Non-Research Tips for Information Science Researchers (Summer 2024)

May 1, 2024

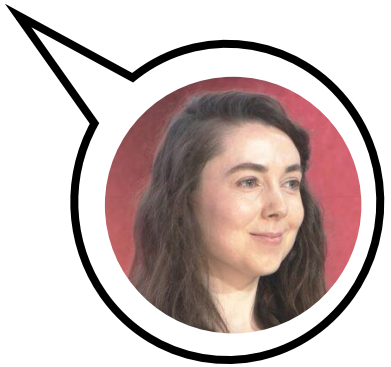
Week 4: Tables and plots

https://non-research-tips.github.io/2024

Yusuke Matsui
(UTokyo)

Schedule

Date (2024)	Contents	Presented by
~~Week 1, Apr 10~~	~~Introduction. Review of fundamental concepts~~	~~Yusuke, Koya, Yuki, Jun~~
~~Week 2, Apr 17~~	~~Equations and pseudo-codes~~	~~Yusuke Matsui~~
~~Week 3, Apr 24~~	~~Presentation~~	~~Koya Narumi~~
Week 4, May 1	Tables and plots	Yusuke Matsui
Week 5, May 8	Figures	Koya Narumi
Week 6, May 22	Videos	Koya Narumi
Week 7, May 29	Invited Talk 1	Dr. Yoshiaki Bando (AIST)
Week 8, June 5	Invited Talk 2	Prof. Katie Seaborn (Tokyo Tech)
Week 9, June 12	GitHub in depth	Yusuke Matsui
Week 10, June 19	Automation of research and research dissemination (Web, Cloud, CI/CD)	Jun Kato
Week 11, June 26	Research community	Jun Kato
Week 12, July 3	3DCG illustrations	Yuki Koyama
Week 13, July 10	Final presentations	-



Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

Author

My current table appears unprofessional. I want to create a more visually appealing table…

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The table looks better! I often find this kinds of tables in top-conference papers.

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Name	Height (cm)	Weight (kg)
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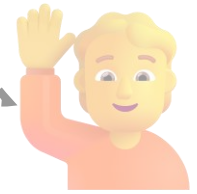
Good job!
Keep doing!



Reviewer 2

The table looks better! I often find this kinds of tables in top-conference papers.

Name	Height (cm)	Weight (kg)
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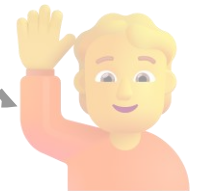
Author

ant

1. Structure your table.
2. Use the booktabs package.

Name	He	
LeBron James	206	113
Anthony Davis	208	115

ob!
Keep doing!



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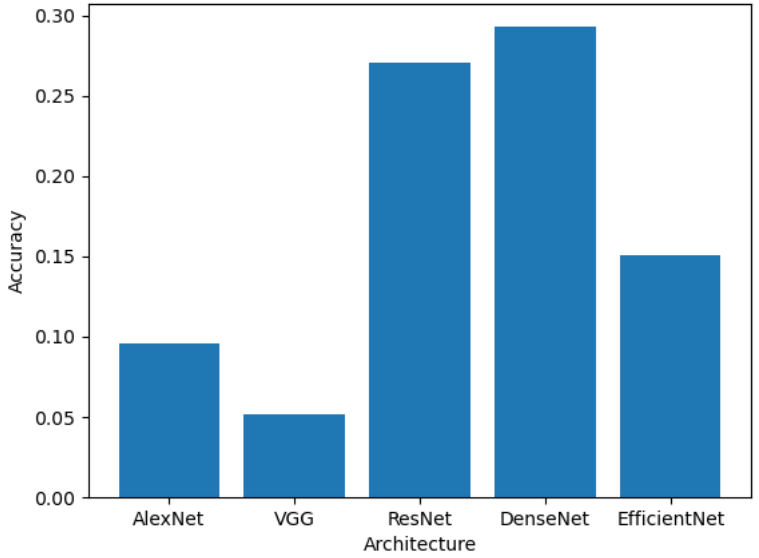
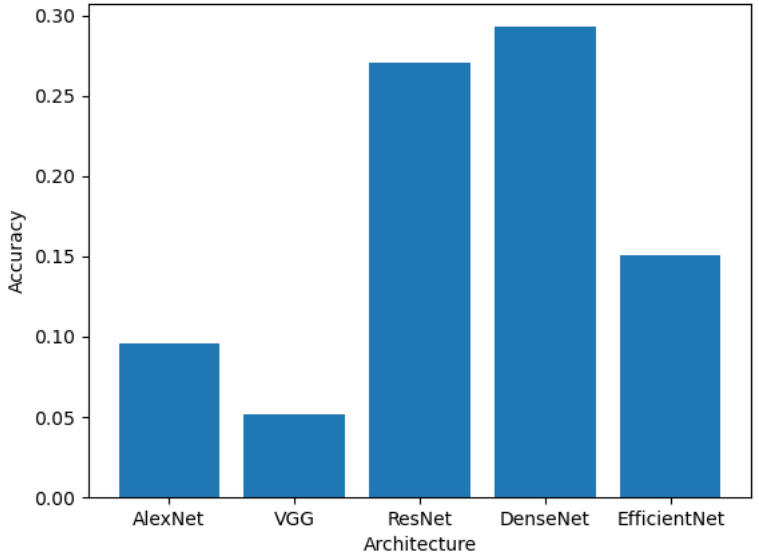


Author

Whenever I display data, I always use a bar graph, but I feel like it doesn't provide enough information.



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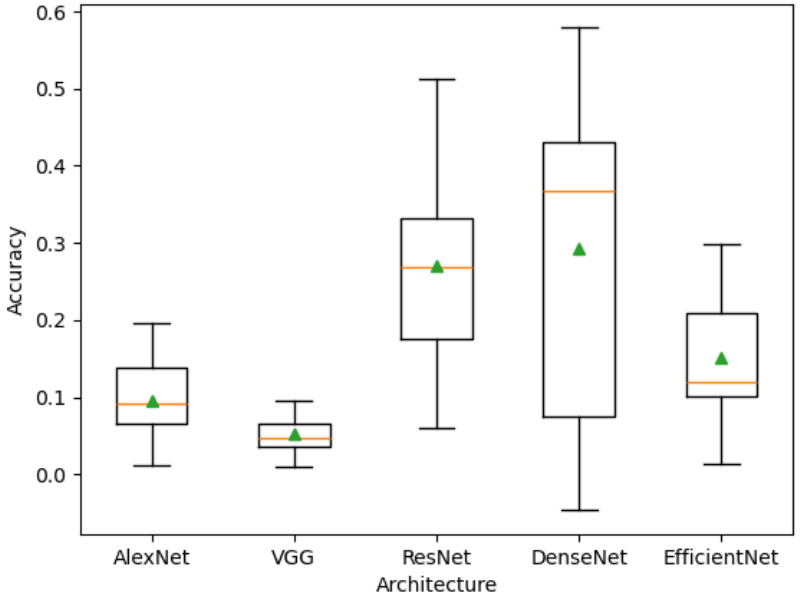
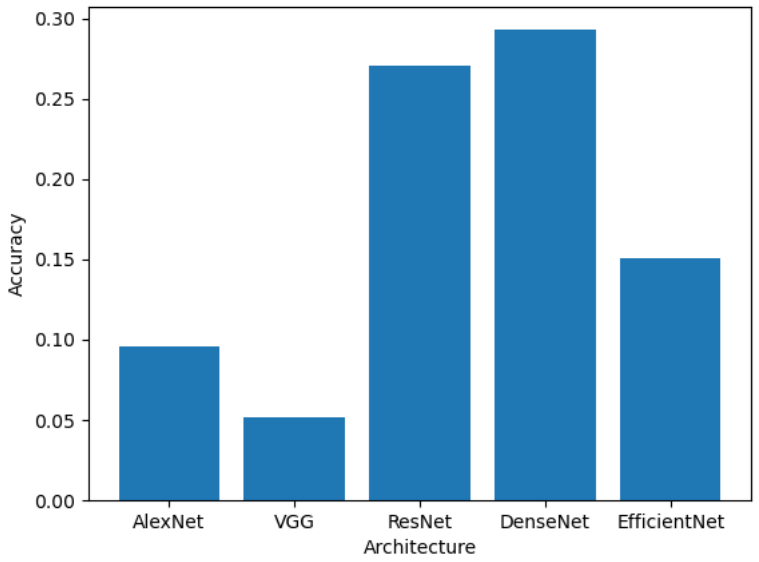


Box plots seem better! Now, I can see that DenseNet's scores are scattered.



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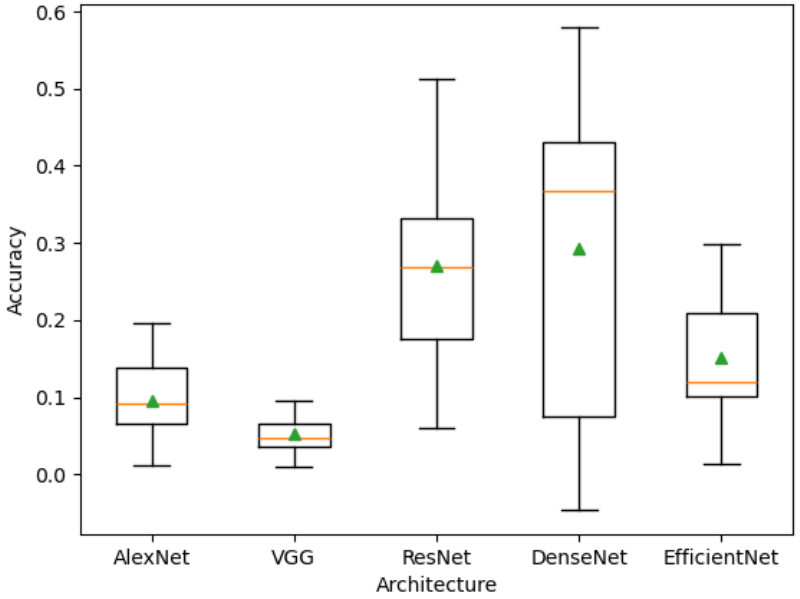

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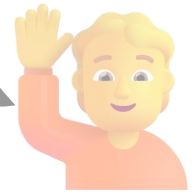
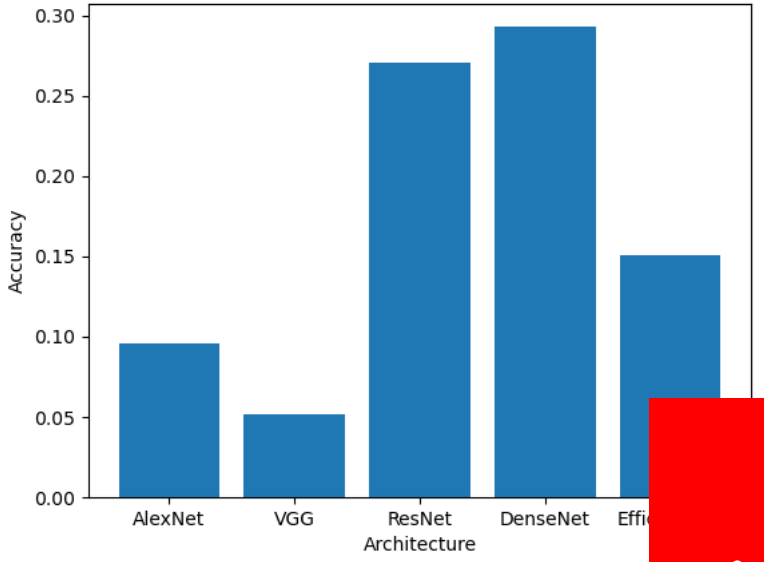


Reviewer 2



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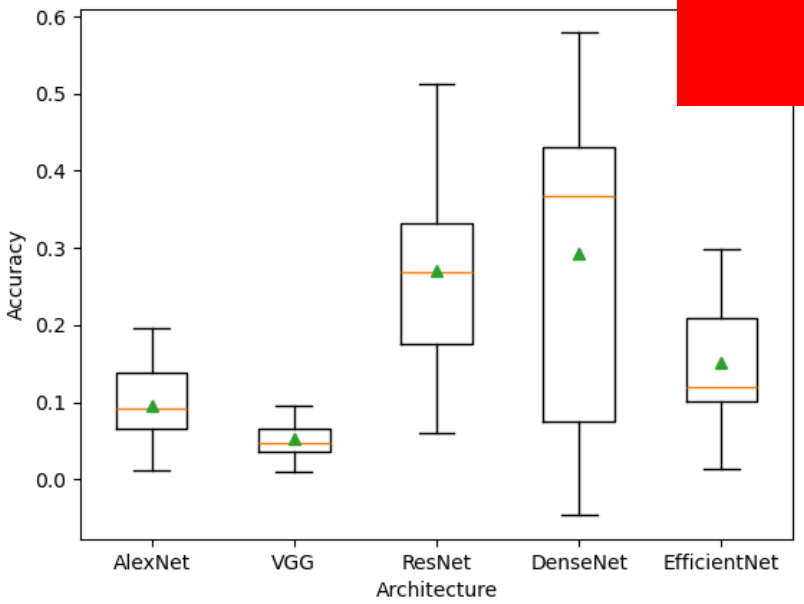
Tips for good plots



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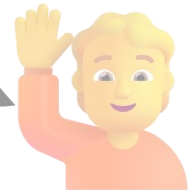


Reviewer 2

Reference

booktabs

- S. Fear, “Publication quality tables in LaTeX”, Official documentation for booktabs in CTAN, 2020. http://mirrors.ctan.org/macros/latex/contrib/booktabs/booktabs.pdf
- M. Püschel, “Small Guide to Making Nice Tables”, https://people.inf.ethz.ch/markusp/teaching/guides/guide-tables.pdf Introduction of booktabs (I was inspired by this document.)

Boxplot

- M. Streit and N. Gehlenborg, “Bar charts and box plots”, Nature Methods, 2014. https://www.nature.com/articles/nmeth.2807

The original document for this lecture

- 松井勇佑, ”とにかくbooktabsを使おう”, GitHub, 2022. https://github.com/mti-lab/use_booktabs_anyway

とにかく booktabs を使おう

東京大学　情報理工学系研究科　講師　松井勇佑

初版 2022 年 9 月 5 日 / 最終更新 2023 年 1 月 23 日

- 本資料の GitHub リポジトリ：https://github.com/matsui528/use_booktabs_anyway
- 著者のウェブページ：http://yusukematsui.me

1　はじめに

論文に表を記載する際、booktabs パッケージを使いましょう。booktabs は通常の TeX の表に対し適切な線の使用やスペースの配置を補助してくれるパッケージです。booktabs を使うだけで表がシュッと綺麗になります。それだけでなく、booktabs 流の表の作り方（行を基本とする思考、縦線を入れない、など）を考えていくと、論理的にわかりやすい表になります。以下の 2 つが基本的な文献です。

- 公式ドキュメント。細かいオプションなどは CTAN の公式ドキュメントを参照しましょう。
- Markus Püschel, “Small Guide to Making Nice Tables”. 本資料と同じ立ち位置の、booktabs 紹介記事です。

本文章は上記文献と松井の経験則をベースにしています。間違いや、より良い方法もあると思います。提案やコメントやミスの指摘など

I’d like to translate it into English, but I have no time… PR welcome!

Powerpoint?

- The contents of today's lecture are for rendering tables by TeX.

- When you want to render tables in Powerpoint, you can imitate the TeX's one, like:

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

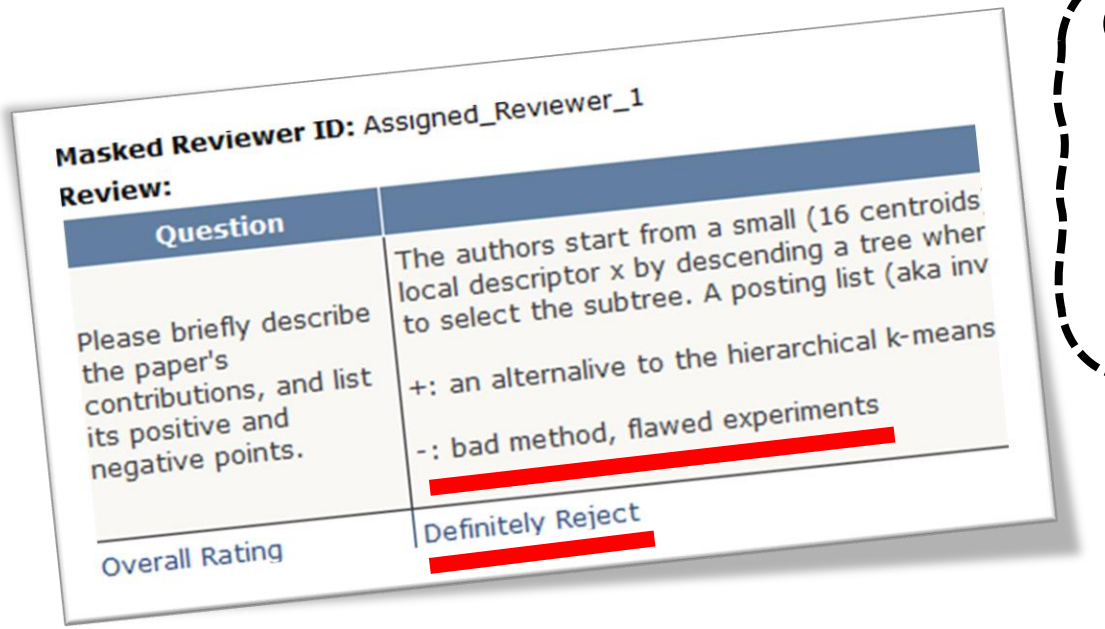
But I don't like this space…

- Or you can do it in other ways, like:

Example	Meaning	
$a \in [2,7]$	$2 \leq a \leq 7$	More informative than $a \in \mathbb{R}$
$a \in (2,7)$	$2 < a < 7$	
$a \in [2,7)$	$2 \leq a < 7$	
$a \in \{2,7\}$	$a = 2$ or $a = 7$	
$a \in \{2,\ldots,7\}$	If naturally interpreted, $a = 2$ or $a = 3$ or … or $a = 7$.	

