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Human - Centric Indoor Climate for Healthcare Facilities (HumanIC)
HORIZON-MSCA-2022-DN-01

How to present your research results in a journal paper

Turning data into knowledge

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Department of Aerospace Engineering, Universidad Carlos III de Madrid, Leganés, Spain

Challenges

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Challenges

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1. What to show?

Challenges

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1. What to show?
2. How to show?

Challenges

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1. What to show?
2. How to show?
3. How to explain it without over or under-interpretating the results?

Challenges

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1. What to show?
2. How to show?
3. How to explain it without over or under-interpretating the results?

One sentence summary = What is the message of the paper

Plan

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1. Introduction
2. What is a result?
3. Tables vs figures vs text
4. Writing the results section
5. Wrap-up

Introduction

Let's start with some bad examples

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Vehicle Type	Year Make Model	0-60 MPH Time (Seconds)	Fuel Efficiency (MPG)
Car	1986 Yugo	16.8	27
Car	2008 VW Rabbit	8.0	29
Car	1999 Plymouth Neon	10.2	24
SUV	2011 Jeep Compass	11.5	32
SUV	2010 Cadillac Escalade	6.7	12

Let's start with some bad examples

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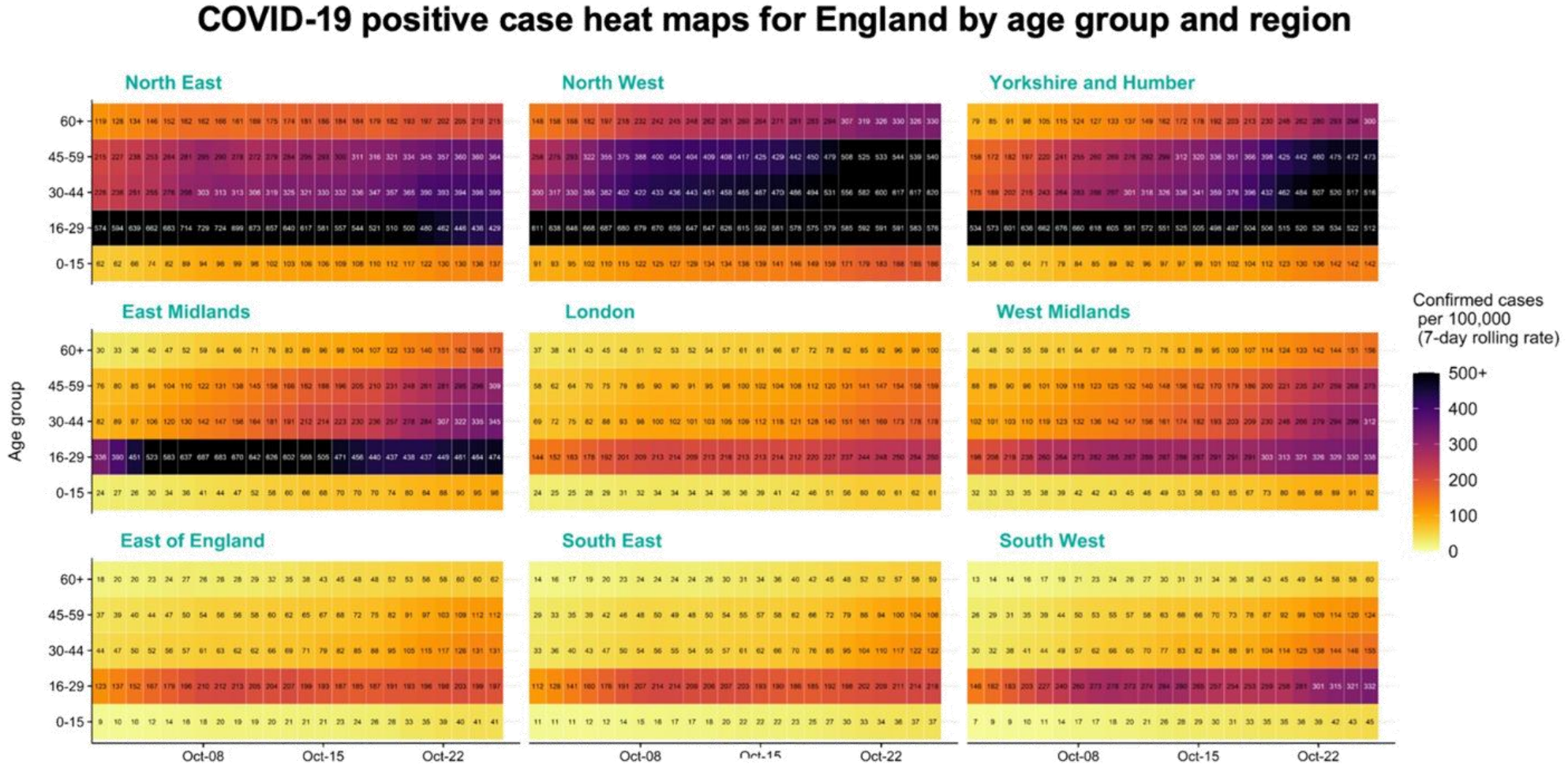
HumanIC



