

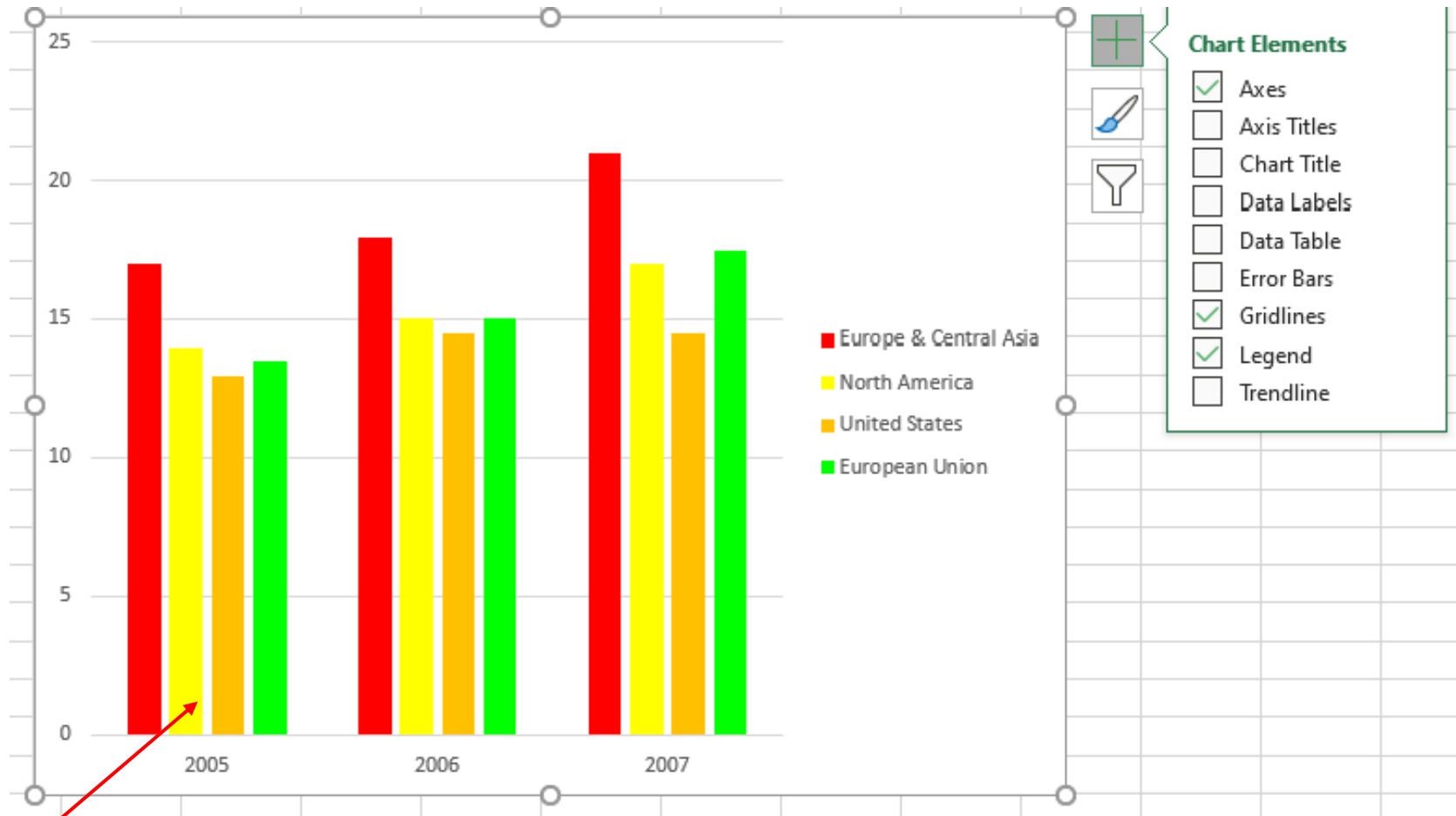
Visual Style Extraction from Chart Images for Chart Restyling