Disclaimer

- The contents of today's lecture are based on Matsui's rule of thumb.
- Please consider the contents as guidelines and apply them to your field at your discretion.
- If you have better tips, please always let me know!
- I would like to offer you helpful tips and enhance the quality of your papers. (**All of you!**)



Masked Reviewer ID: Assigned_Reviewer_1

Review:

Question	
Please briefly describe the paper's contributions, and list its positive and negative points.	The authors start from a small (16 centroids local descriptor x by descending a tree wher to select the subtree. A posting list (aka inv +: an alternalive to the hierarchical k-means -: bad method, flawed experiments
Overall Rating	Definitely Reject

Can we systematically overcome the typical mistakes that beginners make?

I have been thinking about such a thing for more than a decade ...

The review for my first CVPR submission (2013)

Tables

- Basics
- Row-oriented structure
- Row grouping
- Row hierarchization
- Column hierarchization
- Partial horizontal line (`cmidrule`)
- Column to row
- Flowchart

Plots

- Basics
- Bar chart to box plot
- Control parameter
- Misc

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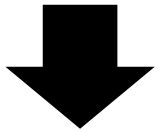
Basics

- Follow the 5 steps below.

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
\begin{tabular}{|c|c|c|} \hline
    Name & Height (cm) & Weight (kg) \\ \hline
    LeBron James   & 206 & 113 \\ \hline
    Anthony Davis  & 208 & 115 \\ \hline
\end{tabular}
```



Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
\usepackage{booktabs}

\begin{tabular}{@{}lll@{}} \toprule
    Name & Height (cm) & Weight (kg) \\ \midrule
    LeBron James   & 206 & 113 \\
    Anthony Davis  & 208 & 115 \\ \bottomrule
\end{tabular}
```

Basics

- Follow the 5 steps below.

Name	Height (cm)	Weight (kg)
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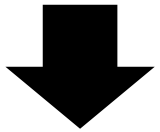

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\end{tabular}
```

Step 1: import the package.

```
\usepackage{booktabs}
```

```
\begin{tabular}{@{}lll@{}} \toprule
    Name & Height (cm) & Weight (kg) \\ \midrule
    LeBron James   & 206 & 113 \\
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\end{tabular}
```

Step 2: Delete all vertical lines.

- i.e., {|c|c|c|} ➡ {ccc}
- If you table is well structured, you don't need vertical lines.
- If you think you need vertical lines, I recommend splitting the table into smaller ones

Name	Height (cm)	Weight (kg)
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```
\begin{tabular}{|c|c|c|} \hline
    Name & Height (cm) & Weight (kg) \\ \hline
    LeBron James  & 206 & 113 \\ \hline
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\end{tabular}
```

Name	Height (cm)	Weight (kg)
LeBron James	206	113
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\usepackage{booktabs}

\begin{tabular}{@{}lll@{}} \toprule
    Name & Height (cm) & Weight (kg) \\ \midrule
    LeBron James  & 206 & 113 \\
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\end{tabular}
```

Step 3: Align left.

- i.e., `{ccc}` ➡ `{lll}`
- Left-align is beautiful (Remember "invisible lines" in Week 3!)
- If you have problems with left alignment, try right or center alignment

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
\begin{tabular}{|c|c|c|} \hline
    Name & Height (cm) & Weight (kg) \\ \hline
    LeBron James   & 206 & 113 \\ \hline
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\end{tabular}
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Name	Height (cm)	Weight (kg)
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\begin{tabular}{@{}lll@{}} \toprule
    Name & Height (cm) & Weight (kg) \\ \midrule
    LeBron James   & 206 & 113 \\
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Basics

- Follow the 5 steps below.

Name	Height (cm)	Weight (kg)
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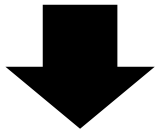

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
\begin{tabular}{|c|c|c|} \hline
    Name & Height (cm) & Weight (kg) \\ \hline
```

Step 4: Put a magical spacer symbols, "@{}"

- i.e., {lll} ➡ {@{}lll@{}}
- This eliminates excess spaces.
- Many papers forget this.

```
\usepackage{booktabs}

\begin{tabular}{@{}lll@{}} \toprule
    Name & Height (cm) & Weight (kg) \\ \midrule
    LeBron James   & 206 & 113 \\
    Anthony Davis  & 208 & 115 \\ \bottomrule
\end{tabular}
```

Basics

w/o “@{}”

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

- Weird spaces… 😥
- Remember “invisible lines” in Week 3!

w/ “@{}”

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

No spaces. Beautiful! 😊

```
Anthony Davis  & 208 & 115 \\ \bottomrule
\end{tabular}
```

Step 5: Use “top/mid/bottomrule”

- i.e.,
  - ✓ The top \hline ➡ \toprule
  - ✓ The next \hline ➡ \midrule
  - ✓ The bottom \hline ➡ \bottomrule
  - ✓ Other \hlines ➡ Delete!
- Well-structured tables require horizontal lines just a bit.

Anthony Davis	208	115

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
|c|} \hline
m) & Weight (kg) \\ \hline
& 206 & 113 \\ \hline
ny Davis  & 208 & 115 \\ \hline
}
```

```
\usepackage{booktabs}

\begin{tabular}{@{}lll@{}} \toprule
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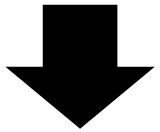

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
\toprule
  \usepackage{booktabs}
\midrule
  \begin{tabular}{@{}lll@{}} \toprule
Delete!          Height (cm) & Weight (kg) \\ \midrule
        LeBron James   & 206 & 113 \\
        Anthony Davis  & 208 & 115 \\ \bottomrule
  \end{tabular}
```

Basics

- You can always apply these 5 steps, and your table will be much more beautiful! 😊

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

```
\begin{tabular}{|c|c|c|} \hline
    Name & Height (cm) & Weight (kg) \\ \hline
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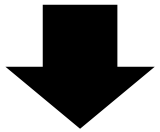

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Row-oriented structure

- A table should be **a stack of rows**, i.e., **row-oriented**.
- The best structure: “header” + “row1” + “row2” + …

Header / Row1 / Row2

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115

- Each row should be semantically same level
- i.e., instances (rows) of the same class (header)

- Each row should be semantically interchangeable.

Name	Height (cm)	Weight (kg)
Anthony Davis	208	115
LeBron James	206	113

- Usually, rows are sorted by some criteria.
- Yet, rows should be interchangeable.

Row-oriented structure

- A table should be **a stack of rows**, i.e., **row-oriented**.
- The best structure: "header" + "row1" + "row2" + ...

Header	Name	Height (cm)	Weight (kg)
Row1	LeBron James	206	113
Row2	Anthony Davis	208	115

- Each row should be semantically same level
- i.e., instances (rows) of the same class (header)

- Each row should be semantically i

```
class Person:
    def __init__(self, name, height, weight):
        self.name = name
        self.height = height
        self.weight = weight

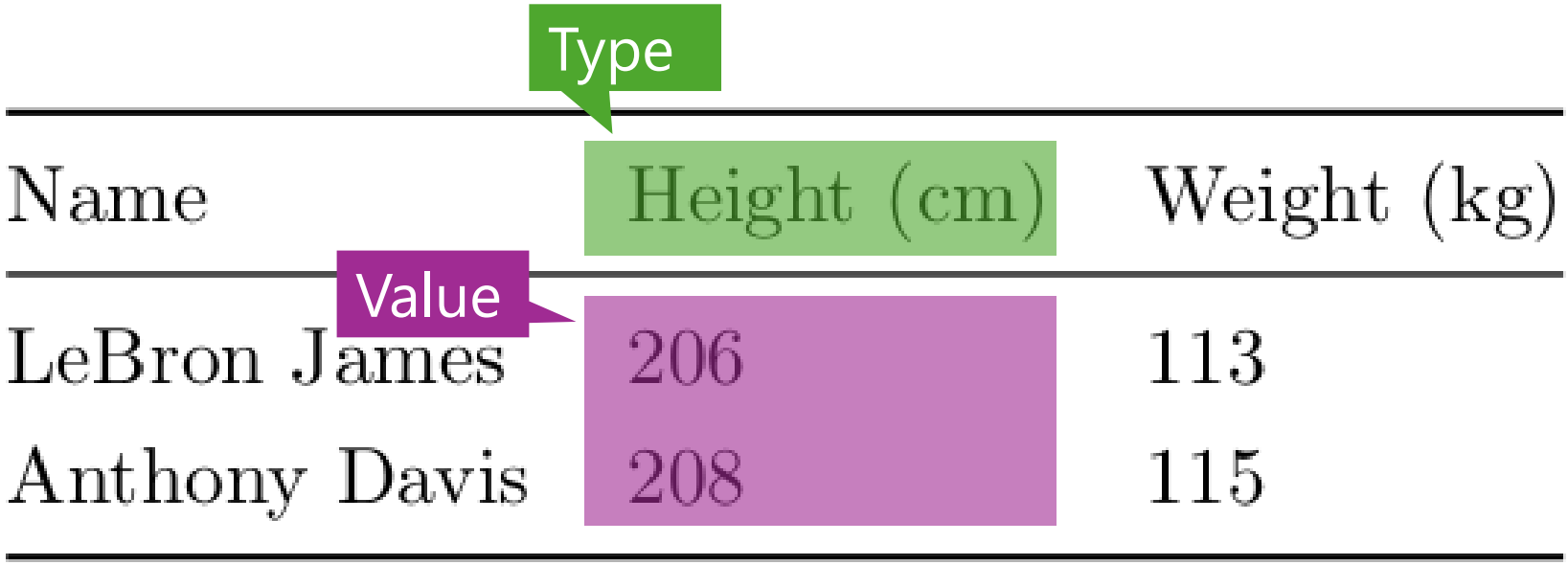
row1 = Person('LeBron James', 206, 113)
row2 = Person('Anthony Davis', 208, 115)
```

Name	Height (cm)
Anthony Davis	208
LeBron James	206

interchangeable.

Row-oriented structure

- For each column,
  - ✓ The header defines the type, i.e., “int”.
  - ✓ Each row shows the value, i.e., “34”.
- Seems obvious? But it’s not easy to strictly follow this principal.



Name	Height (cm)	Weight (kg)
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Row-oriented structure

- From S. Ren+, "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks", TPAMI 2017 (30K+ citation paper)
- Object detection papers do not follow this principal (because #class is ~20 and can fit the paper, thus it's possible to write everything one line).
- One may restructure this table clearer as we'll show later, but it requires more spaces.
- Everything up to the situation!

principal.

Type

method	# box	data	mAP	areo	bike	bird	boat	bottle	bus	car	cat	chair	cow	table	dog	horse	mbike	person	plant	sheep	sofa	train	tv
SS	2000	07	66.9	74.5	78.3	69.2	53.2	36.6	77.3	78.2	82.0	40.7	72.7	67.9	79.6	79.2	73.0	69.0	30.1	65.4	70.2	75.8	65.8
SS	2000	07+12	70.0	77.0	78.1	69.3	59.4	38.3	81.6	78.6	86.7	42.8	78.8	68.9	84.7	82.0	76.6	69.9	31.8	70.1	74.8	80.4	70.4
RPN*	300	07	68.5	74.1	77.2	67.7	53.9	51.0	75.1	79.2	78.9	50.7	78.0	61.1	79.1	81.9	72.2	75.9	37.2	71.4	62.5	77.4	66.4
RPN	300	07	69.9	70.0	80.6	70.1	57.3	49.9	78.2	80.4	82.0	52.2	75.3	67.2	80.3	79.8	75.0	76.3	39.1	68.3	67.3	81.1	67.6
RPN	300	07+12	73.2	76.5	79.0	70.9	65.5	52.1	83.1	84.7	86.4	52.0	81.9	65.7	84.8	84.6	77.5	76.7	38.8	73.6	73.9	83.0	72.6
RPN	300	COCO+07+12	**78.8**	**84.3**	**82.0**	**77.7**	**68.9**	**65.7**	**88.1**	**88.4**	**88.9**	**63.6**	**86.3**	**70.8**	**85.9**	**87.6**	**80.1**	**82.3**	**53.6**	**80.4**	**75.8**	**86.6**	**78.9**

Exceptional cases: e.g., average values

- There are several exceptions, such as a row of average values
- Such row is a special and cannot be swapped to other rows (usually placed at the bottom).

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115
D'Angelo Russell	193	88
Average	202	105.3

The last row is for "average".

Name	Height (cm)	Weight (kg)
LeBron James	206	113
Anthony Davis	208	115
D'Angelo Russell	193	88
Average	202	105.3

You can use `\midrule` if you want.

- Creating tables: **Following the row-oriented structure as much as possible while aiming for the clearest presentation.**

Tables

- Basics
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Row grouping

- You can group rows to improve the readability.

A good table. Rows are interchangeable.

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
XYZ	32	0.61	0.44
Ours	9	0.47	0.26
Ours	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

However, there are repetitive descriptions, which makes the table unnecessarily wordy. 🤔

Row grouping

- You can group rows to improve the readability.

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
XYZ	32	0.61	0.44
Ours	9	0.47	0.26
Ours	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
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Ours	9	0.47	0.26
	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

- You can simply group some rows. 😊
- Delete unnecessary descriptions.

Row grouping

- You can group rows to improve the readability.

- You can further draw a `\midrule`

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
XYZ	32	0.61	0.44
Ours	9	0.47	0.26
Ours	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
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Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

- You can combine rows if you want.
- `\multirow`

Row grouping

```
XYZ   & 16 & 0.32 & 0.21   \\
      & 32 & 0.61 & 0.44   \\
Ours  &  9 & 0.47 & 0.26   \\
      & 18 & 0.99 & 0.77   \\ \bottomrule
```

```
\multirow{2}{*}{XYZ}    & 16 & 0.32 & 0.21 \\
                        & 32 & 0.61 & 0.44 \\ \midrule
\multirow{2}{*}{Ours}   &  9 & 0.47 & 0.26 \\
                        & 18 & 0.99 & 0.77 \\ \bottomrule
```

- You can further draw \midrule

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
XYZ	32	0.61	0.44
Ours	9	0.47	0.26
Ours	18	0.99	0.77

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XYZ	16	0.32	0.21
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Ours	9	0.47	0.26
	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

- You can combine rows if you want.
- \multirow

Row grouping

- Many prefer the third one.
- Personally speaking, the second one is straightforward enough in many cases (simpler is better).
- Choose what you like!

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
XYZ	32	0.61	0.44
Ours	9	0.47	0.26
Ours	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

Method	k	Runtime (ms)	Accuracy
XYZ	16	0.32	0.21
	32	0.61	0.44
Ours	9	0.47	0.26
	18	0.99	0.77

Multiple-level grouping

- You can group rows recursively.

Nearest Station	Store Name	Item	Price (JPY)
Hongo-Sanchome	Umite	Natsu-Ramen	700
		Maze Men X	850
	IBASA	Ramen	700
		Cold Ramen	650
Todai-mae	Yojinmen	Ramen	700
		Tsukemen	800

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- Control parameter
- Misc

Row hierarchization

- Row hierarchization = Deleting a row + Indentation
  - ✓ In other words, horizontally-long ↔ vertically-long
- Row hierarchization may make a table easier to read.

Item	Type	Price (¥)	Floor
Pork	Meat	300	2
Beef	Meat	500	2
Tomato	Vegetables	100	3
Corn	Vegetables	200	3
Cabbage	Vegetables	30	4

Item	Type	Price (¥)	Floor
Pork	Meat	300	2
Beef		500	2
Tomato	Vegetables	100	3
Corn		200	3
Cabbage		30	4

Item	Price (¥)	Floor
Meat		
Pork	300	2
Beef	500	2
Vegetables		
Tomato	100	3
Corn	200	3
Cabbage	30	4

A good table. Rows are interchangeable.

Row hierarchization

- Row hierarchization = Deleting a row + Indentation
  - ✓ In other words, horizontally-long ↔ vertically-long
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Item	Type	Price (¥)	Floor
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Beef	Meat	500	2
Tomato	Vegetables	100	3
Corn	Vegetables	200	3
Cabbage	Vegetables	30	4

Item	Type	Price (¥)	Floor
Pork	Meat	300	2
Beef		500	2
Tomato	Vegetables	100	3
Corn		200	3
Cabbage		30	4

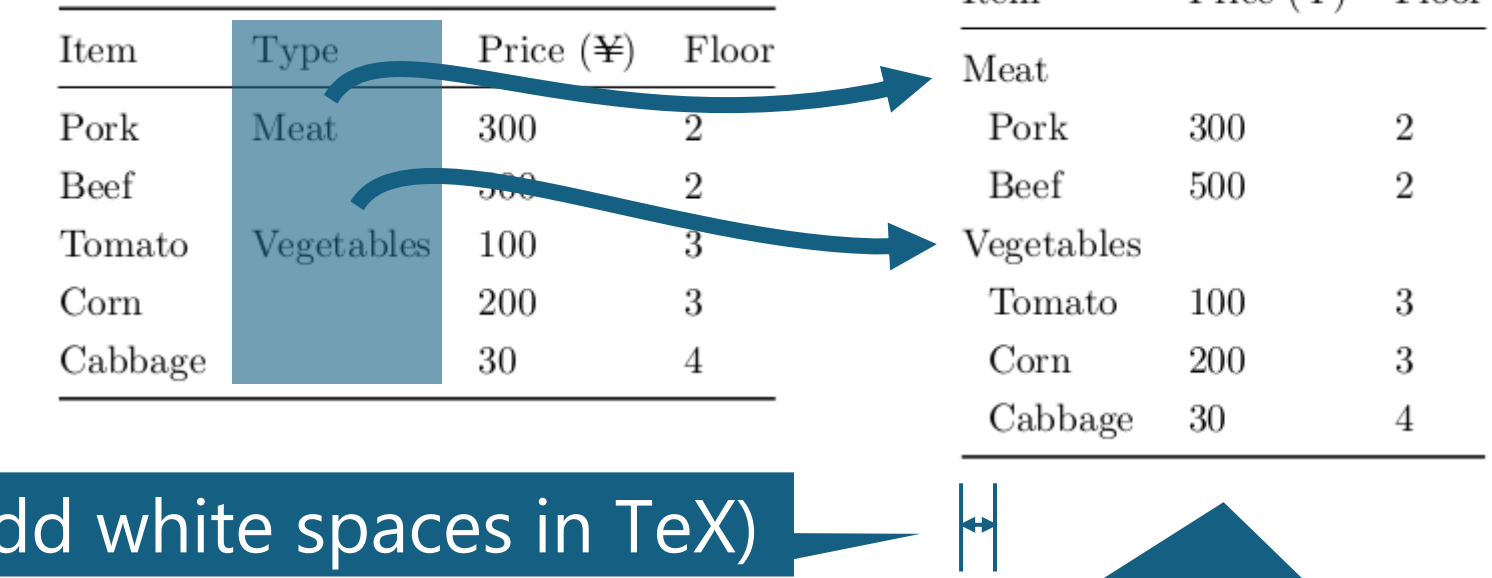
Item	Price (¥)	Floor
Meat		
Pork	300	2
Beef	500	2
Vegetables		
Tomato	100	3
Corn	200	3
Cabbage	30	4

Row grouping. Easier to read. Good.