COBR
Cabinet Office Briefing Rooms

Source: Case data from SGSS. Produced by Outbreak Surveillance Team, PHE.
Contains National Statistics data © Crown copyright and database right 2020.

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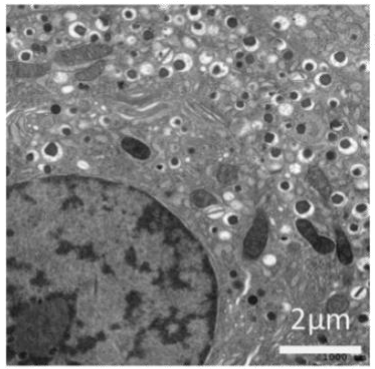
1. No annotation



https://doi.org/10.1371/journal.pbio.3001161

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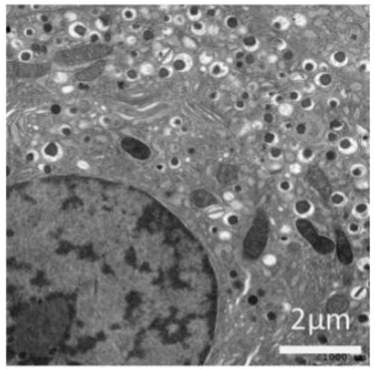

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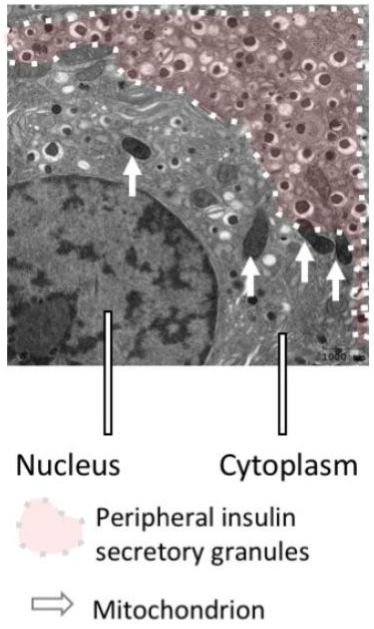

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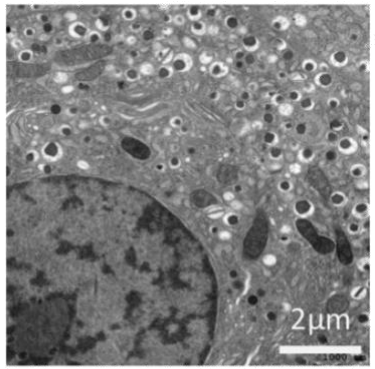