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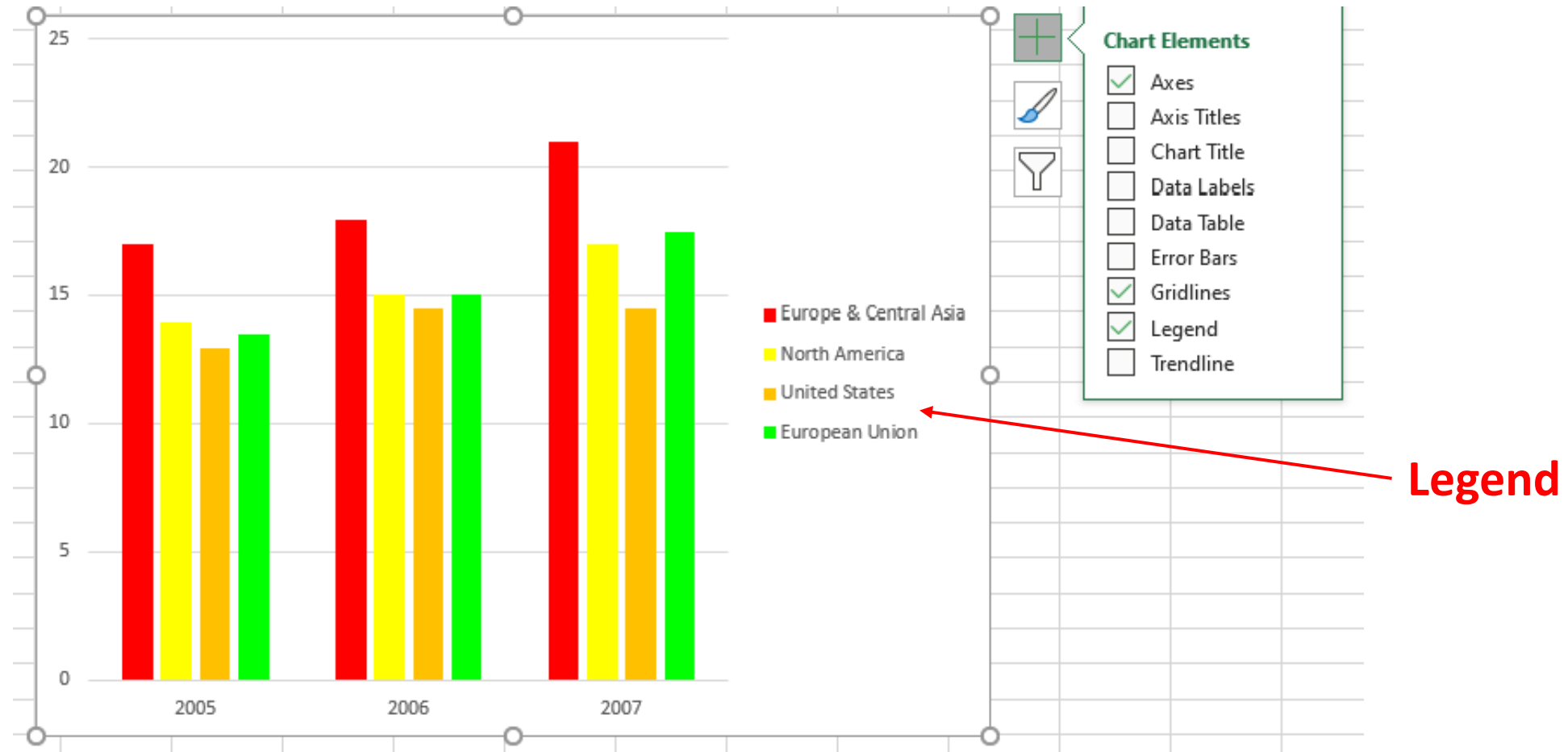
{dahua¹, guow³, cyl¹}@microsoft.com; wjp.pku@gmail.com²