Row hierarchization

- Row hierarchization = Deleting a row + Indentation
  - ✓ In other words, horizontally-long ↔ vertically-long
- Row hierarchization may make a table easier to read.

Item	Type	Price (¥)	Floor
Pork	Meat	300	2
Beef	Meat	500	2
Tomato	Vegetables	100	3
Corn	Vegetables	200	3
Cabbage	Vegetables	30	4



Item	Price (¥)	Floor
Meat		
Pork	300	2
Beef	500	2
Vegetables		
Tomato	100	3
Corn	200	3
Cabbage	30	4

Indentation (add white spaces in TeX)

Row hierarchization. In this case, this one is also good.

```
\begin{tabular}{@{}lll@{}} \toprule
    Item        & Price ($\yen$) & Floor \\ \midrule
    Meat        &                &       \\
    ~~Pork      & 300            & 2     \\
    ~~Beef      & 500            & 2     \\
    Vegetables  &                &       \\
    ~~Tomato    & 100            & 3     \\
    ~~Corn      & 200            & 3     \\
    ~~Cabbage   & 30             & 4     \\ \bottomrule
\end{tabular}
```

ntation
ally-long
to read.

Item	Price (¥)	Floor
Meat		
Pork	300	2
Beef	500	2
Vegetables		
Tomato	100	3
Corn	200	3
Cabbage	30	4

Beef	Meat	500	2
Tomato	Vegetables	100	3
Corn	Vegetables	200	3
Cabbage	Vegetables	30	4

Beef		[illegible]	2
Tomato	Vegetables	100	3
Corn		200	3
Cabbage		30	4

Indentation (add white spaces in TeX)

Row hierarchization. In this case, this one is also good.

Row hierarchization

- Row hierarchization = Deleting a row + Indentation
  - ✓ In other words, horizontally-long ↔ vertically-long
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Item	Type	Price (¥)	Floor
Pork	Meat	300	2
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Cabbage	Vegetables	30	4

Item	Type	Price (¥)	Floor
Pork	Meat	300	2
Beef		500	2
Tomato	Vegetables	100	3
Corn		200	3
Cabbage		30	4

Item	Price (¥)	Floor
Meat		
Pork	300	2
Beef	500	2
Vegetables		
Tomato	100	3
Corn	200	3
Cabbage	30	4

- Row-grouping and row-hierarchization are just for visualization
- Semantically, one should be able to convert the table to the original "stack of rows" from easily.

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Column hierarchization

- Columns cannot be grouped. But can be hierarchically summarized.

- Ok. But there are multiple "error"s.
- Not only wordy, but also requires spaces.

Method	Min. error	Avg. error	Max. error
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

Column hierarchization

	Error		
Method	Min.	Avg.	Max.
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

- Hierarchize "error".
- No redundant information. Good!
- Again, this is for visualization. We can always back to the original form.

Column hierarchization

```
\begin{tabular}{@{}llll@{}} \toprule
    & \multicolumn{3}{c}{Error} \\ \cmidrule(l){2-4}
    Method & Min. & Avg. & Max. \\ \midrule
    Isomap & 0.23 & 0.44 & 0.92 \\
    LLE    & 0.10 & 0.73 & 1.82 \\ \bottomrule
\end{tabular}
```

erarchically summarized.

Method	Min. error	Avg. error	Max. error
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

\multicolumn

\cmidrule

Column hierarchization

	Error		
Method	Min.	Avg.	Max.
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

- Hierarchize “error”.
- No redundant information. Good!
- Again, this is for visualization. We can always back to the original form.

Multiple column-hierarchization

- You can hierarchize columns multiple times.

With hierarchization, one needs to write a unit just once, making the table shorter

	Temperature (°C)			Precipitation (mm)		Access		
Prefecture	Max.	Avg.	Min.	August	December	By shinkansen	By plane	Density (persons/km^2)
Ishikawa	32	20	-1	179.8	304.7	✓	✓	267
Shizuoka	27	23	5	250.9	63.0	✓	✓	461
Okinawa	33	28	15	175.4	104.4		✓	643

It's ok to mix usual columns and hierarchized columns

Multiple column-hierarchization

```
\begin{tabular}{@{}lllllllll@{}} \toprule
    & \multicolumn{3}{c}{Temperature ($\mathrm{^\circ C}$) } & \multicolumn{2}{c}{Precipitation (mm) } & \multicolumn{2}{c}{Access} & \\ \cmidrule(lr){2-4} \cmidrule(lr){5-6} \cmidrule(lr){7-8}
    Prefecture & Max. & Avg. & Min. & August & December & By shinkansen & By plane & Density (persons/${km}^2$)  \\ \midrule
    Ishikawa & 32 & 20 & -1 & 179.8 & 304.7 & \checkmark & \checkmark & 267 \\
    Shizuoka & 27 & 23 & 5 & 250.9 & 63.0 & \checkmark & \checkmark & 461 \\
    Okinawa & 33 & 28 & 15 & 175.4 & 104.4 &  & \checkmark & 643 \\ \bottomrule
\end{tabular}
```

With hierarchization, one needs to write a unit just once, making the table shorter

	Temperature (°C)			Precipitation (mm)		Access		
Prefecture	Max.	Avg.	Min.	August	December	By shinkansen	By plane	Density (persons/km^2)
Ishikawa	32	20	-1	179.8	304.7	✓	✓	267
Shizuoka	27	23	5	250.9	63.0	✓	✓	461
Okinawa	33	28	15	175.4	104.4		✓	643

It's ok to mix usual columns and hierarchized columns

Tables

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Partial horizontal line (`cmidrule`)

- Partial horizontal line (`cmidrule`) has two parameters.
  - ✓ Trims the ends of the line?: "`l`" (left) or "`r`" (right) or "`lr`" (both)
  - ✓ Range (e.g., "2-4")
- By setting these params correctly, the table becomes much beautiful.

```
\begin{tabular}{@{}llll@{}} \toprule
    & \multicolumn{3}{c}{Error} \\ \cmidrule(l){2-4}
    Method & Min. & Avg. & Max. \\ \midrule
    Isomap & 0.23 & 0.44 & 0.92 \\
    LLE    & 0.10 & 0.73 & 1.82 \\ \bottomrule
\end{tabular}
```

Trim!

Method	Error		
	Min.	Avg.	Max.
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

1 2 3 4

Partial horizontal line (`cmidrule`)

	error		
Method	Min.	Avg.	Max.
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

`cmidrule(){2-4}`

	error		
Method	Min.	Avg.	Max.
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

`cmidrule(l){2-4}`

Trim left

	error		
Method	Min.	Avg.	Max.
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

`cmidrule(r){2-4}`

Trim right

	Error		
Method	Min.	Avg.	Max
Isomap	0.23	0.44	0.92
LLE	0.10	0.73	1.82

`cmidrule(lr){2-4}`

Trim left and right

Small differences… But *god is in the details*…

Partial horizontal line (`cmidrule`)

w/ proper params

	Temperature (°C)			Precipitation (mm)		Access		
Prefecture	Max.	Avg.	Min.	August	December	By shinkansen	By plane	Density (persons/km^2)
Ishikawa	32	20	-1	179.8	304.7	✓	✓	267
Shizuoka	27	23	5	250.9	63.0	✓	✓	461
Okinawa	33	28	15	175.4	104.4		✓	643

w/o proper params

	Temperature (°C)			Precipitation (mm)		Access		
Prefecture	Max.	Avg.	Min.	August	December	By shinkansen	By plane	Density (persons/km^2)
Ishikawa	32	20	-1	179.8	304.7	✓	✓	267
Shizuoka	27	23	5	250.9	63.0	✓	✓	461
Okinawa	33	28	15	175.4	104.4		✓	643

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Column to row

- This is **not** recommended, but moving **a column to a row** often makes the table clearer. Consider the following typical table.

Method	Dataset	Runtime (ms)
k-means	MNIST	10.2
	ImageNet	45.3
	Places	57.1
Ours	MNIST	8.3
	ImageNet	39.1
	Places	82.3

- This table is good (rows are interchangeable), but…
  - ✓ If we compare methods in the same dataset, the values are far away (e.g., on MNIST, k-means (10.2) vs Ours (8.3)).
  - ✓ With more methods/datasets, the table becomes more vertical.

Column to row

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Method	Dataset	Runtime (ms)
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	Places	82.3

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  - ✓ If we compare methods in the same dataset, the values are far away (e.g., on MNIST, k-means (10.2) vs Ours (8.3)).
  - ✓ With more methods/datasets, the table becomes more vertical.

Column to row

Restructure the problem.
- Each row is (method, dataset, runtime) to…
- Each row is (method, runtime for MNIST, runtime for ImageNet, runtime for Places)

Method	Dataset	Runtime (ms)
k-means	MNIST	10.2
	ImageNet	45.3
	Places	57.1
Ours	MNIST	8.3
	ImageNet	39.1
	Places	82.3

Column-to-row

Method	Runtime (ms) for Dataset=MNIST	Runtime (ms) for Dataset=ImageNet	Runtime (ms) for Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Column hierarchization

	Runtime (ms)		
Method	Dataset=MNIST	Dataset=ImageNet	Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Still wordy? 🤔

Column to row

	Runtime (ms)		
Method	Dataset=MNIST	Dataset=ImageNet	Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Pattern 1:
Delete "Dataset="

Pattern 2:
Move "Dataset"

	Runtime (ms)		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

	Dataset		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Column to row

	Runtime (ms)		
Method	Dataset=MNIST	Dataset=ImageNet	Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Pattern 1:
Delete "Dataset="

Pattern 2:
Move "Dataset"

	Runtime (ms)		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

	Dataset		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

- Seems clear. But there's no descriptions for "Dataset"
- This approach works only if it's acceptable not to show "Dataset"

Column to row

	Runtime (ms)		
Method	Dataset=MNIST	Dataset=ImageNet	Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Pattern 1:
Delete "Dataset="

Pattern 2:
Move "Dataset"

	Runtime (ms)		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

	Dataset		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

- Seems perfect? But there's no description for "Runtime".
- You need to write "This table reports runtime (ms)" in the caption.
- If a table consists of only one type of value, you may clarify the table by removing the type in the header and explaining the type in the caption.

Column to row

	Runtime (ms)		
Method	Dataset=MNIST	Dataset=ImageNet	Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Pattern 1:

Note that this violates "row-oriented principal". Thus personally I don't recommend this style, though.

Pattern 2:
Move "Dataset"

	Runtime (ms)		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

		Dataset	
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

- Seems perfect? But there's no description for "Runtime".
- You need to write "This table reports runtime (ms)" in the caption.
- If a table consists of only one type of value, you may clarify the table by removing the type in the header and explaining the type in the caption.

Column to row

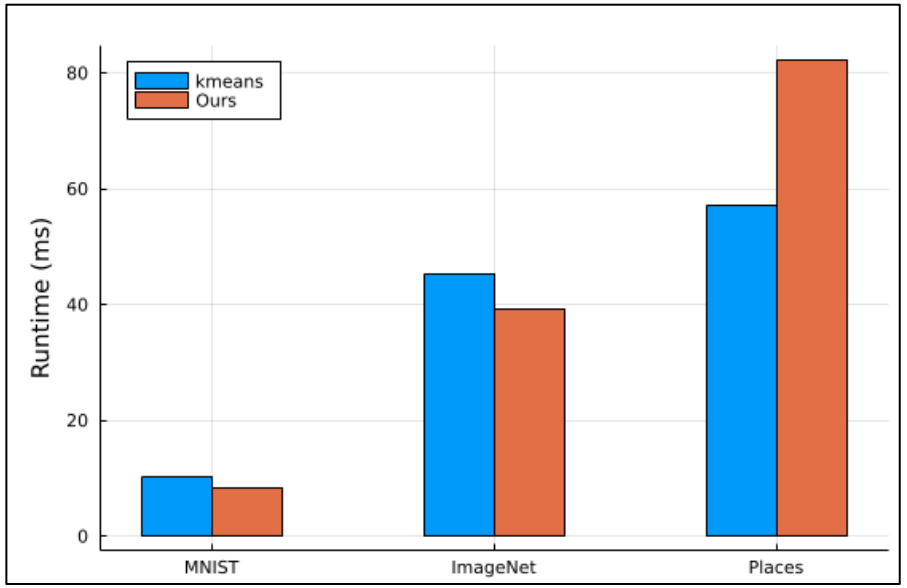
	Runtime (ms)		
Method	Dataset=MNIST	Dataset=ImageNet	Dataset=Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

Pattern 1:
Delete "Dataset="

Pattern 2:
Move "Dataset"

Pattern 3: Plots

	Runtime (ms)		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3



	Dataset		
Method	MNIST	ImageNet	Places
k-means	10.2	45.3	57.1
Ours	8.3	39.1	82.3

- The original cause is that there are two factors to focus (Method and Dataset).
- If there are two factors to focus, the table would be "matrix-like".
- In this case, plotting may be better (you can further improve this by box-plot!).

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- Row hierarchization
- Column hierarchization
- Partial horizontal line (`cmidrule`)
- Column to row
- Flowchart

Plots

- Basics
- Bar chart to box plot
- Control parameter
- Misc

Flowchart

- When you have trouble creating tables, then…

1. Break up the table until it becomes the “good” table (e.g., satisfying stack-of-rows principal). It is OK if it is very vertically long.
2. Repeat the “row grouping” for the most important column. Do “row hierarchization” as needed.
3. Perform “column grouping” as necessary.
4. If it still does not fit, do “move a column to a row” and then do “row hierarchization”. Delete redundant descriptions.
5. If it still does not fit well, consider using a plot.

Tables

- Basics
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Plots

- Basics
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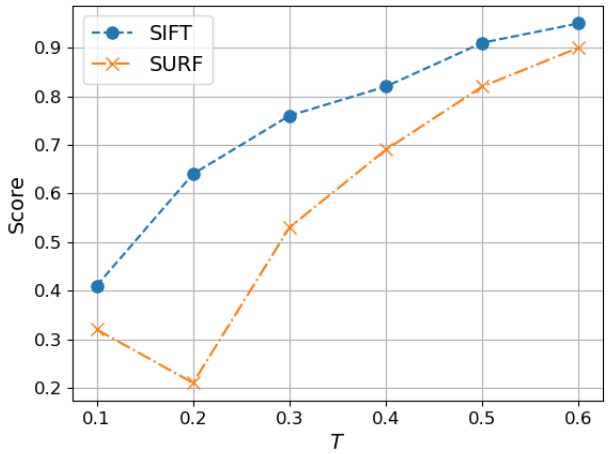
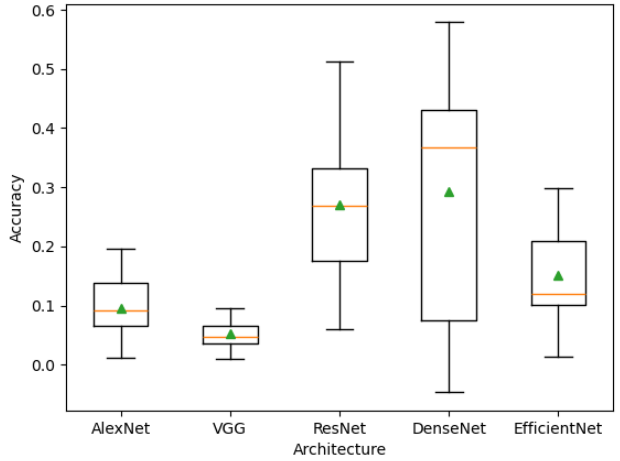
- Control parameter
- Misc

Basics

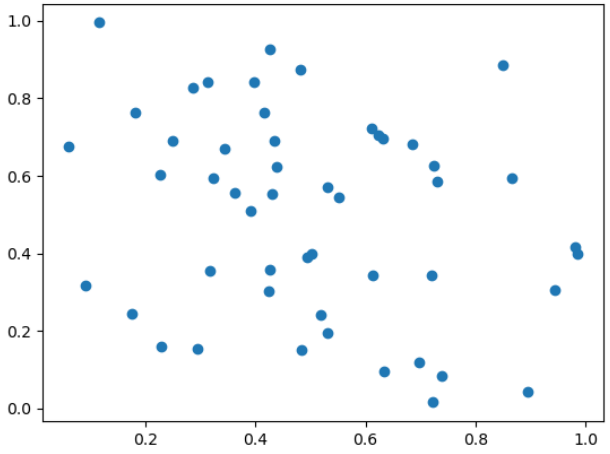
- Three basic plots; **line chart**, **box plot (bar chart)**, and **scatter plot**
- Try these basic plots first. In many cases, that will suffice.
- Avoid using overly complex/sophisticated plots, as reviewers may have difficulty understanding them.



Line chart

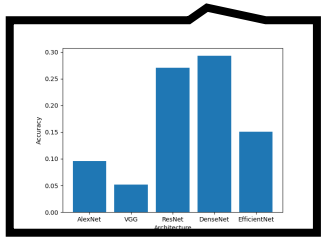


Box plot



Scatter plot

Bar chat is more natural, but a bar chart can be (and should be) converted to a box plot.