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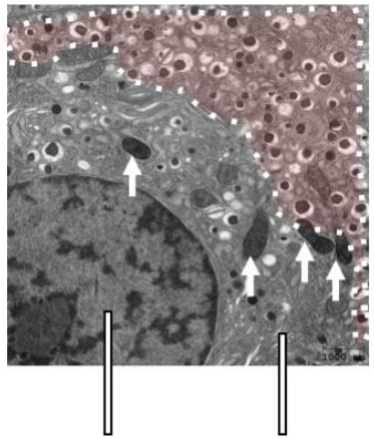
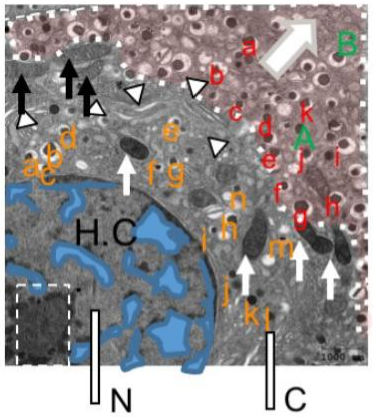


3. Excessive labels



N: Nucleus
C: Cytoplasm
H.C.: Heterochromatin
blue shape: Euchromatin
arrowhead: Golgi
white arrow: Mitochondrion
black arrow: light mitochondrion
pale red shape: Peripheral insulin secretory granules
white fat arrow: Cell periphery
dashed rectangle: Nucleolus
red letters: Individual insulin secretory granules
green capital letters: Lysosomes
orange letters: Central insulin secretory granules

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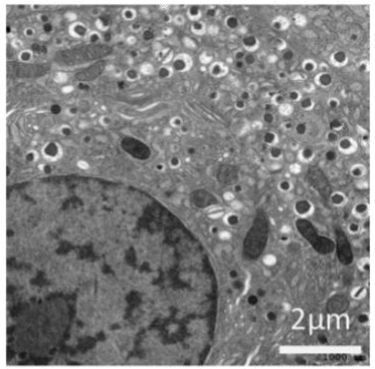

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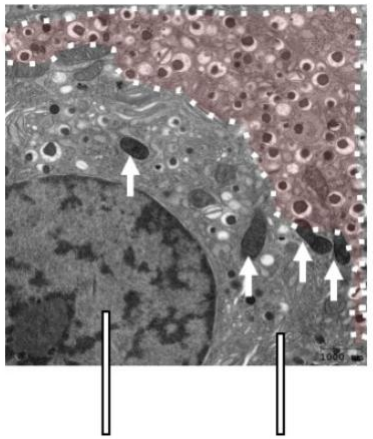

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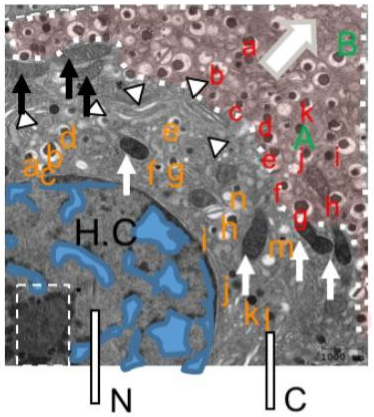

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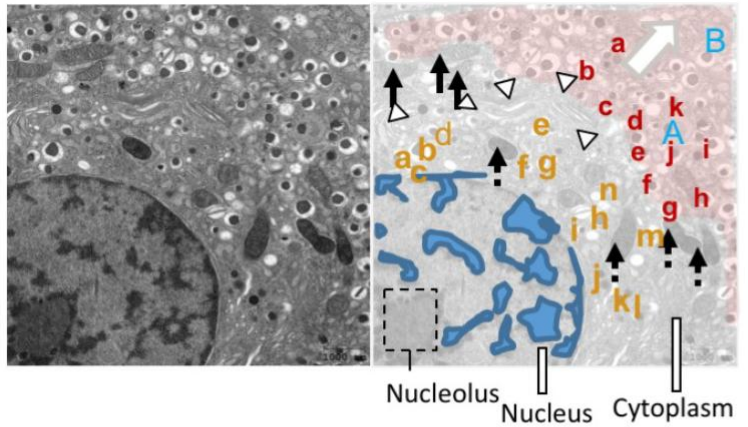
4. Solution for many annotations



Euchromatin
Peripheral area insulin granules
Golgi
Plasma membrane
Mitochondria
Mitochondria (light)
A,B: lysosomes
a-k: peripheral insulin granules
a-n: central insulin granules

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Which one is better?