Editing a Chart



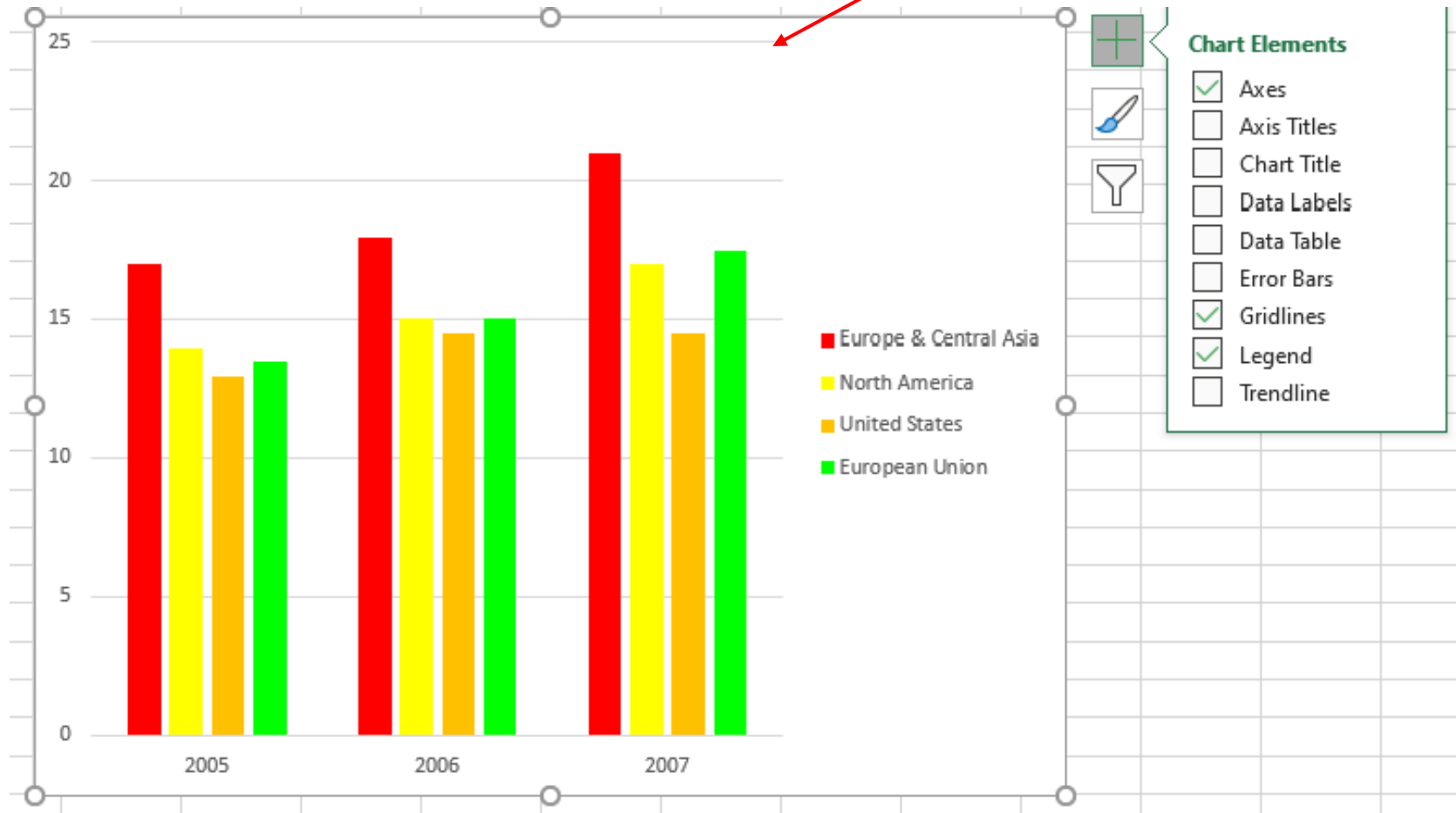
Foreground Color

Editing a Chart

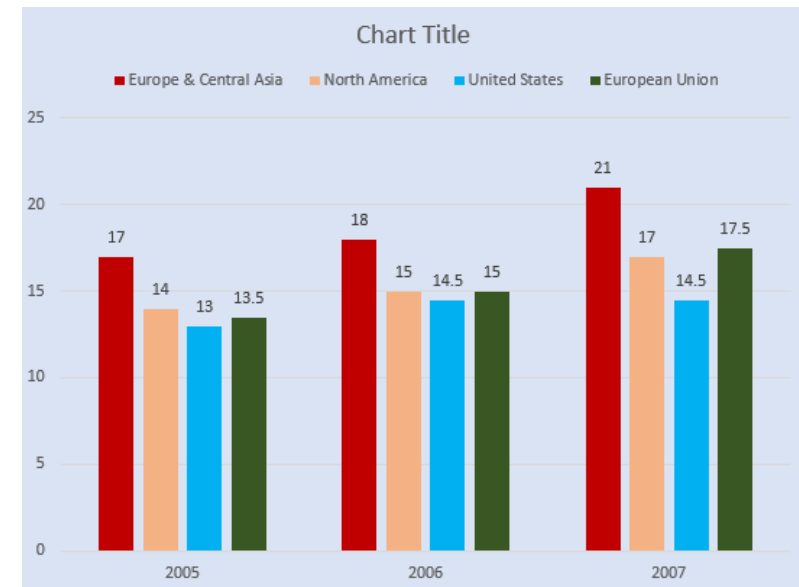
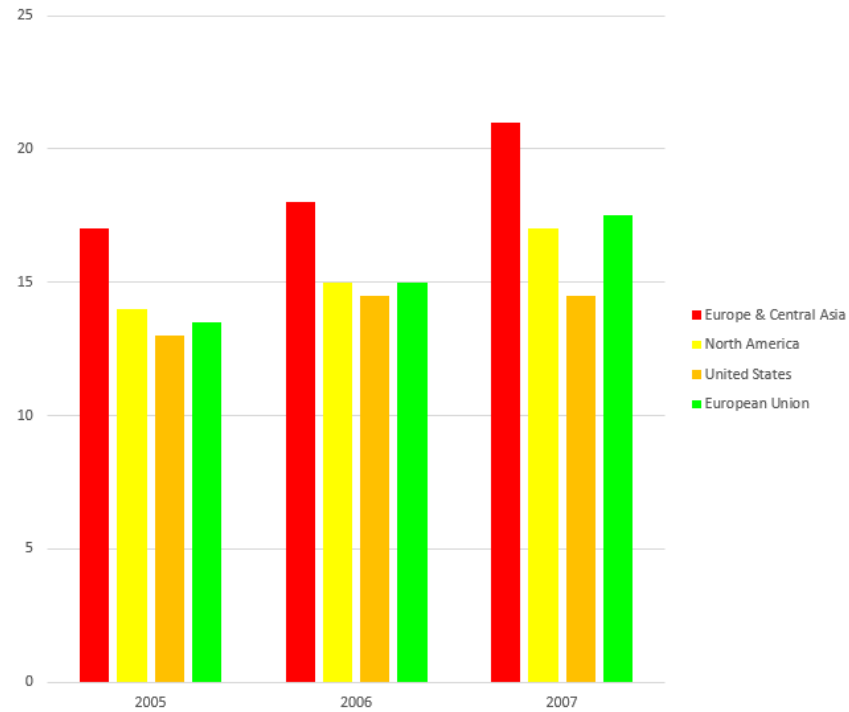