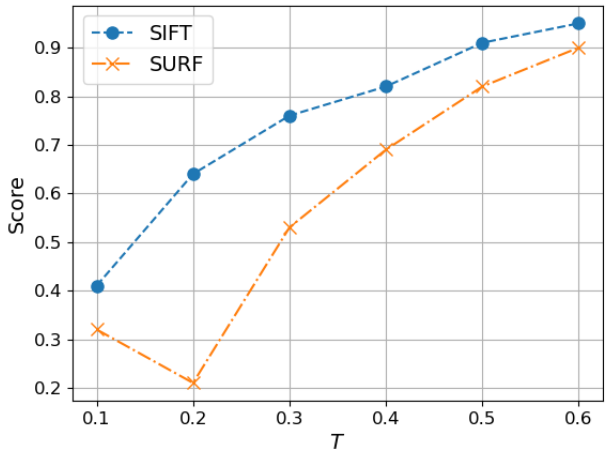


Basics

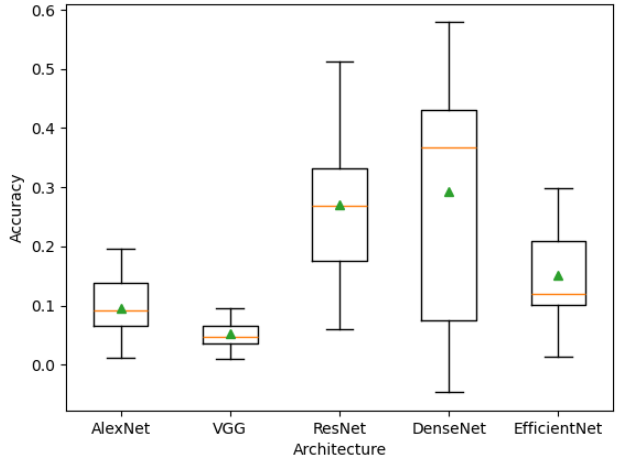
- Three basic plots; **line chart**, **box plot (bar chart)**, and **scatter plot**
  - es, that will suffice.
  - ated plot
  - lem.

- There exist discrete labels. (x-axis)
- For each label, several observations. (y-axis)

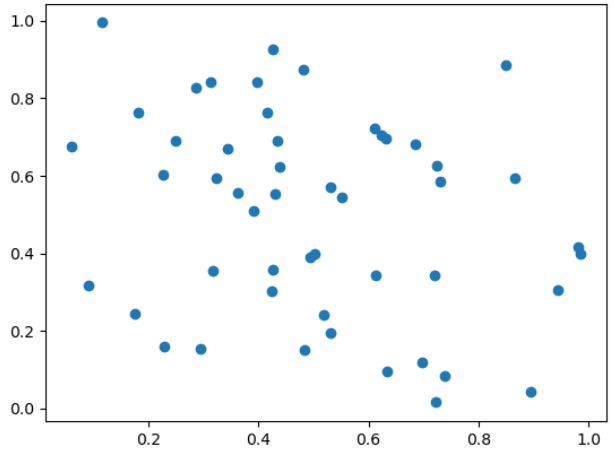
- Several 2D instances



Line chart



Box plot



Scatter plot

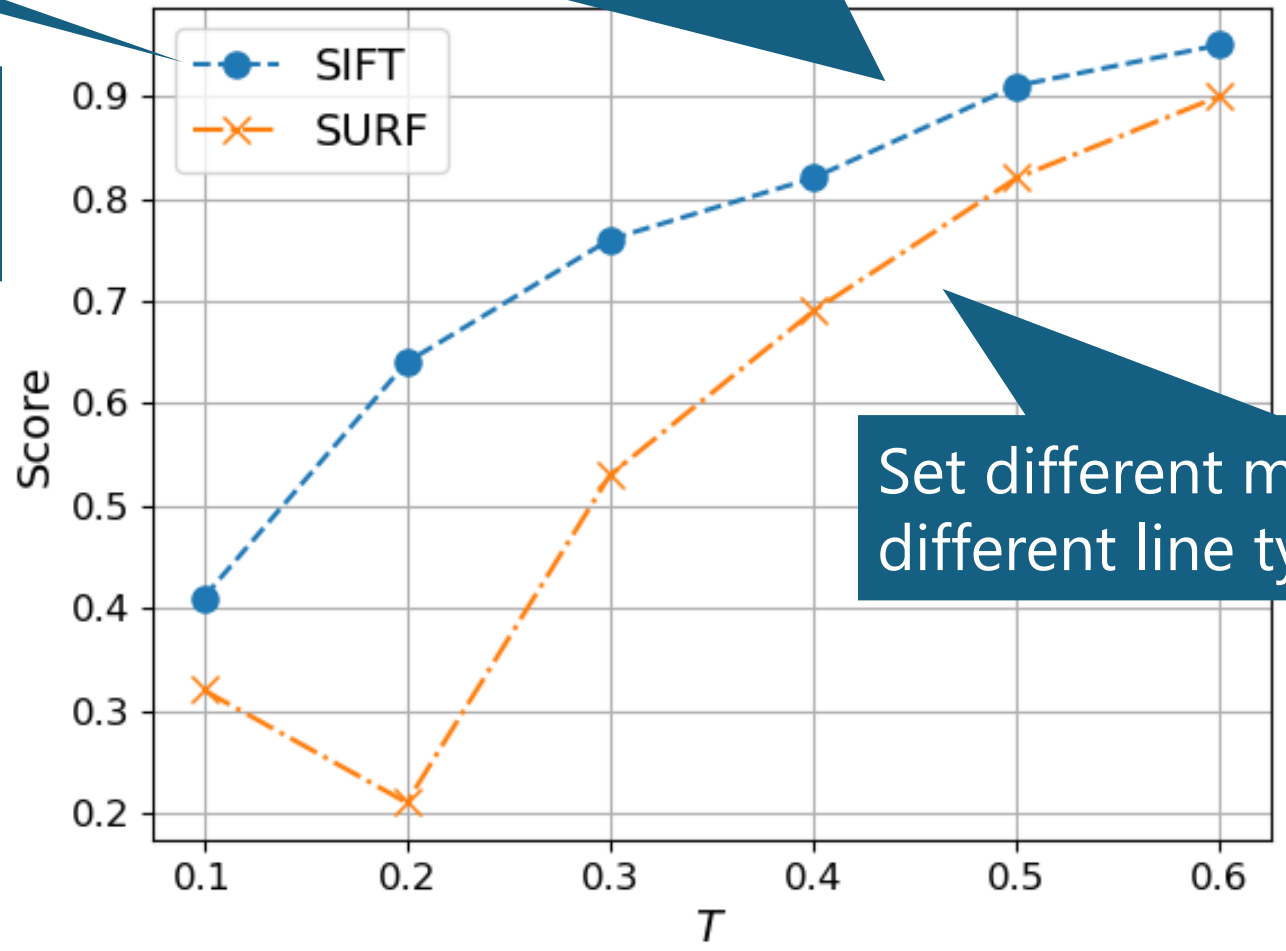
- One control parameter (a continuous value, not discrete labels).
- Compare several functions (lines) of the parameter.

Basics

Be sure to separate the measured value (marker) and the line to be complemented (do not use a polyline chart without markers).

Legend

MUST put xlabel and ylabel.



Set different marker values and different line types for each plot.

The font size should be large! Ideally, the same size as the main text.

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Plots

- Basics
- Bar chart to box plot
- Control parameter
- Misc

Bar chart to box plot

- A bar chart is the first choice, however,
  - ✓ A bar chart with error bars is basically better.
  - ✓ A box plot is further better.
- Considering the following observations.

Accuracy of AlexNet
[0.14 0.06 0.05 0.11 0.14 0.08 0.2 0.14 0.1 0.08 0.07 0.15 0.09 0.01 0.08 0.15 0.04 0.04 0.11 0.11]

Accuracy of VGG
[0.06 0.08 0.07 0.06 0.07 0.03 0.04 0.02 0.03 0.06 0.01 0.04 0.04 0.05 0.04 0.03 0.04 0.09 0.09 0.05]

Accuracy of ResNet
[0.32 0.06 0.16 0.22 0.45 0.13 0.25 0.51 0.27 0.32 0.06 0.43 0.31 0.28 0.18 0.16 0.22 0.35 0.46 0.27]

Accuracy of DenseNet
[0.42 0.36 0.39 0.43 0.55 0. 0.49 0.12 0.08 0.35 0.01 0.58 0.39 0.46 -0.05 0.37 0.34 0.06 0.05 0.44]

Accuracy of EfficientNet
[0.1 0.21 0.17 0.12 0.28 0.25 0.11 0.01 0.09 0.12 0.21 0.3 0.11 0.23 0.18 0.21 0.05 0.12 0.07 0.1]

Bar chart to box plot

- A bar chart is the first choice, however,
  - ✓ A bar chart with error bars is basically better.
  - ✓ A box plot is further better.
- Considering the following observations.

Accuracy of AlexNet
[0.14 0.06 0.05 0.11 0.14 0.08 0.2 ...]

Accuracy of VGG
[0.06 0.08 0.07 0.06 0.07 0.03 0.04 ...5]

- Comparison over the discrete labels (methods). So we don't use a line chart.
- Let's consider a bar chart first.

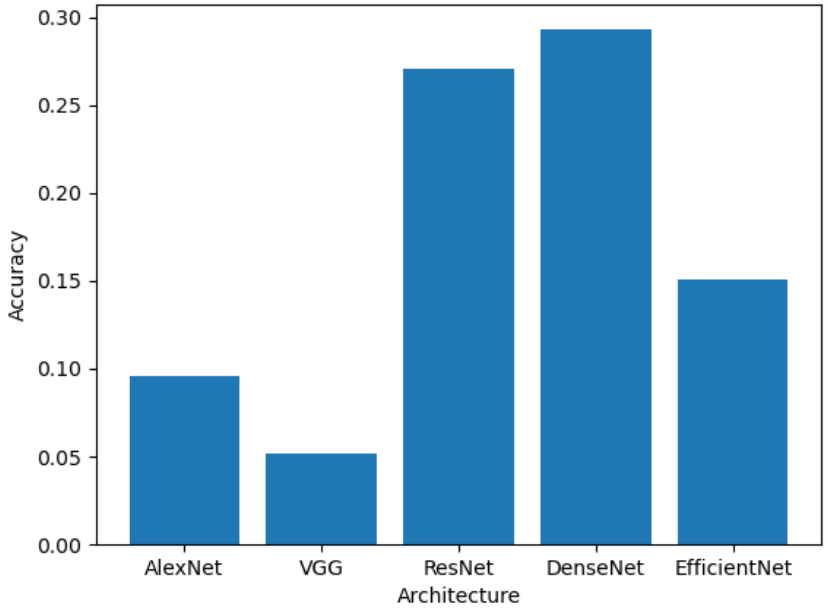
Accuracy of ResNet
[0.32 0.06 0.16 0.22 0.45 0.13 0.25 0.51 0.27 0.32 0.06 0.43 0.31 0.28 0.18 0.16 0.22 0.35 0.46 0.27]

Accuracy of DenseNet
[0.42 0.36 0.39 0.43 0.55 0. 0.49 0.12 0.08 0.35 0.01 0.58 0.39 0.46 -0.05 0.37 0.34 0.06 0.05 0.44]

Accuracy of EfficientNet
[0.1 0.21 0.17 0.12 0.28 0.25 0.11 0.01 0.09 0.12 0.21 0.3 0.11 0.23 0.18 0.21 0.05 0.12 0.07 0.1]

Bar chart to box plot

- Comparison of the average values.
- That's it. Not so much informative.



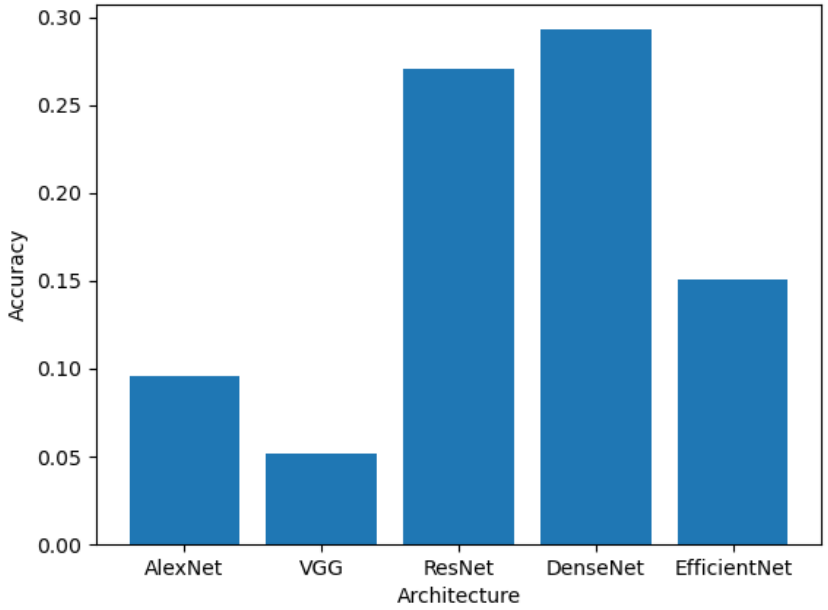
- By a box plot, we can see more information with the same space!

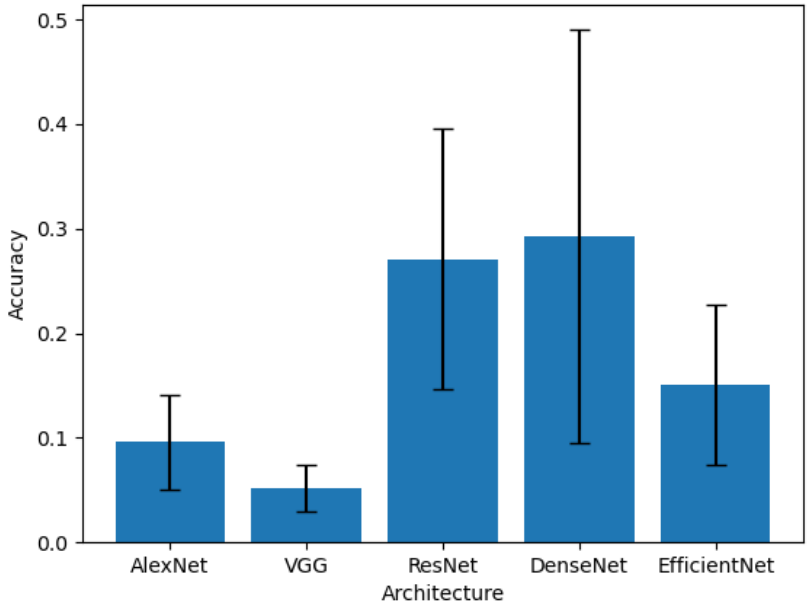
- With error bars, we can see the variation of values.
- More informative with the same space (area)

Bar chart to box plot

- Comparison of the average values.
- That's it. Not so much informative.

- By a box plot, we can see more information with the same space!





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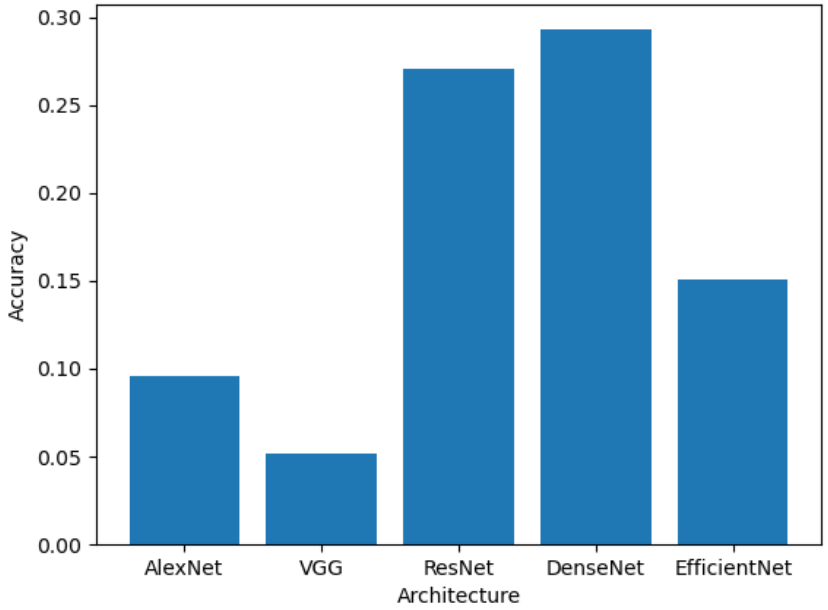
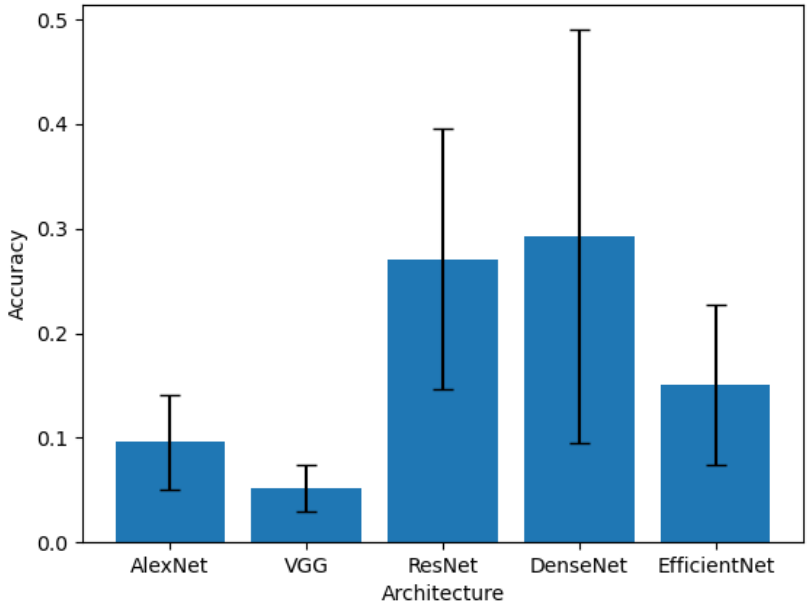
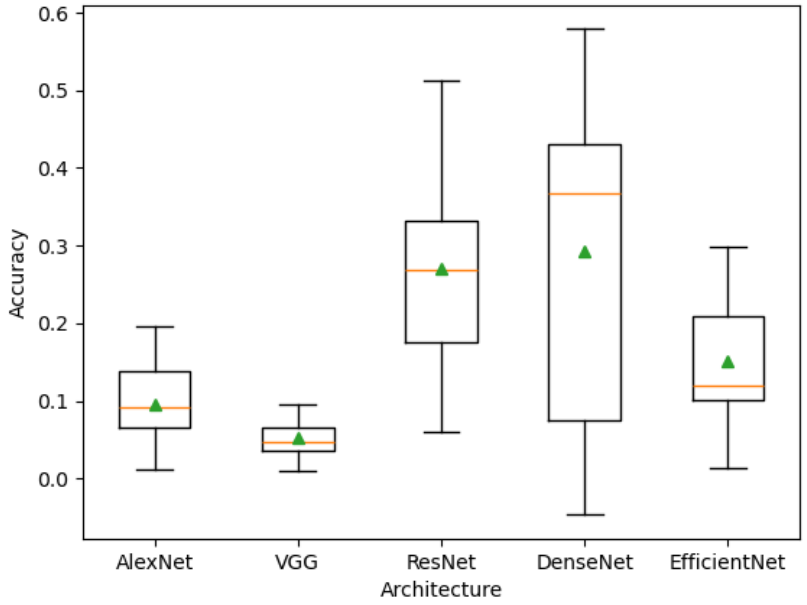
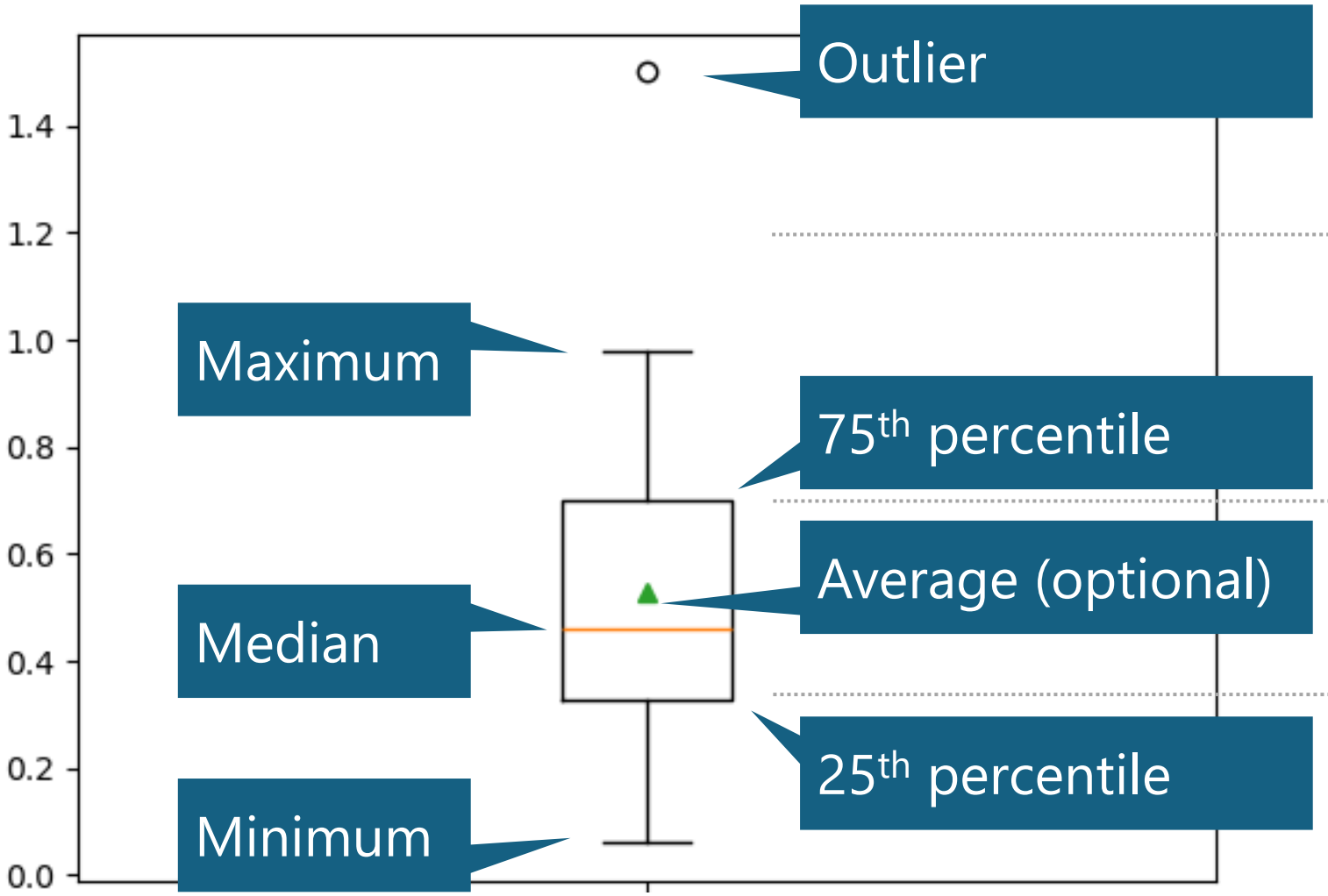