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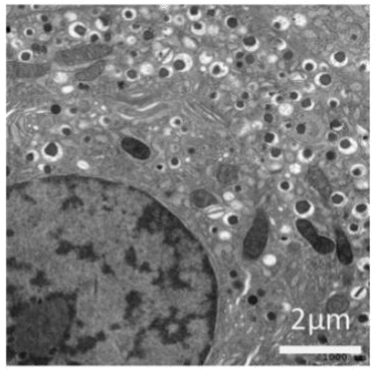

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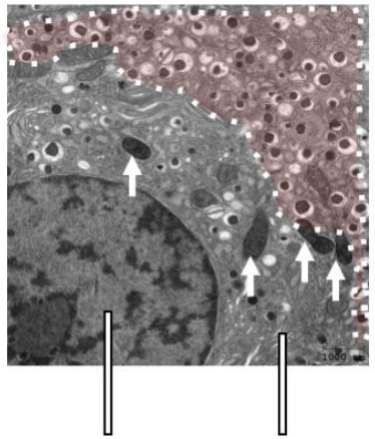

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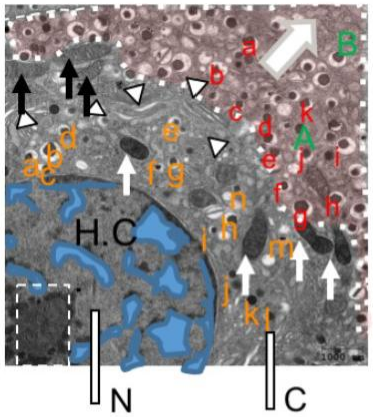

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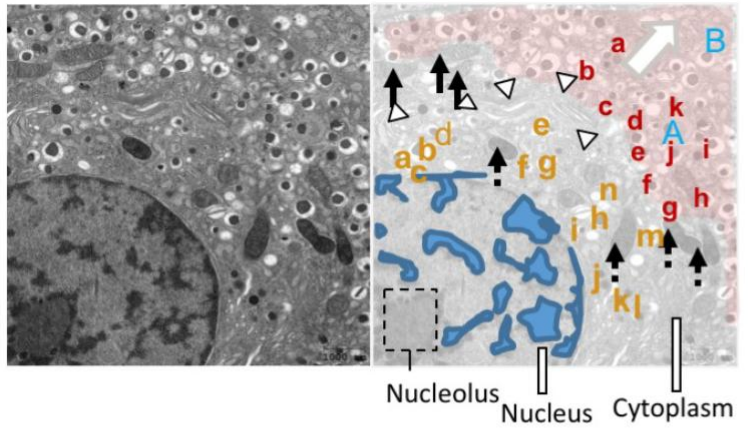

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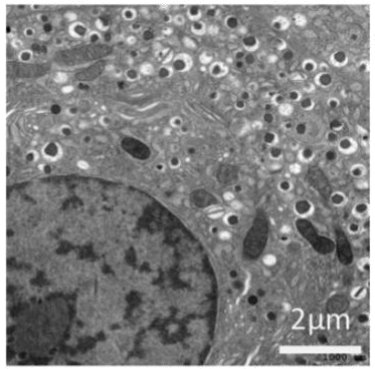

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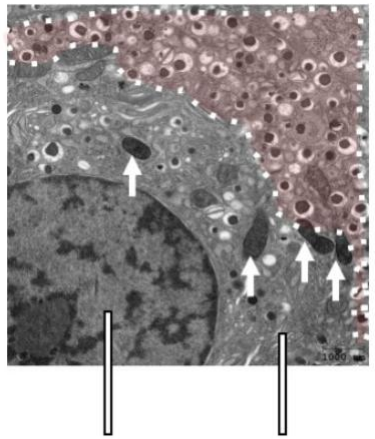