Editing a Chart

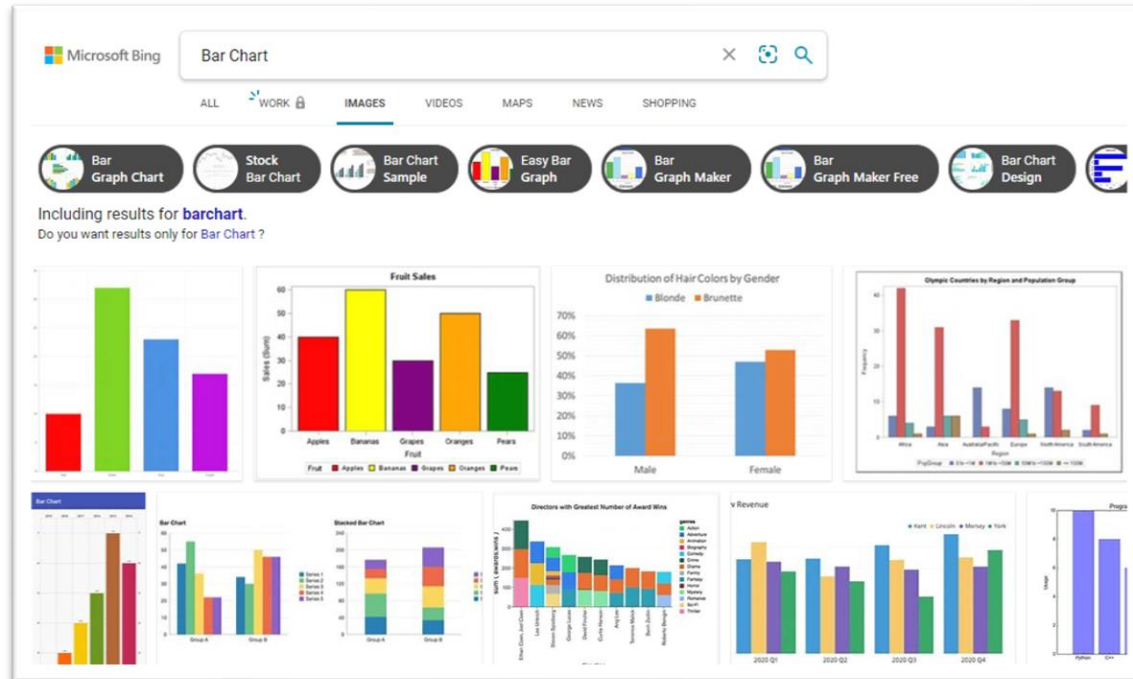
Gridline



Restyling to Well-Designed Charts

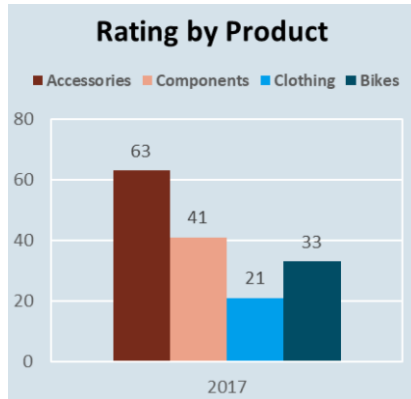


Well-Designed Charts on the Web



- Good templates for style imitation
- Store as bitmap images
 - Hinder machine interpretation of visual settings
 - Cannot be applied automatically

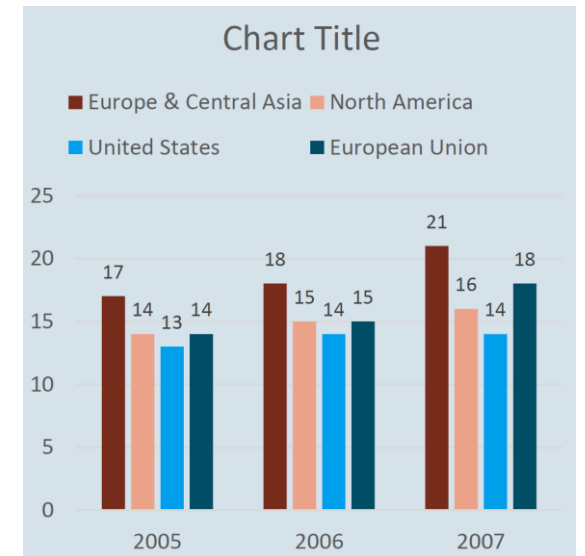
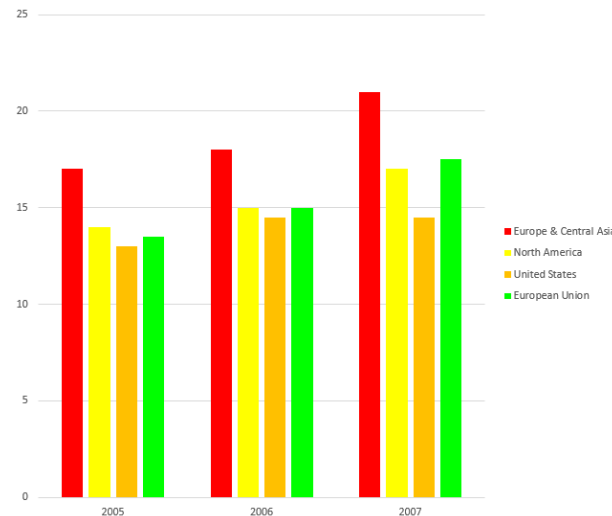
Chart Restyling