- With error bars, we can see the variation of values.
- More informative with the same space (area)

Box plot



Outlier

Maximum

75th percentile

Average (optional)

Median

25th percentile

Minimum

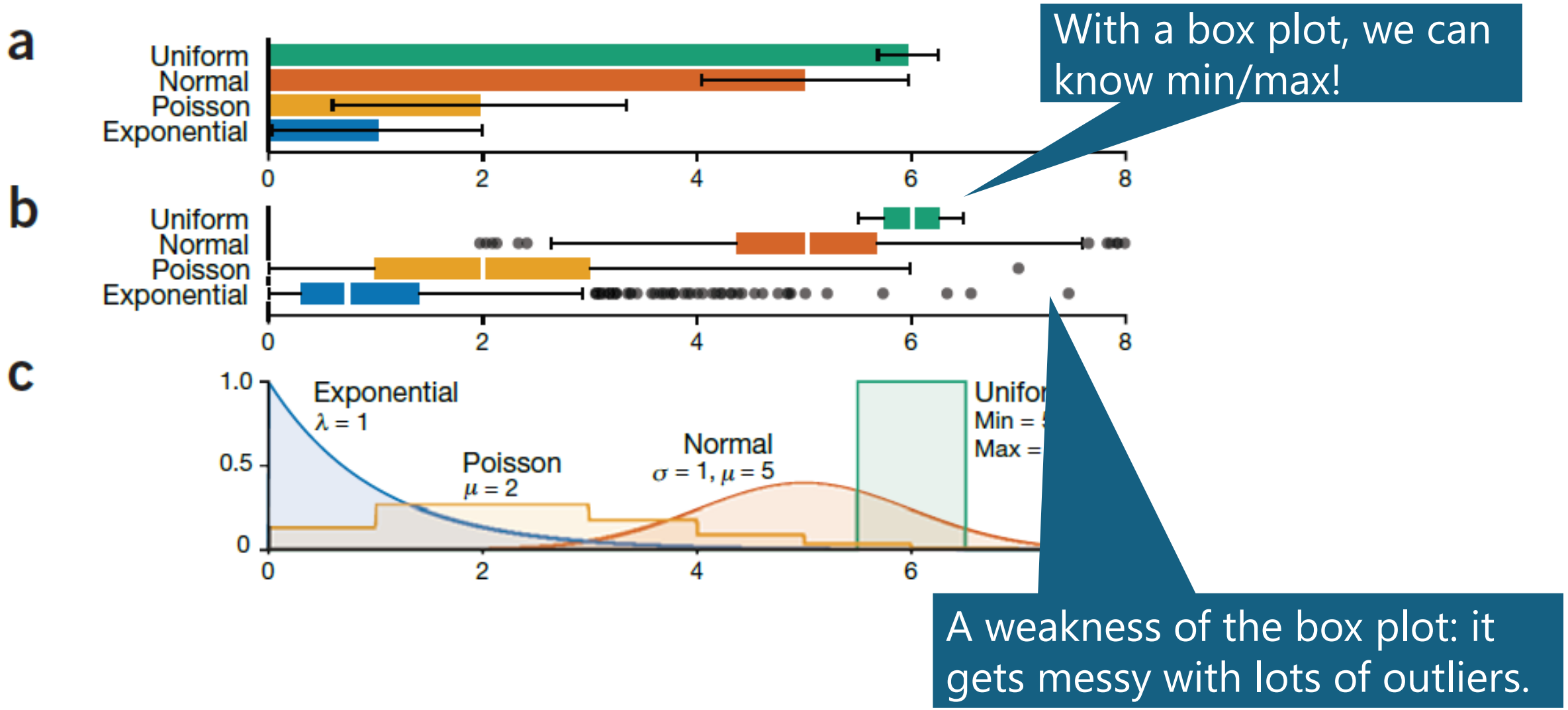
Outlier area

1.5 * IQR

IQR
(Interquartile range)

1.5 * IQR

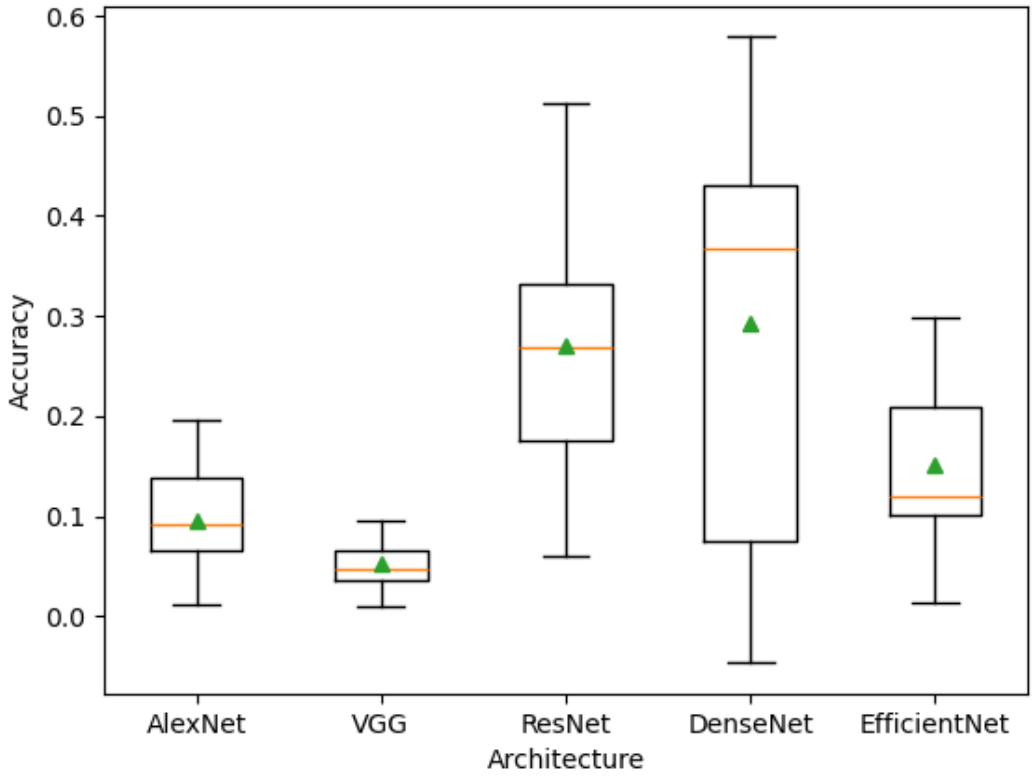
Box plot

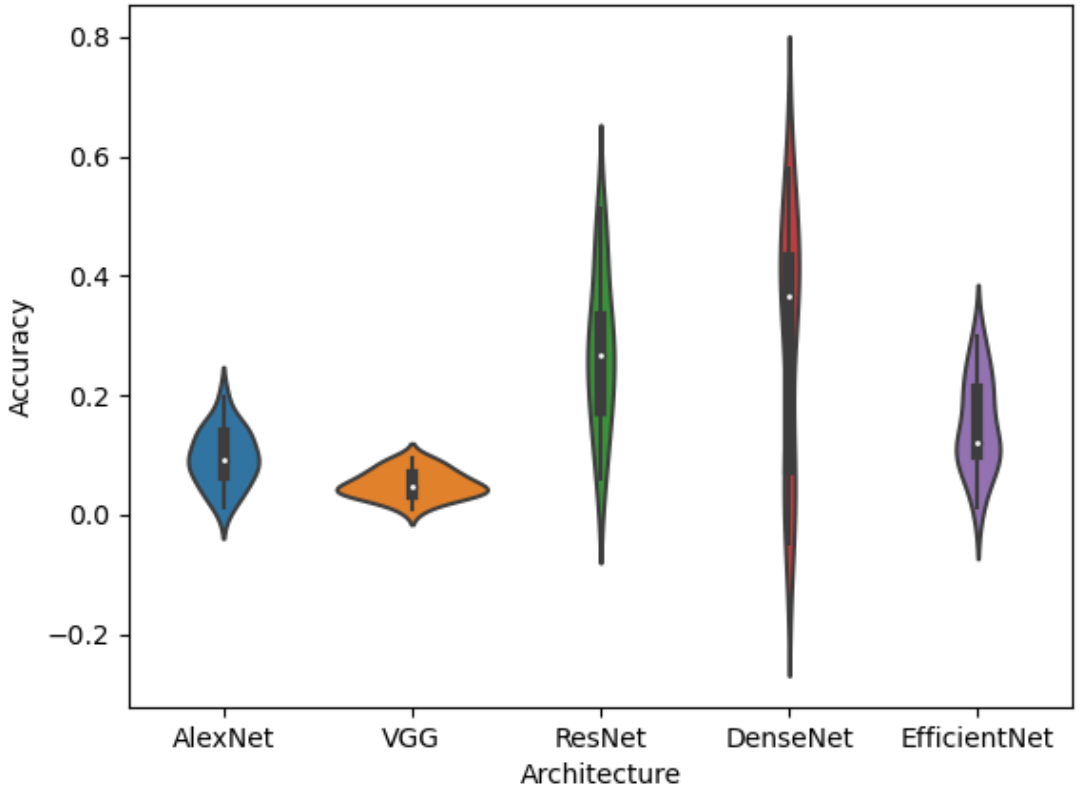


M. Streit and N. Gehlenborg, "Bar charts and box plots", Nature Methods, 2014. https://www.nature.com/articles/nmeth.2807

Violin plot?

Can be found in the seaborn package



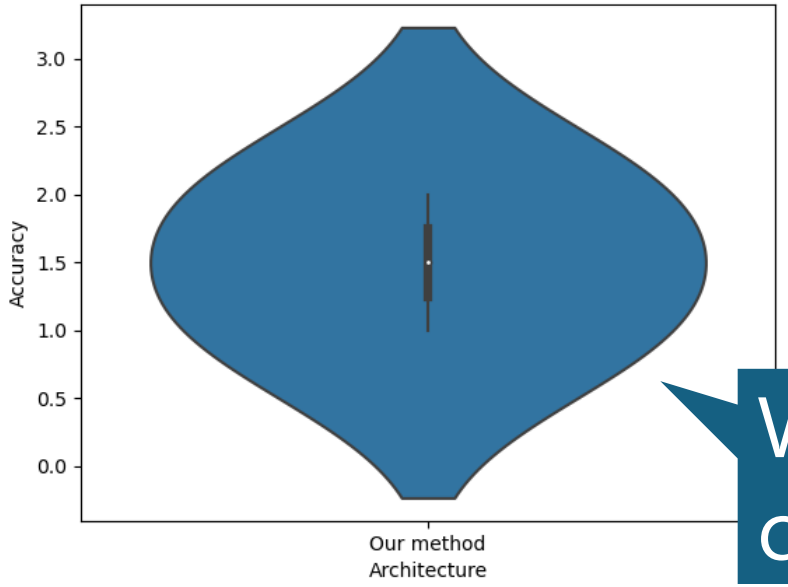


- A violin plot is considered as a more sophisticated visualization.
- We can visualize the distribution itself.
- I personally don't recommend a violin plot much.

Violin plot: bad points

- A violin plot automatically generates (interpolates) the distribution.
- It is dangerous, especially when #data is not enough.

Data: [1.0, 2.0]



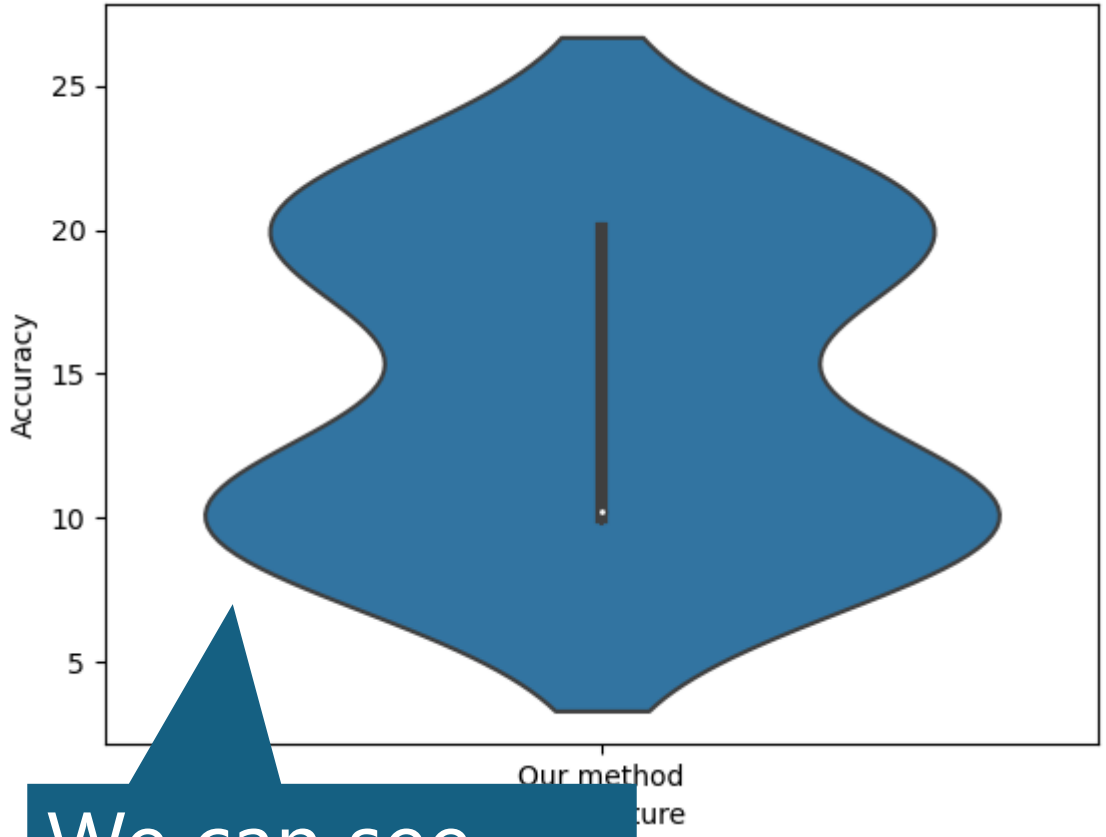
What is this curve? 🤔

- The reviewers may not understand the violin plot anyway.