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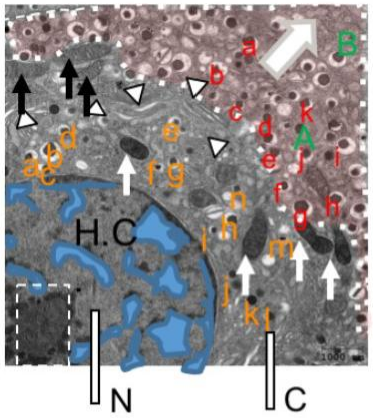

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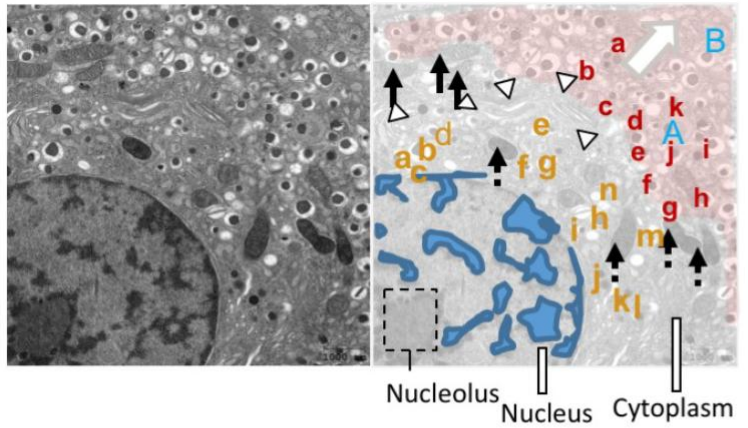

Don’t show everything, only what answers the research question

https://doi.org/10.1371/journal.pbio.3001161

What is a result?

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When does data becomes a good results?

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When does data becomes a good results?

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Three questions:

When does data becomes a good results?

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Three questions:

1. What did you observe?
   Algorithm B outperforms algorithm A

When does data becomes a good results?

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Three questions:

1. What did you observe?
   Algorithm B outperforms algorithm A

2. What data support it? Is it significative?
   Algorithm B converges at least 20% faster than algorithm A on all testing cases.

When does data becomes a good results?

Funded by the European Union

Three questions:

1. What did you observe?
   Algorithm B outperforms algorithm A

2. What data support it? Is it significative?
   Algorithm B converges at least 20% faster than algorithm A on all testing cases.

3. Why does it matter? What does it imply?
   Algorithm B converges at least 20% faster than algorithm A on all testing cases, suggesting that feature X gives a good estimate of the solution.

When does data becomes a good results?

Funded by the European Union

Three questions:

1. What did you observe?
   Algorithm B outperforms algorithm A

2. What data support it? Is it significative?

These questions need to be answered regarding the research question

3. Why does it matter? What does it imply?
   Algorithm B converges at least 20% faster than algorithm A on all testing cases, suggesting that feature X gives a good estimate of the solution.

When does data becomes a good results?

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Three questions:

1. What did you observe?
   Algorithm B outperforms algorithm A

2. What data support it? Is it significative?

3. Why does it matter? What is novel?
   feature X gives a good estimate of the solution.

These questions need to be answered regarding the research question

The research question the type of paper and the resulting contribution

The four types of scientific papers

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The four types of scientific papers

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Methodological papers

A new tool

The four types of scientific papers

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Methodological papers

A new tool

Empirical papers

A new observation

The four types of scientific papers

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Methodological papers

A new tool

Empirical papers

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Theoretical papers

A new explanation

The four types of scientific papers

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Methodological papers

A new tool

Empirical papers

A new observation

Theoretical papers

A new explanation

Integrative /synthesis papers

A new pattern

Methodological papers

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“Does this method work better than existing alternatives?”