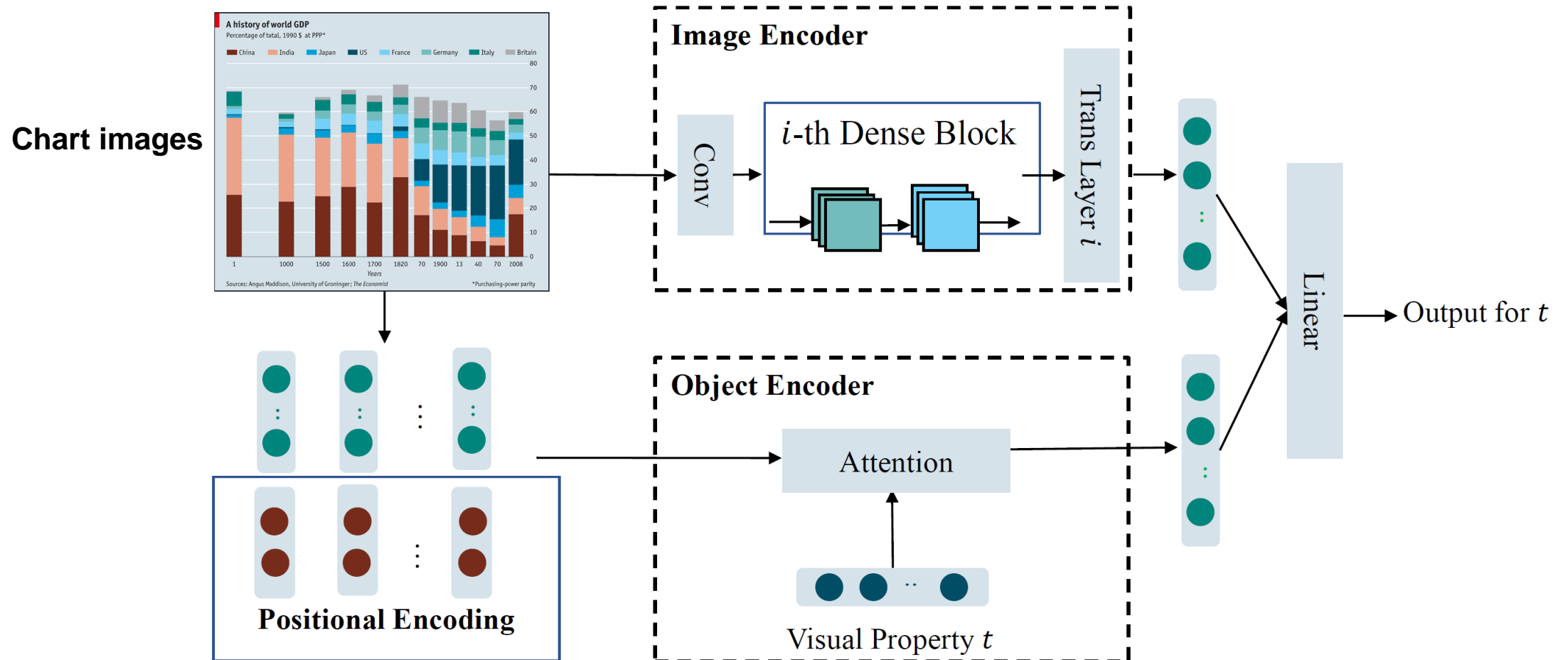
Online chart image



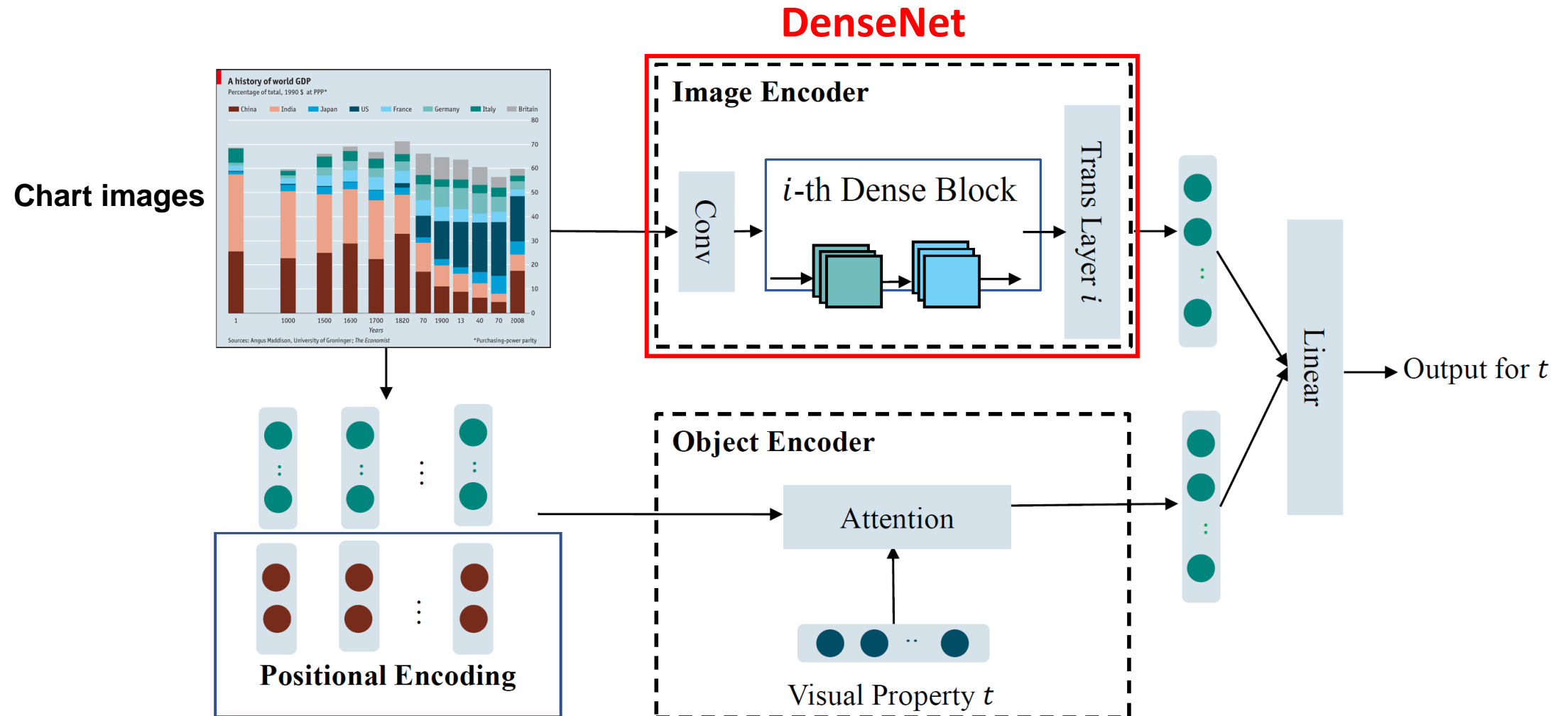
"HasBarBorder": False,
"HasChartTitle": True,
"HasXaxisTitle": False,
"HasYaxisTitle": False,
"HasGridLines": False,
"LegendPosition": Top,
"DataLabelPosition": OutsideEnd,
"ForegroundColor": [■ ■ ■ ■],
"BackgroundColor": [■]