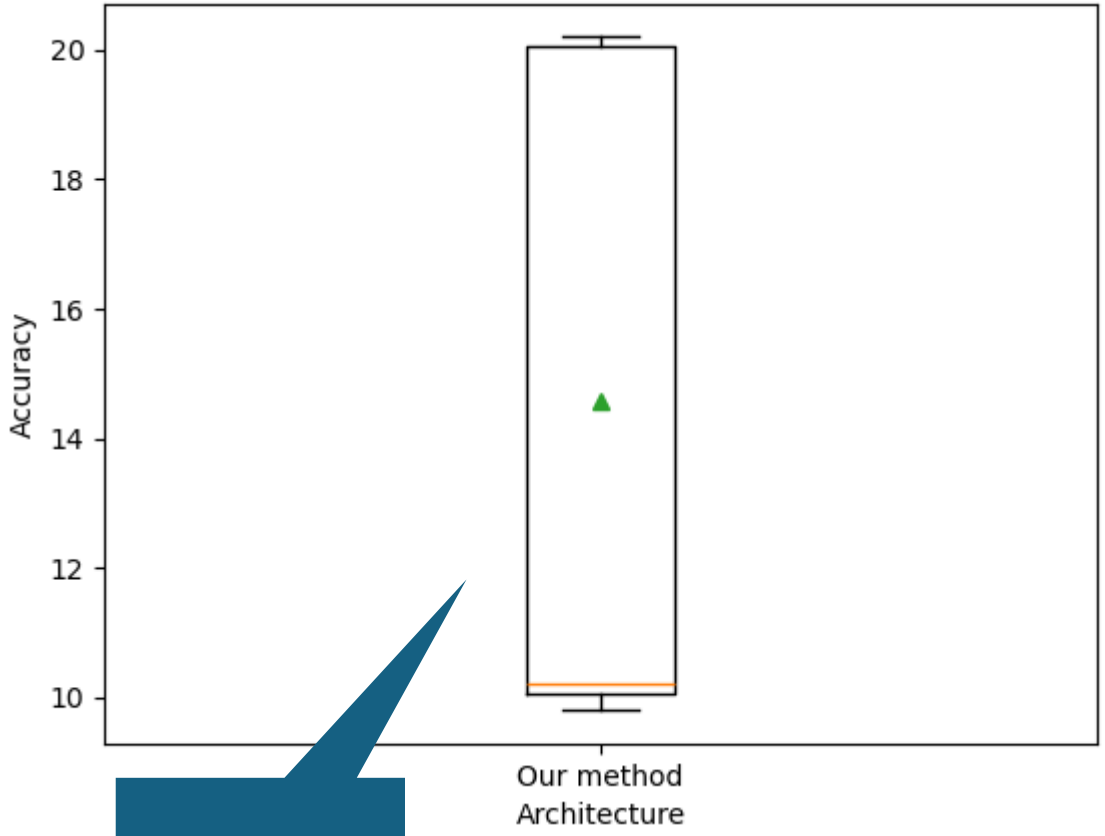
Violin plot: good points

➢ If the data is bi-modal or multi-modal, a violin plot is the only option.

Data: [10.1, 9.9, 10.1, 9.8, 10.2, 10.0, 20.1, 20.2, 20.0, 19.9, 20.1]



We can see two peaks 😊



??? 🤔

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- Basics
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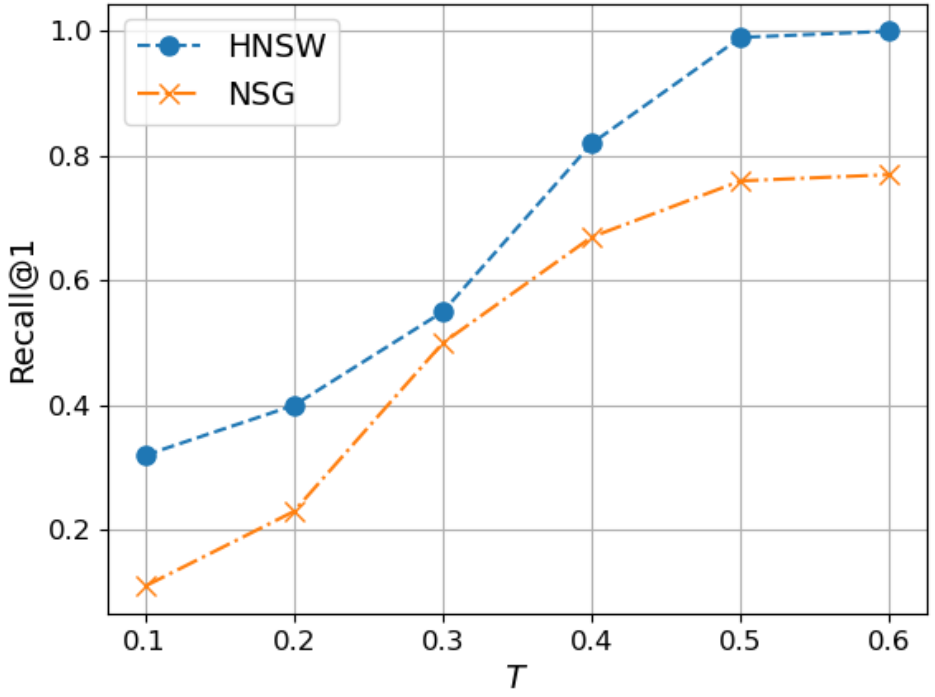
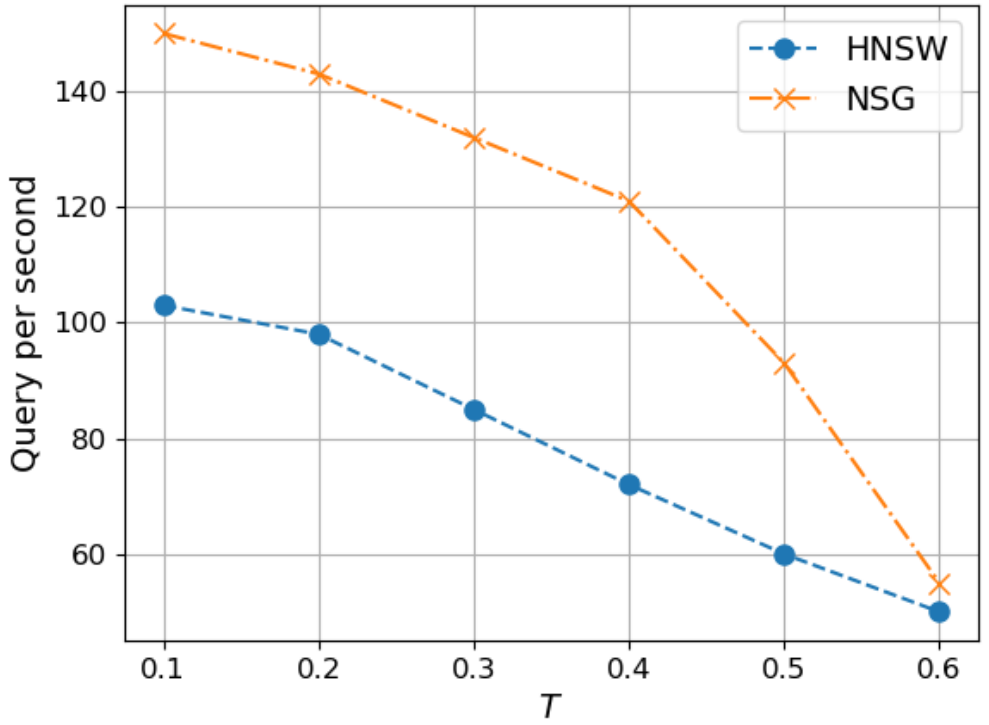
- Control parameter
- Misc

Control parameter

- It often happens that we would like to show the two line-plots with the same control parameter.





Control parameter

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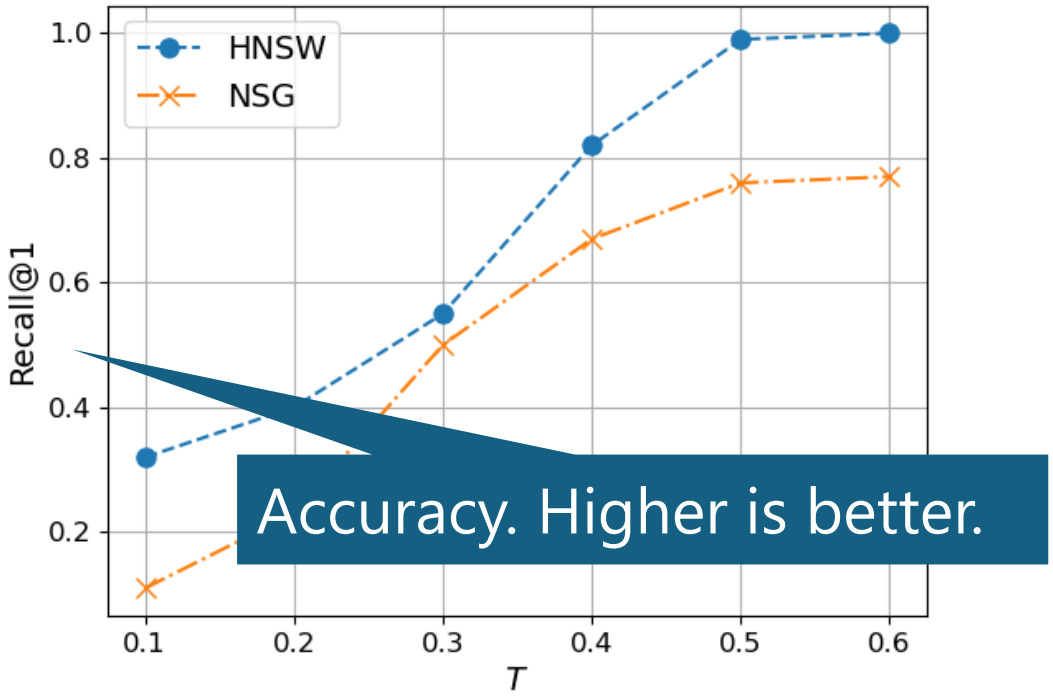
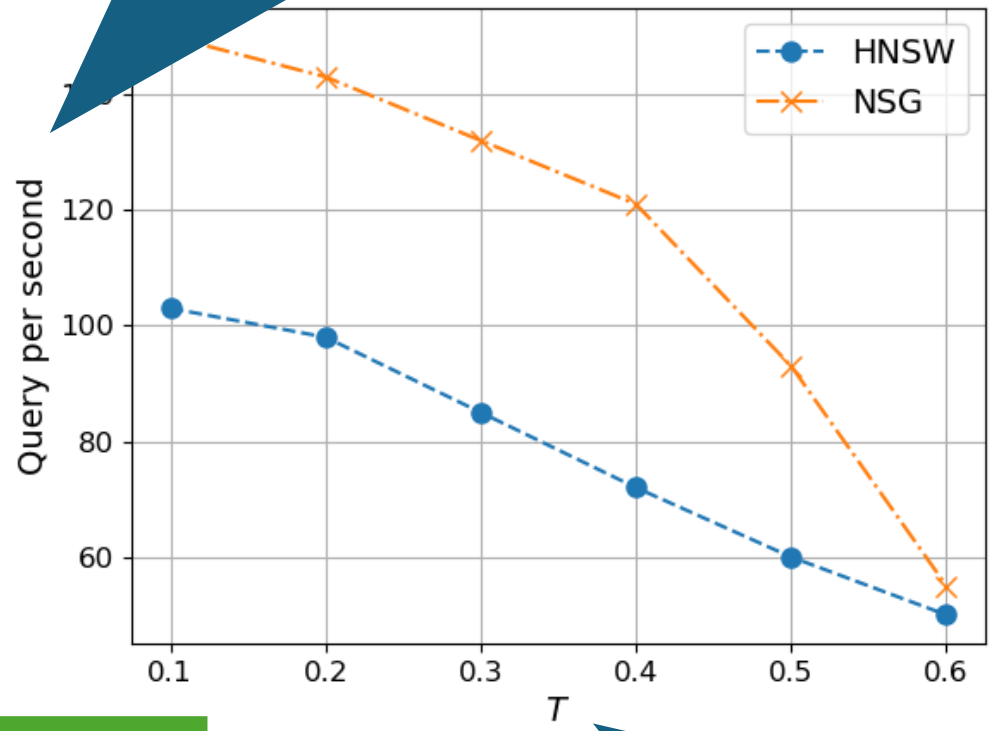


Accuracy. Higher is better.

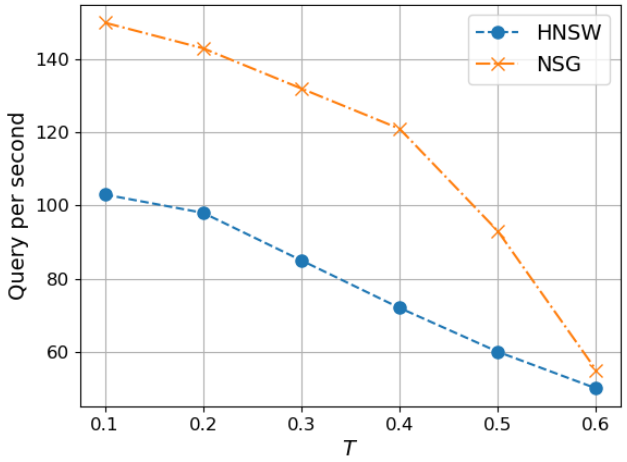
Inverse of runtime. Higher is better.

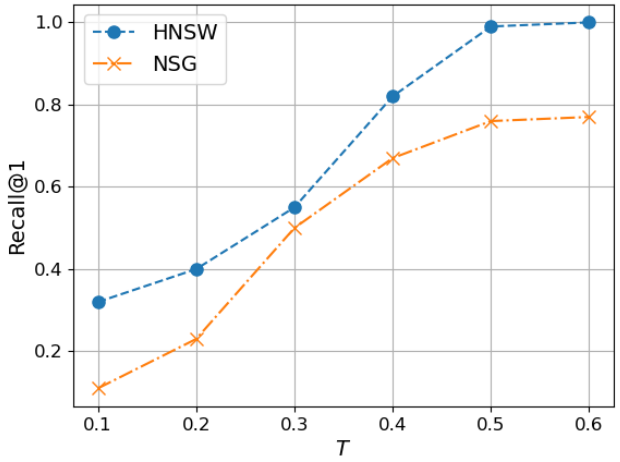


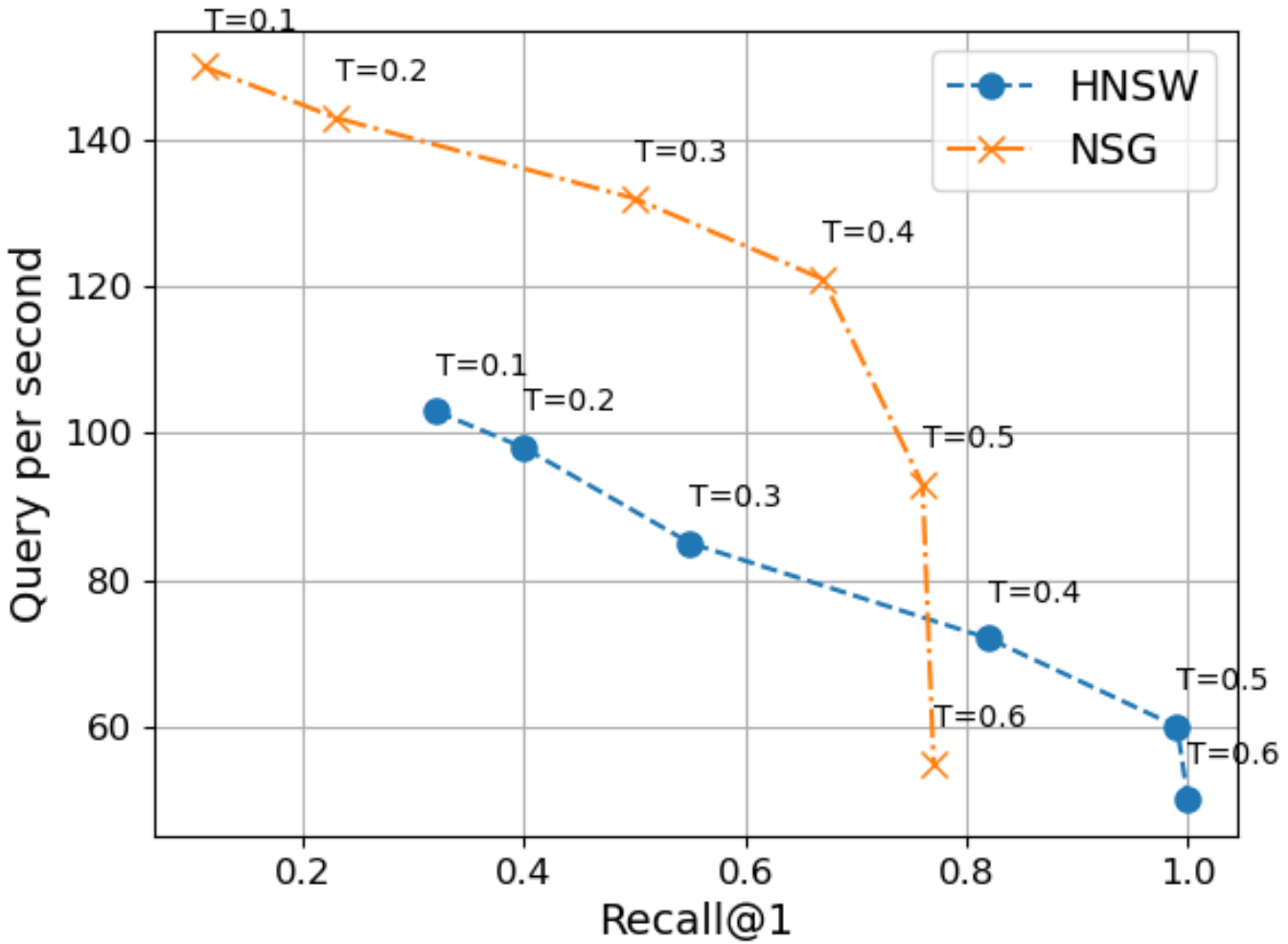
Control parameter T

- HNSW seems more accurate but slower.
- Can we know more information from these? 🤔