Emphasis on:

- Validation
- Benchmarking
- Accuracy
- Precision
- Speed
- Robustness

Typical structure:

- Describe method
- Validate on known cases
- Compare with state-of-the-art
- Demonstrate advantages

Methodological papers – Examples

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Generative Adversarial Nets

Ian J. Goodfellow,* **Jean Pouget-Abadie**,† **Mehdi Mirza**, **Bing Xu**, **David Warde-Farley**, **Sherjil Ozair**,‡ **Aaron Courville**, **Yoshua Bengio**§
Département d'informatique et de recherche opérationnelle
Université de Montréal
Montréal, QC H3C 3J7

9 pages
119 000+ citations

PROTEIN MEASUREMENT WITH THE FOLIN PHENOL REAGENT*

By OLIVER H. LOWRY, NIRA J. ROSEBROUGH, A. LEWIS FARR, AND ROSE J. RANDALL

(*From the Department of Pharmacology, Washington University School of Medicine, St. Louis, Missouri*)

(Received for publication, May 28, 1951)

11 pages
305 000+ citations

Empirical (Knowledge-building) papers

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"What have we learned about the world?"

Emphasis on:

- Data quality
- Measurements
- Statistical evidence
- Uncertainty
- Reproducibility

Typical structure:

- Present observations
- Show analyses
- Quantify uncertainty
- Compare with previous knowledge

Empirical papers – Examples

THE

AMERICAN JOURNAL OF SCIENCE.

[THIRD SERIES.]

ART. XXXVI.—*On the Relative Motion of the Earth and the Luminiferous Ether;* by ALBERT A. MICHELSON and EDWARD W. MORLEY.*

THE discovery of the aberration of light was soon followed by an explanation according to the emission theory. The effect was attributed to a simple composition of the velocity of light with the velocity of the earth in its orbit. The difficulties in this apparently sufficient explanation were overlooked until after an explanation on the undulatory theory of light was proposed. This new explanation was at first almost as simple as the former. But it failed to account for the fact proved by experiment that the aberration was unchanged when observations were made with a telescope filled with water. For if the tangent of the angle of aberration is the ratio of the velocity of the earth to the velocity of light, then, since the latter velocity in water is three-fourths its velocity in a vacuum, the aberration observed with a water telescope should be four-thirds of its true value.†

Michelson & Morley (1887)

The authors **did not** observe the ether wind

XXIX. *An Experimental Investigation of the Circumstances which determine whether the Motion of Water shall be Direct or Sinuous, and of the Law of Resistance in Parallel Channels.*

By OSBORNE REYNOLDS, *F.R.S.*

Received and Read March 15, 1883.

[PLATES 72–74.]

SECTION I.

Introductory.

1. *Objects and results of the investigation.*—The results of this investigation have both a practical and a philosophical aspect.

In their practical aspect they relate to the *law of resistance to the motion of water in pipes*, which appears in a new form, the law for all velocities and all diameters being represented by an equation of two terms.

In their philosophical aspect these results relate to the fundamental principles of fluid motion; inasmuch as they afford for the case of pipes a definite verification of two principles, which are—*that the general character of the motion of fluids in contact with solid surfaces depends on the relation between a physical constant of the fluid and the product of the linear dimensions of the space occupied by the fluid and the velocity.*

The results as viewed in their philosophical aspect were the primary object of the investigation.

Reynolds (1883)

Only observation

Theoretical papers

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“Does this theory explain phenomena better than existing theories?”

Emphasis on:

- Derivations
- Predictions
- Logical consistency
- Explanatory power

Typical structure:

- Introduce assumptions
- Develop theory
- Derive predictions
- Compare with known observations

Theoretical papers – Examples

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Boundary layer theory

Über Flüssigkeitsbewegung bei sehr kleiner Reibung.

Von

L. Prandtl aus Hannover.

(Hierzu eine Figurentafel.)