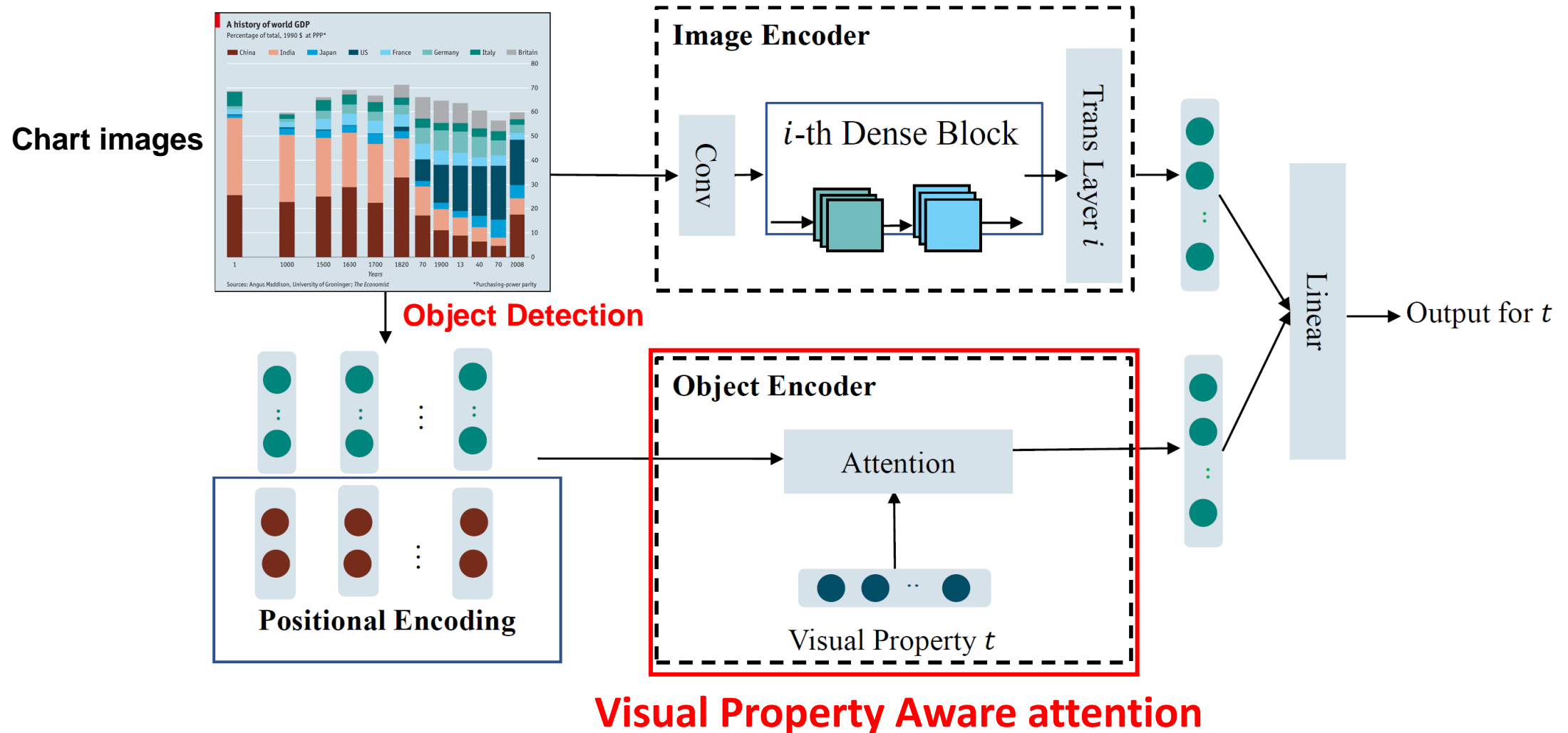
Overview of Style Extractor



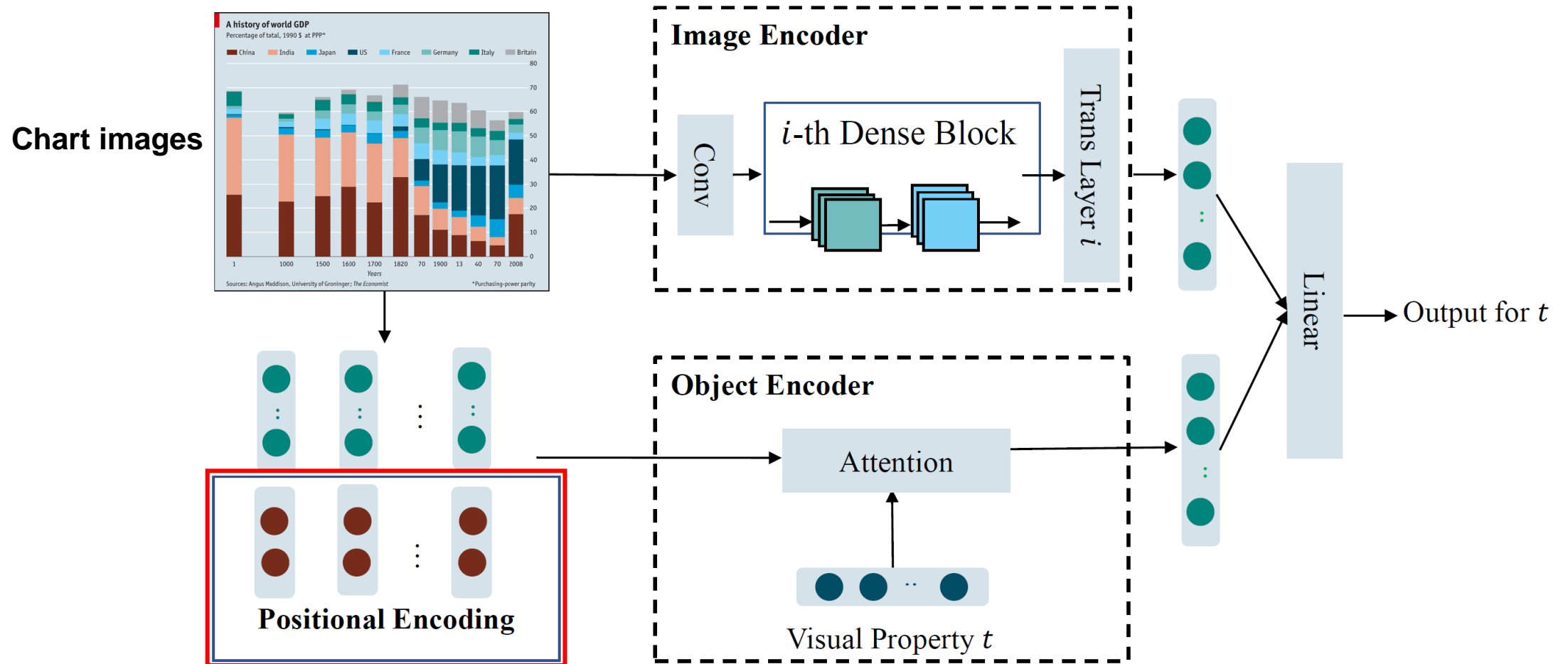
Overview of Style Extractor



Overview of Style Extractor

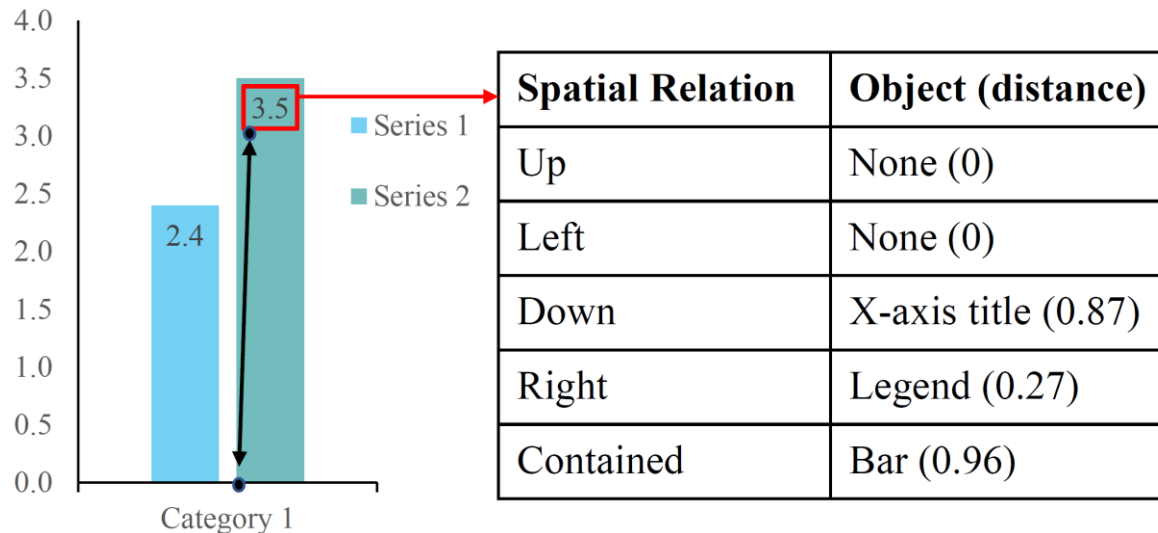


Overview of Style Extractor



Positional Encoding for Spatial Relationship

- Data label position relies on the relation between data labels and the bars (InsideEnd/InsideBase/Center/OutsideEnd/...)
- Relative position indicator of object k : $p^k \in \mathcal{R}^5$
 - Distance to the nearest object
 - Mapped to a vector $h^k = V \cdot p^k$



Our Dataset

- 187,059 chart images with visual properties and bounding box annotation
 - Crawl Microsoft Excel files (.xlsx) on the Web with meta information already
 - Convert the files to images as our dataset

Dataset	Source	# Charts	Type	Annotation
Revision [1]	Web	2,601	bar, pie, line, scatter plot	bounding box, text
[2]	synthetic, docs	5,125	bar, line, scatter plot	bounding box, text and role labels
FigureQA [4]	synthetic	140,000	bar, line, pie	bounding box, chart data, QA pairs
DVQA [5]	synthetic	3,487,194	bar	bounding box, chart data, QA pairs
Our dataset	Web	187,059	bar	bounding box, visual properties, chart data

[1] M. Savva, N. Kong, A. Chhajta, L. Fei-Fei, M. Agrawala, and J. Heer, “Revision: Automated classification, analysis and redesign of chart images”, UIST 2011.

[2] J. Poco and J. Heer, “Reverse-engineering visualizations: Recovering visual encodings from chart images”, Comput. Graph. Forum, vol. 36, 2017.

[4] S. E. Kahou, V. Michalski, A. Atkinson, A. Kadar, A. Trischler, and Y. Bengio, “FigureQA: An annotated figure dataset for visual reasoning”, ArXiv, vol. abs/1710.07300, 2017.

[5] K. Kaffle, S. Cohen, B. Price, and C. Kanan, “DVQA Understanding data visualizations via question answering”, CVPR 2018.

