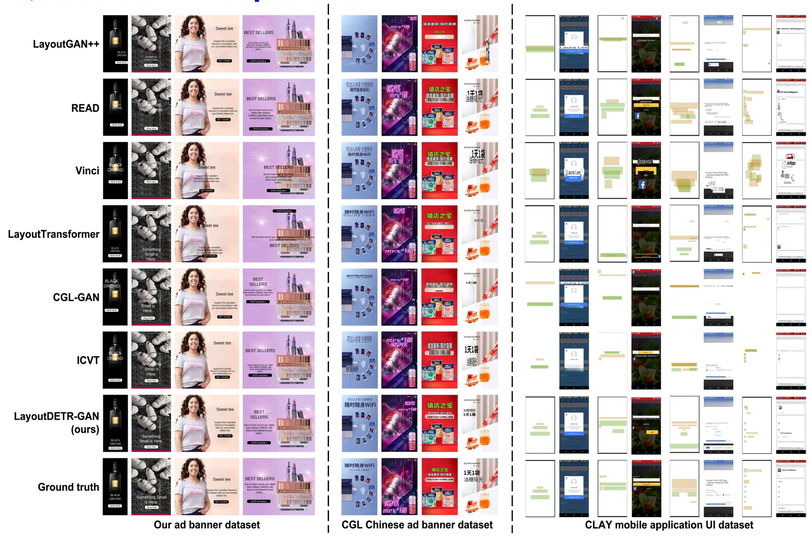
Ablation study

Method	Realism: Layout FID ⇓	Realism: Layout KID ($\times 10^{-3}$) ⇓	Realism: Image FID ⇓	Realism: Image KID ($\times 10^{-5}$) ⇓	Accuracy: IoU ⇑	Accuracy: DocSim ⇑	Regularity: Overlap ⇓	Regularity: Misalign ($\times 10^{-2}$) ⇓
Random layout on real bg	$58.21_{\pm 4.04}$	$525.93_{\pm 45.08}$	$51.01_{\pm 0.41}$	$582.47_{\pm 7.53}$	–	–	–	–
Conditional LayoutGAN++	$11.33_{\pm 0.10}$	$44.77_{\pm 0.36}$	$36.06_{\pm 0.02}$	$115.16_{\pm 3.37}$	$0.111_{\pm 0.001}$	$0.121_{\pm 0.001}$	$0.374_{\pm 0.006}$	$2.194_{\pm 0.058}$
+ Aux. Dec. (Eq. 4-7)	$4.25_{\pm 0.01}$	$16.62_{\pm 0.05}$	$28.40_{\pm 0.06}$	$58.5_{\pm 1.45}$	$0.163_{\pm 0.002}$	$0.130_{\pm 0.001}$	$0.104_{\pm 0.003}$	$0.759_{\pm 0.021}$
+ Gen. Rec. (Eq. 11)	$3.27_{\pm 0.01}$	$11.80_{\pm 0.04}$	$29.56_{\pm 0.06}$	$11.29_{\pm 0.20}$	$0.186_{\pm 0.002}$	$\underline{0.148}_{\pm 0.001}$	$0.125_{\pm 0.003}$	$0.853_{\pm 0.016}$
+ Uncond. Dis. D^u	$3.70_{\pm 0.05}$	$16.23_{\pm 0.08}$	$29.21_{\pm 0.08}$	$25.09_{\pm 0.02}$	$0.177_{\pm 0.002}$	$0.140_{\pm 0.001}$	$\underline{0.103}_{\pm 0.003}$	$\underline{0.681}_{\pm 0.011}$
+ gIoU loss (Eq. 10)	$\underline{3.23}_{\pm 0.01}$	$11.60_{\pm 0.02}$	$\underline{28.20}_{\pm 0.04}$	$\underline{10.51}_{\pm 0.09}$	$0.182_{\pm 0.002}$	$0.138_{\pm 0.001}$	$0.106_{\pm 0.003}$	$0.721_{\pm 0.011}$
+ Overlap & Misalign loss ≙ LayoutDETR-GAN (ours)	$\mathbf{3.19}_{\pm 0.01}$	$\mathbf{5.62}_{\pm 0.01}$	$\mathbf{27.35}_{\pm 0.04}$	$\mathbf{8.31}_{\pm 0.80}$	$\mathbf{0.208}_{\pm 0.002}$	$\mathbf{0.151}_{\pm 0.000}$	$\mathbf{0.101}_{\pm 0.003}$	$\mathbf{0.646}_{\pm 0.011}$
- Text length embeddings	$3.24_{\pm 0.01}$	$\underline{9.25}_{\pm 0.05}$	$28.65_{\pm 0.03}$	$11.42_{\pm 0.35}$	$\underline{0.191}_{\pm 0.002}$	$0.144_{\pm 0.001}$	$0.117_{\pm 0.003}$	$0.807_{\pm 0.012}$
- Text class embeddings	$25.17_{\pm 0.54}$	$171.88_{\pm 5.17}$	$29.25_{\pm 0.25}$	$139.16_{\pm 4.44}$	$0.166_{\pm 0.002}$	$0.132_{\pm 0.001}$	$0.110_{\pm 0.001}$	$0.000_{\pm 0.000}$

Quantitative comparisons



Quantitative comparisons



User study

Method	READ	Vinci	LayoutTransformer	CGL-GAN	ICVT	LayoutDETR-GAN (ours)
LayoutGAN++	$49.8\%_{p=0.4}$	$45.6\%_{p=3e-3}$	$44.4\%_{p=3e-4}$	$53.9\%_{p=0.01}$	$47.1\%_{p=0.04}$	$55.7\%_{p=2e-4}$
READ	–	$45.1\%_{p=1e-3}$	$44.5\%_{p=3e-4}$	$53.8\%_{p=0.01}$	$53.0\%_{p=0.04}$	$54.2\%_{p=5e-3}$
Vinci	–	–	$51.7\%_{p=0.2}$	$55.8\%_{p=2e-4}$	$56.9\%_{p=1e-5}$	$62.6\%_{p=3e-15}$
LayoutTransformer	–	–	–	$57.1\%_{p=8e-6}$	$56.0\%_{p=2e-4}$	$63.5\%_{p=2e-17}$
CGL-GAN	–	–	–	–	$48.9\%_{p=0.2}$	$54.7\%_{p=3e-3}$
ICVT	–	–	–	–	–	$55.4\%_{p=6e-4}$