In der klassischen Hydrodynamik wird vorwiegend die Bewegung der *reibungslosen* Flüssigkeit behandelt. Von der *reibenden Flüssigkeit* besitzt man die Differentialgleichung der Bewegung, deren Ansatz durch physikalische Beobachtungen wohl bestätigt ist. An Lösungen dieser Differentialgleichung hat man außer eindimensionalen Problemen, wie sie u. a. von Lord Rayleigh*) gegeben wurden, nur solche, bei denen die Trägheit der Flüssigkeit vernachlässigt ist, oder wenigstens keine Rolle spielt. Das zwei- und dreidimensionale Problem mit Berücksichtigung von Reibung *und* Trägheit harrt noch der Lösung. Der Grund hierfür liegt wohl in den unangenehmen Eigenschaften der Differentialgleichung. Diese lautet in Gibbsscher Vektorsymbolik**)

$$\varrho\left(\frac{\partial \boldsymbol{v}}{\partial t} + \boldsymbol{v} \circ \nabla \boldsymbol{v}\right) + \nabla\,(V + p) = k\nabla^2 \boldsymbol{v} \qquad (1)$$

($\boldsymbol{v}$ Geschwindigkeit, ϱ Dichte, V Kräftefunktion, p Druck, k Reibungskonstante); dazu kommt noch die Kontinuitätsgleichung: für inkompressible Flüssigkeiten, die hier allein behandelt werden sollen, wird einfach

$$\operatorname{div} \boldsymbol{v} = 0.$$

Prandtl (1904)
Resolution of the drag paradox

Theory of turbulence

Dissipation of energy in the locally isotropic turbulence†

By A. N. Kolmogorov

In my note (Kolmogorov 1941*a*) I defined the notion of local isotropy and introduced the quantities

$$\left.\begin{aligned} B_{dd}(r) &= \overline{[u_d(M') - u_d(M)]^2}, \\ B_{nn}(r) &= \overline{[u_n(M') - u_n(M)]^2}, \end{aligned}\right\} \qquad (1)$$

where r denotes the distance between the points M and M', $u_d(M)$ and $u_d(M')$ are the velocity components in the direction $\overline{MM'}$ at the points M and M', and $u_n(M)$ and $u_n(M')$ are the velocity components at the points M and M' in some direction, perpendicular to MM'.

In the sequel we shall need the third moments

$$B_{ddd}(r) = \overline{[u_d(M') - u_d(M)]^3}. \qquad (2)$$

For the locally isotropic turbulence in incompressible fluid we have the equation

$$4\bar{E} + \left(\frac{\mathrm{d}B_{ddd}}{\mathrm{d}r} + \frac{4}{r}B_{ddd}\right) = 6\nu\left(\frac{\mathrm{d}^2 B_{dd}}{\mathrm{d}r^2} + \frac{4}{r}\frac{\mathrm{d}B_{dd}}{\mathrm{d}r}\right) \qquad (3)$$

Kolmogorov (1941)
Dimensional analysis and reasoning gives $E(k) \sim k^{-5/3}$

Integrative/synthesis papers

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“What emerges when existing evidence is combined?”

Emphasis on:

- Meta-analysis
- Systematic review with quantitative synthesis
- Data integration studies
- Multi-dataset analyses

Typical structure:

- Cross-study patterns
- Consistency
- Heterogeneity
- Overall effect sizes

Integrative/synthesis – Examples

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Friction Factors for Pipe Flow

By LEWIS F. MOODY,[1] PRINCETON, N. J.

The object of this paper is to furnish the engineer with a simple means of estimating the friction factors to be used in computing the loss of head in clean new pipes and in closed conduits running full with steady flow. The modern developments in the application of theoretical hydrodynamics to the fluid-friction problem are impressive and scattered through an extensive literature. This paper is not intended as a critical survey of this wide field. For a concise review, Professor Bakhmeteff's (1)[2] small book on the mechanics of fluid flow is an excellent reference. Prandtl and Tietjens (2) and Rouse (3) have also made notable contributions to the subject. The author does not claim to offer anything particularly new or original, his aim merely being to embody the now accepted conclusions in convenient form for engineering use.