Baselines

- Rule System
 - Train the Faster-RCNN to detect bounding boxes of chart objects
 - Simple rules with the object detection results (e.g., if a title is detected, predict “HasChartTitle” as True)
- Image-Encoder-Only Classifier (IEC)
 - Only use Image Encoder in the network
- Object-Encoder-Only Classifier (OEC)
 - Only use Object Encoder in the network

Results

TABLE V: Accuracy (%) of different visual properties. “w/o pos.” means ablation setting of positional feature. “-” means that the system does not have an output.

Models	HasBarBorder	HasChartTitle	HasXaxisTitle	HasYaxisTitle	HasGridLines	LegendPosition	DataLabelPosition
Rule	-	91.44	16.62	36.66	-	74.39	75.52
IEC	79.75	88.58	89.60	94.80	93.98	90.08	84.07
OEC	80.18	91.69	88.02	95.03	84.26	90.03	91.66
Our model	88.07	92.06	93.06	95.94	94.50	94.71	92.14
w/o pos.	80.61	90.16	88.74	93.84	94.37	92.76	91.70

TABLE VI: Accuracy (%) of each class in DataLabelPosition. acc_M means macro accuracy.

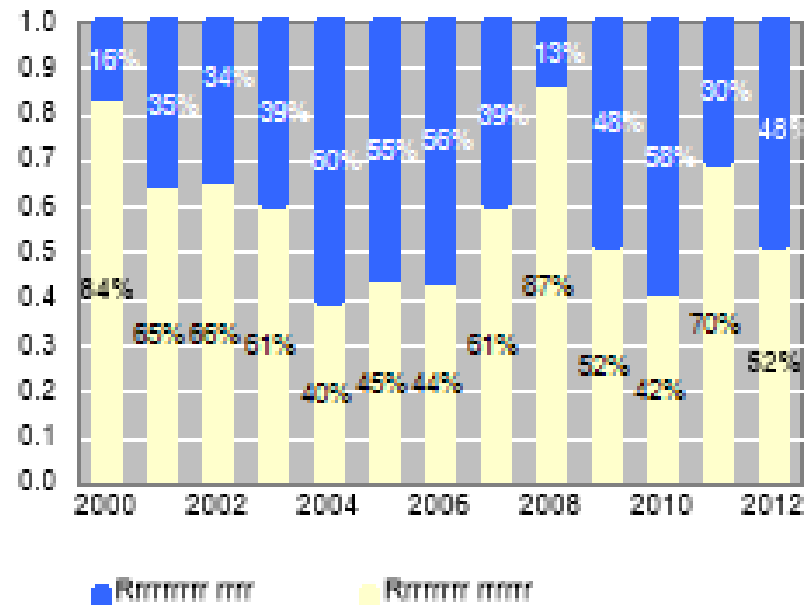
Models	None	InsideEnd	OutsideEnd	InsideBase	Center	acc_M
Rule	86.66	2.08	81.91	0	4.70	35.06
IEC	92.43	75.69	78.51	14.55	48.90	62.02
OEC	91.61	81.94	91.66	67.27	92.24	85.75
Our model	92.77	93.75	93.19	61.82	94.20	86.95
w/o pos.	92.72	91.66	88.67	60.09	94.67	85.56

TABLE VIII: Accuracy (%) of each class in LegendPosition. acc_M means macro accuracy.

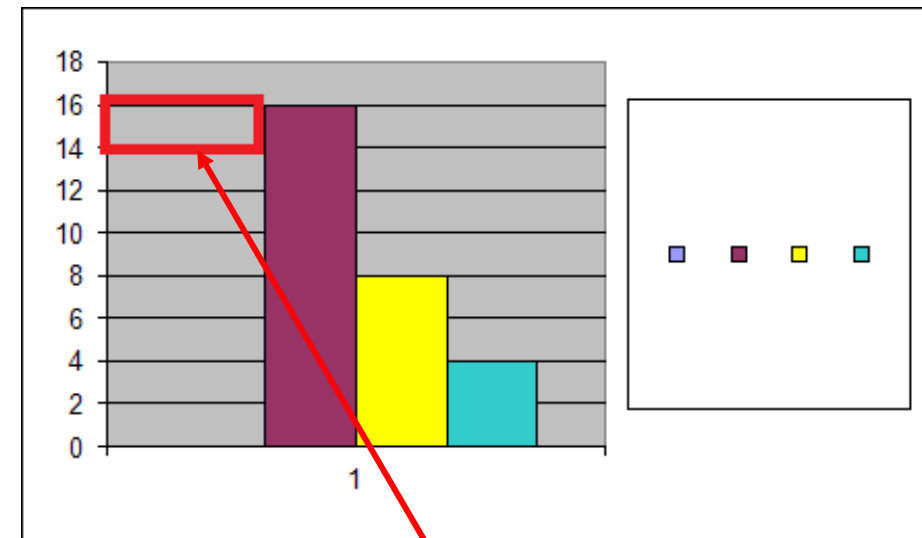
Models	None	Top	Bottom	Left	Right	acc_M
Rule	95.04	70.16	50.78	94.05	76.15	77.23
IEC	91.78	77.54	92.49	82.73	93.30	87.57
OEC	90.54	84.61	94.55	76.19	89.45	87.07
Our model	95.50	87.12	93.45	93.45	95.61	93.81
w/o pos.	93.18	85.87	94.22	92.86	94.58	92.14

Error Analysis

I. Charts with complicated relations



II. Object detection error propagation



Faster-RCNN wrongly detect as bar object

Summary

- In this paper, we explore the task of chart restyling
 - Extracting visual properties from chart images
 - End-to-end network with relative positional encoding
 - Construct a large-scale dataset of chart images from real-world data
- Future Work
 - Consider more chart types and more visual properties