Control parameter

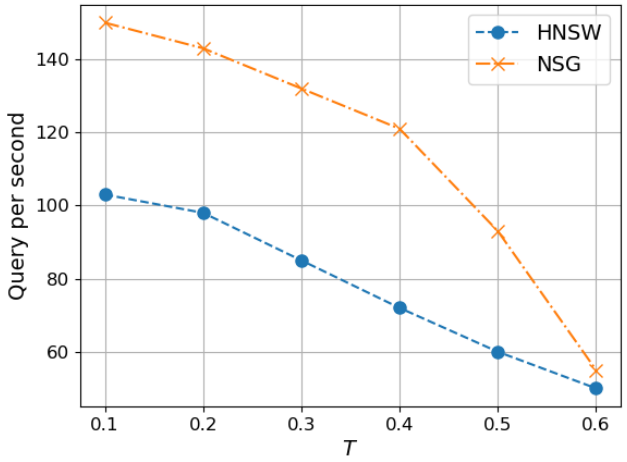


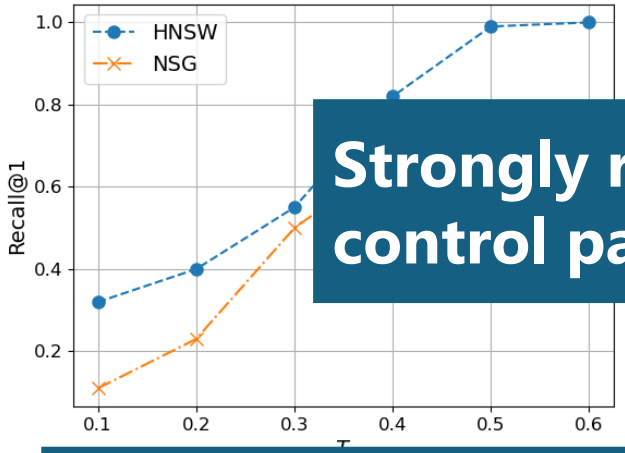


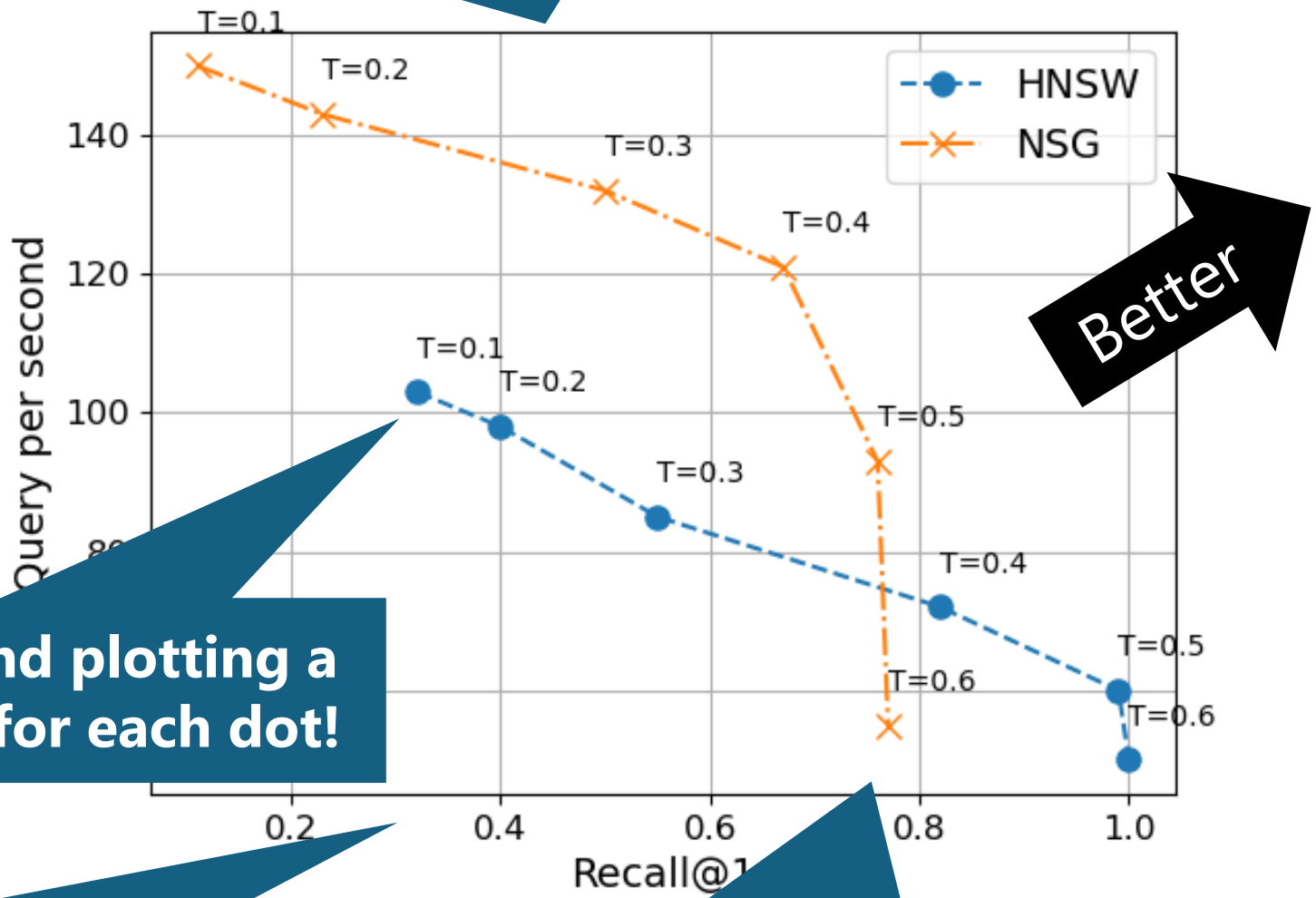


Control parameter

- Informative plot with a less space!
- Trade-off between the two curves.







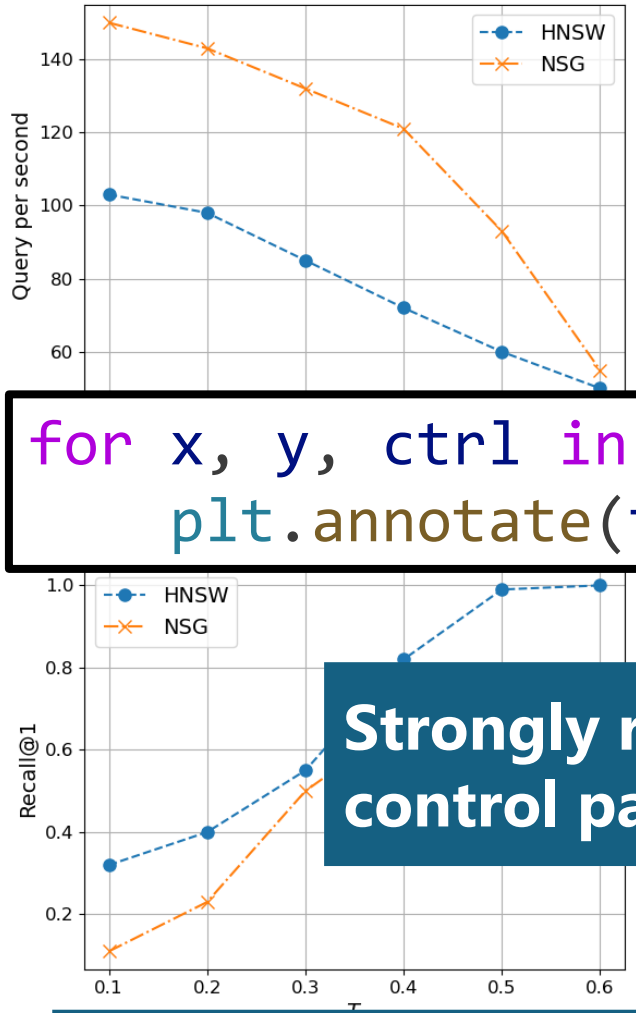
Strongly recommend plotting a control parameter for each dot!

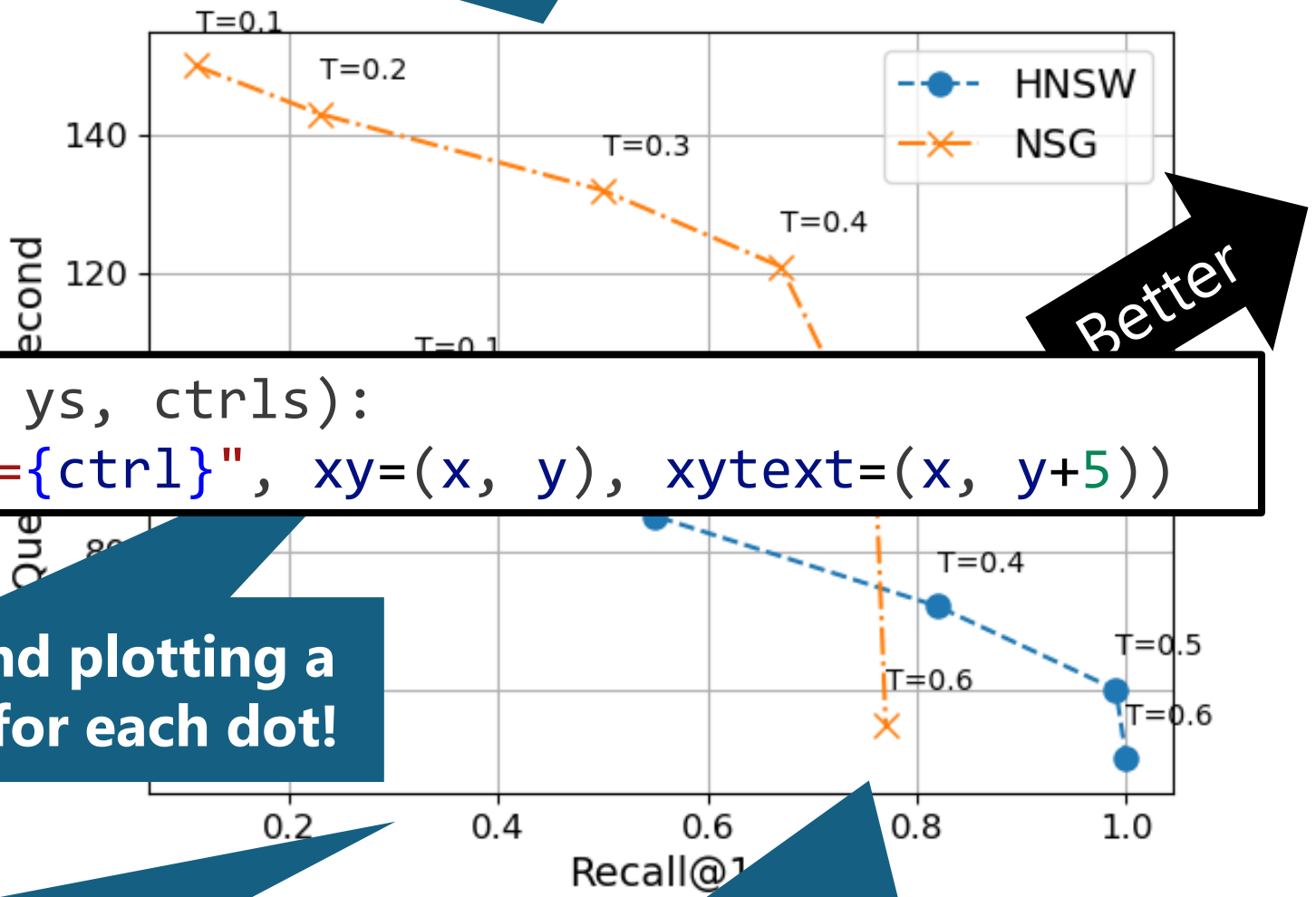
Depending on the context, one may evaluate the curve by AUC (area under the curve)

Runtime of NSG suddenly drops around R@1=0.7

Control parameter

- Informative plot with a less space!
- Trade-off between the two curves.





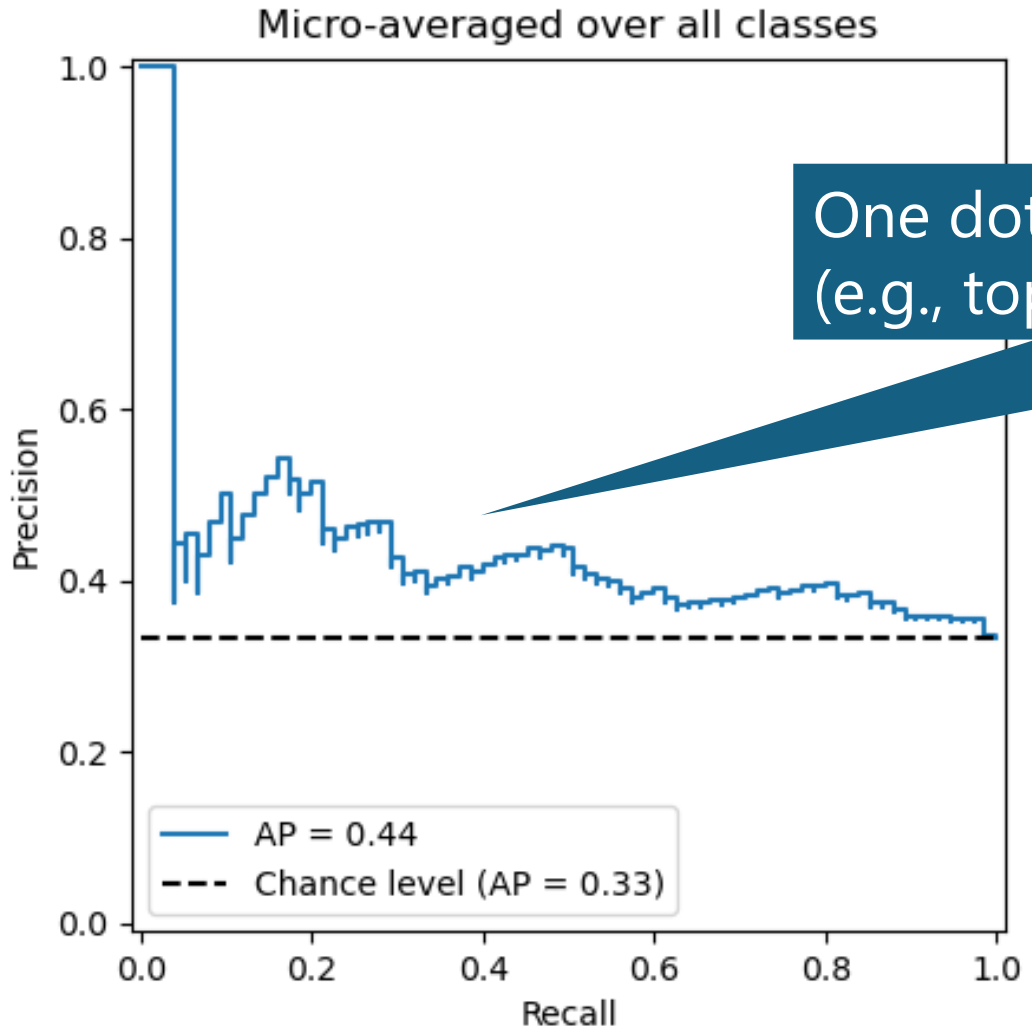

```
for x, y, ctrl in zip(xs, ys, ctrls):
    plt.annotate(text=f"T={ctrl}", xy=(x, y), xytext=(x, y+5))
```

Strongly recommend plotting a control parameter for each dot!

Depending on the context, one may evaluate the curve by AUC (area under the curve)

Runtime of NSG suddenly drops around R@1=0.7

Precision-recall curve has the same structure



One dot is obtained by setting one parameter (e.g., top-k in the context of retrieval)

https://scikit-learn.org/stable/auto_examples/model_selection/plot_precision_recall.html

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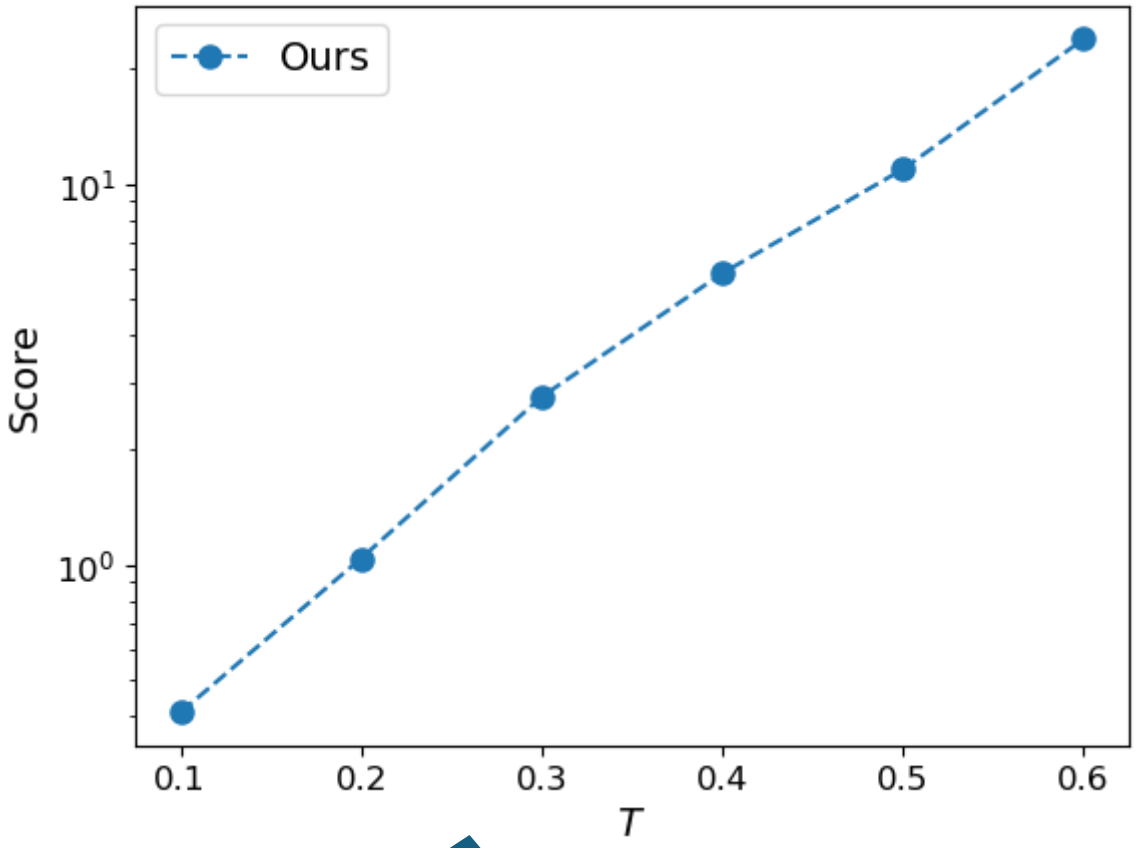
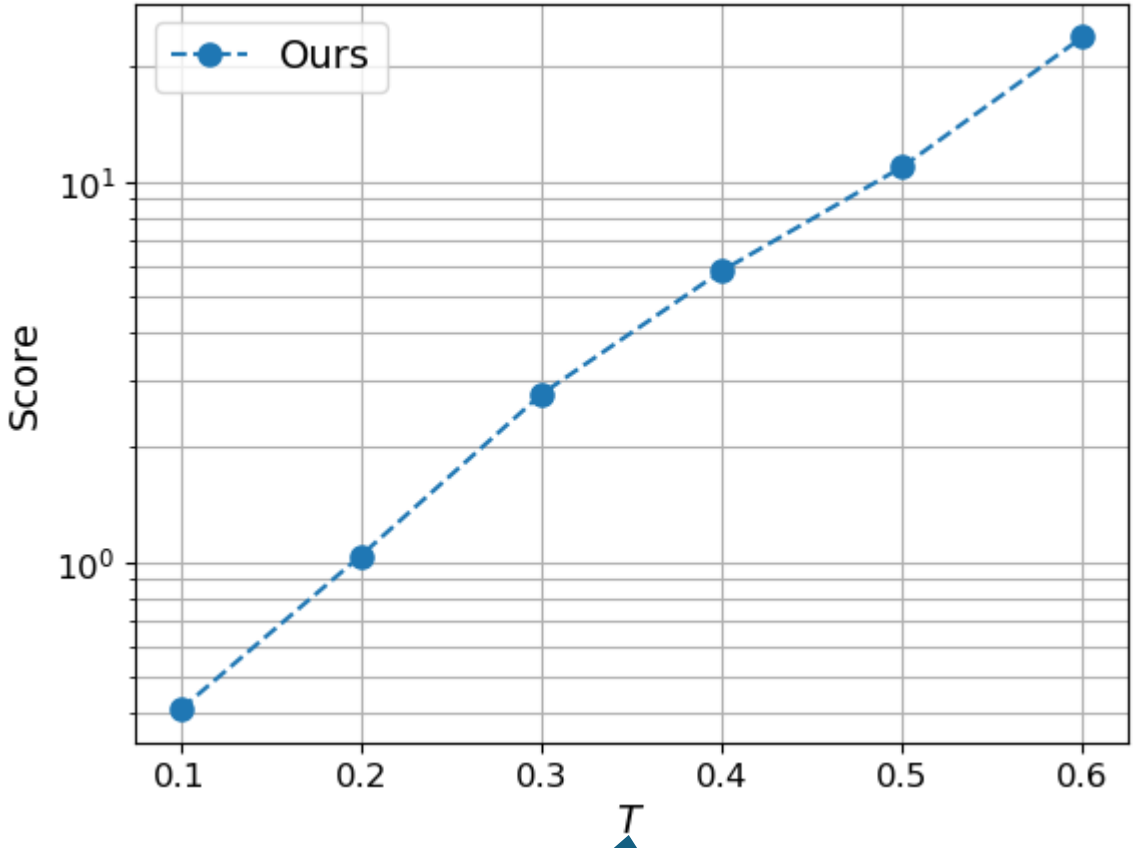
Put the grid on a logarithmic graph



Not clear yscale is log 😕

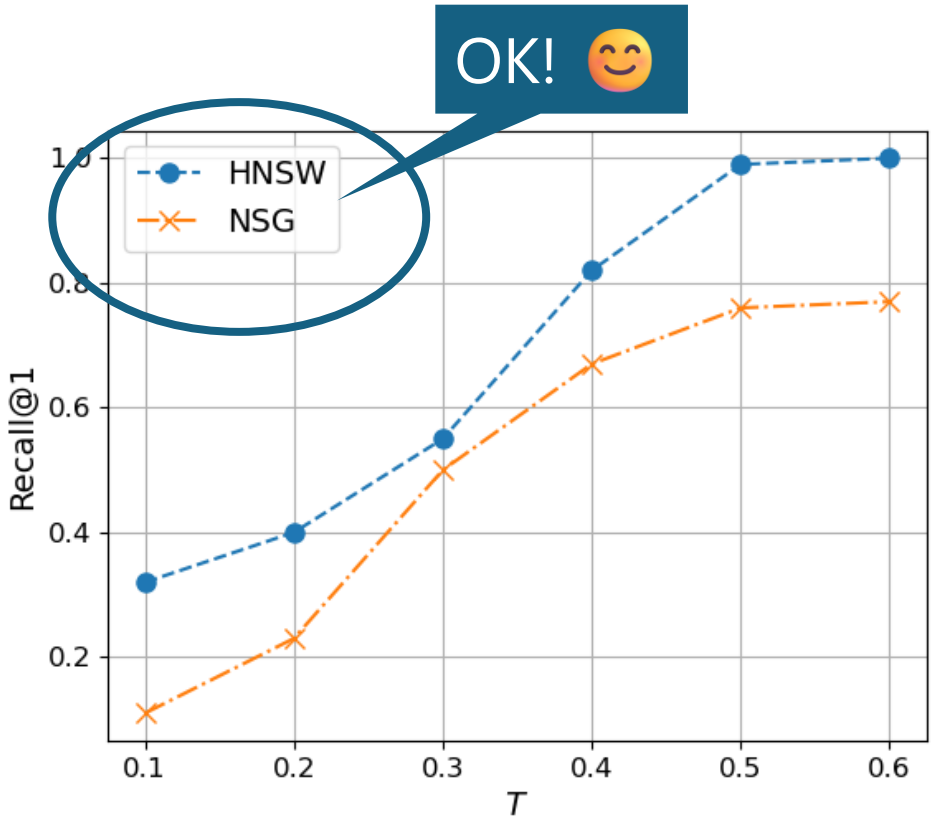
```
plt.grid(which="both")
```

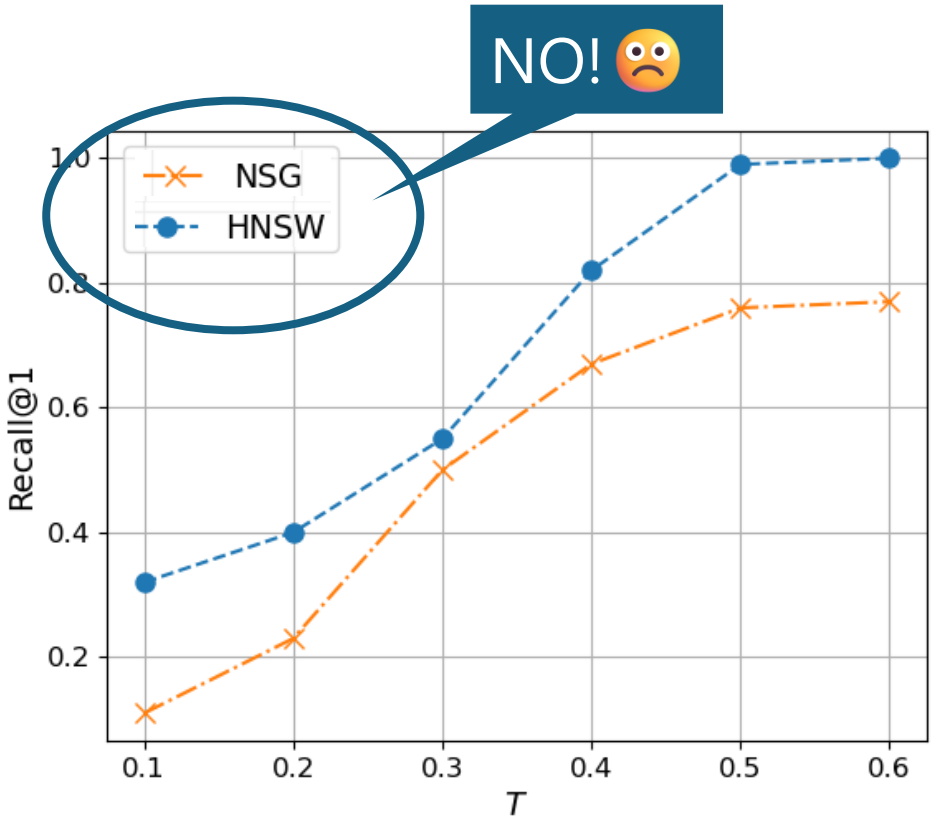


Yscale is log! 😊

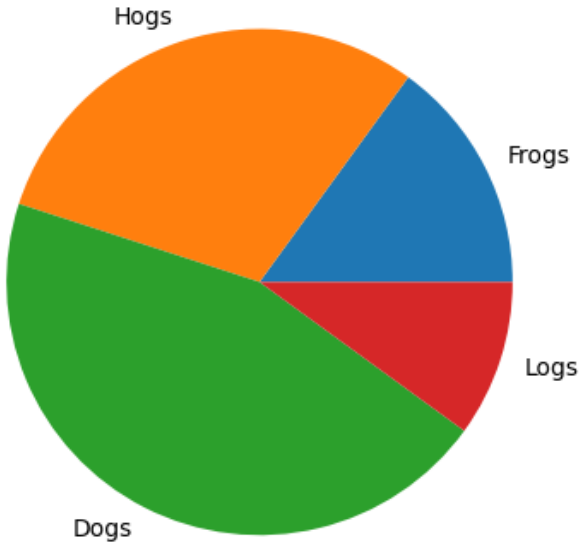
Legend

- The order of the methods in the legend should match the lines as much as possible.

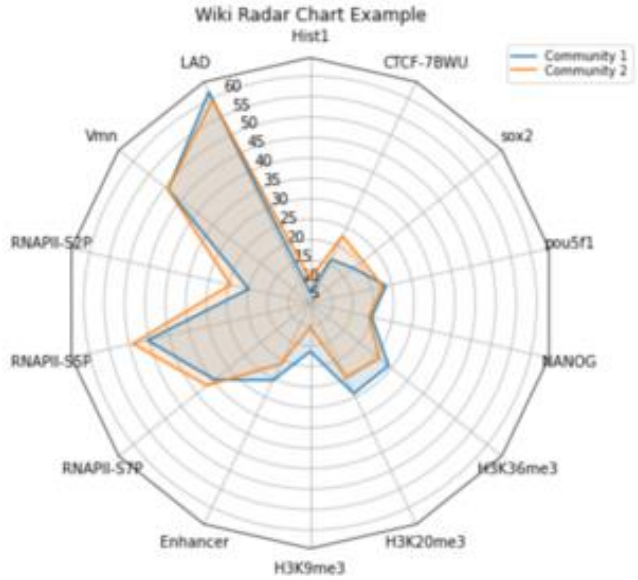




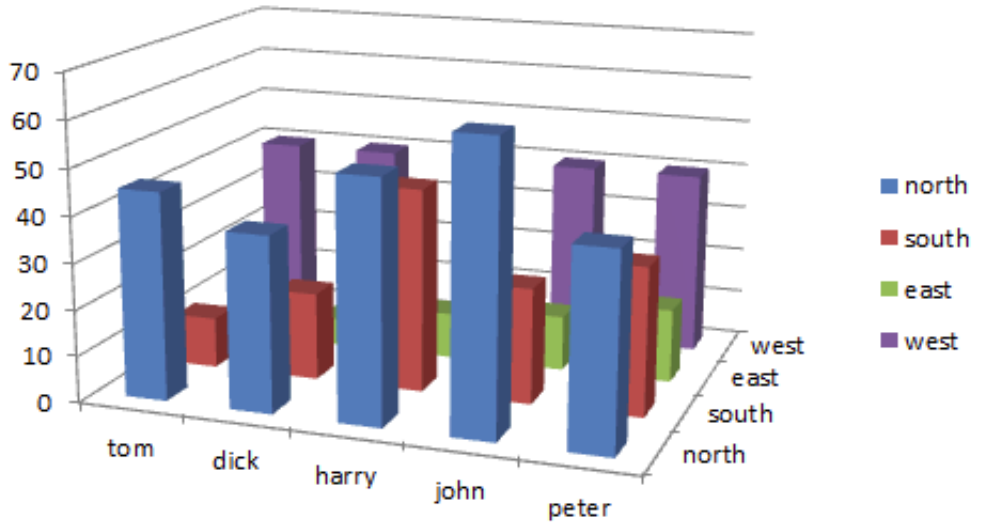
Don’t use dangerous charts



Pie charts



Radar charts



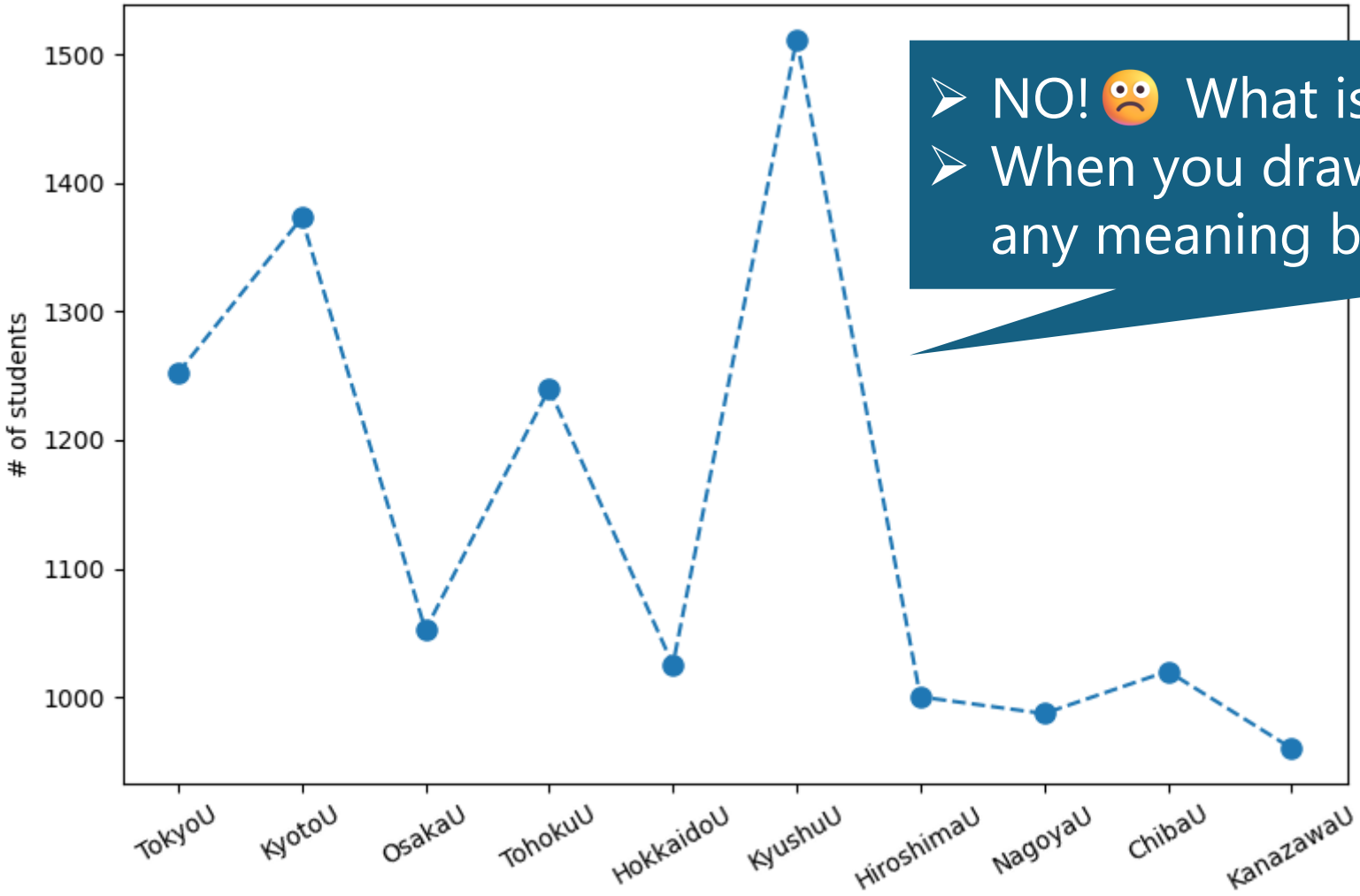
3D bar charts

But recent LLM papers like radar charts.... 😟

https://matplotlib.org/stable/gallery/pie_and_polar_charts/pie_features.html#sphx-glr-gallery-pie-and-polar-charts-pie-features-py
https://en.wikipedia.org/wiki/Radar_chart
https://www.forbes.com/sites/naomirobbins/2012/06/07/trellis-plot-alternative-to-three-dimensional-bar-charts/?sh=7ed6126d7dab

Continuous parameter or discrete labels

- Don’t draw a line for data of discrete labels.



- NO! 😳 What is the meaning of these lines?
- When you draw a line, ask yourself: “Is there any meaning between the dots?”

What should we do to improve our paper?

- Do good research
  - ✓ 😐 Yes, of course! But we know it takes time.

- Improve a writing skill.
  - ✓ 😐 Yes, of course! But we know it takes time.

- Improve English (if you're a non-native English speaker).
  - ✓ 😐 Yes, of course! But we know it takes time.

- Improve equations/tables/plots.
  - ✓ 👊 👊 👊 This won't take much time – study for a few days and you'll master it. **So go ahead and do it!**

Schedule

Date (2024)	Contents	Presented by
~~Week 1, Apr 10~~	~~Introduction. Review of fundamental concepts~~	~~Yusuke, Koya, Yuki, Jun~~
~~Week 2, Apr 17~~	~~Equations and pseudo-codes~~	~~Yusuke Matsui~~
~~Week 3, Apr 24~~	~~Presentation~~	~~Koya Narumi~~
~~Week 4, May 1~~	~~Tables and plots~~	~~Yusuke Matsui~~
Week 5, May 8	Figures	Koya Narumi
Week 6, May 22	Videos	Koya Narumi
Week 7, May 29	Invited Talk 1	Dr. Yoshiaki Bando (AIST)
Week 8, June 5	Invited Talk 2	Prof. Katie Seaborn (Tokyo Tech)
Week 9, June 12	GitHub in depth	Yusuke Matsui
Week 10, June 19	Automation of research and research dissemination (Web, Cloud, CI/CD)	Jun Kato
Week 11, June 26	Research community	Jun Kato
Week 12, July 3	3DCG illustrations	Yuki Koyama
Week 13, July 10	Final presentations	-