IN the present pipe-flow study, the friction factor, denoted by f in the accompanying charts, is the coefficient in the Darcy formula

$$h_f = f \frac{L}{D} \frac{V^2}{2g}$$

with numerical constants for the case of perfectly smooth pipes or those in which the irregularities are small compared to the thickness of the laminar boundary layer, and for the case of rough pipes where the roughnesses protrude sufficiently to break up the laminar layer, and the flow becomes completely turbulent.

The analysis did not, however, cover the entire field but left a gap, namely, the transition zone between smooth and rough pipes, the region of incomplete turbulence. Attempts to fill this gap by the use of Nikuradse's results for artificial roughness produced by closely packed sand grains, were not adequate, since the results were clearly at variance from actual experience for ordinary surfaces encountered in practice. Nikuradse's curves showed a sharp drop followed by a peculiar reverse curve,[3] not observed with commercial surfaces, and nowhere suggested by the Pigott chart based on many tests.

Recently Colebrook (11), in collaboration with C. M. White, developed a function which gives a practical form of transition curve to bridge the gap. This function agrees with the two extremes of roughness and gives values in very satisfactory agreement with actual measurements on most forms of commercial piping and usual pipe surfaces. Rouse (12) has shown that it is a reasonable and practically adequate solution and has plotted a chart based upon it. In order to simplify the plotting, Rouse

Moody (1944)
Synthesis of knowledge

Annual Review of Fluid Mechanics

Machine Learning for Fluid Mechanics

Steven L. Brunton,[1] Bernd R. Noack,[2,3] and Petros Koumoutsakos[4]

[1]Department of Mechanical Engineering, University of Washington, Seattle, Washington 98195, USA

[2]LIMSI (Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur), CNRS UPR 3251, Université Paris-Saclay, F-91403 Orsay, France

[3]Institut für Strömungsmechanik und Technische Akustik, Technische Universität Berlin, D-10634 Berlin, Germany

[4]Computational Science and Engineering Laboratory, ETH Zurich, CH-8092 Zurich, Switzerland; email: petros@ethz.ch

Brunton, Noack & Koumoutsakos (2020)
Classifies methodologies.
Identifies future directions.

The four types of scientific papers

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Methodological papers

“We developed …”

The four types of scientific papers

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Methodological papers

"We developed ..."

Empirical papers

"We observed ..."

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Methodological papers

"We developed ..."

Empirical papers

"We observed ..."

Theoretical papers

"We derived..."

The four types of scientific papers

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Methodological papers

"We developed ..."

Empirical papers

"We observed ..."

Theoretical papers

"We derived..."

Integrative /synthesis papers

"We reviewed, compared and synthesized ..."

The four types of scientific papers

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Methodological

What kind of contribution is your paper making?

This determines:

- **Figures**
- **Tables**
- **Content**

compared and synthesized …”

Tables vs figures vs text

The three types of results – Decision tree

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I want to show a …

The three types of results – Decision tree

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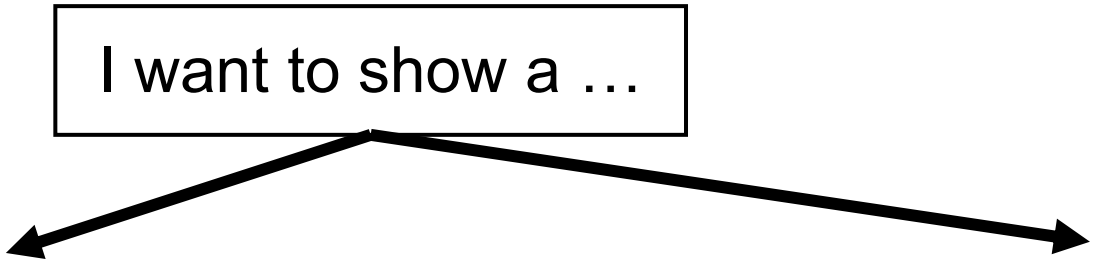

The three types of results – Decision tree

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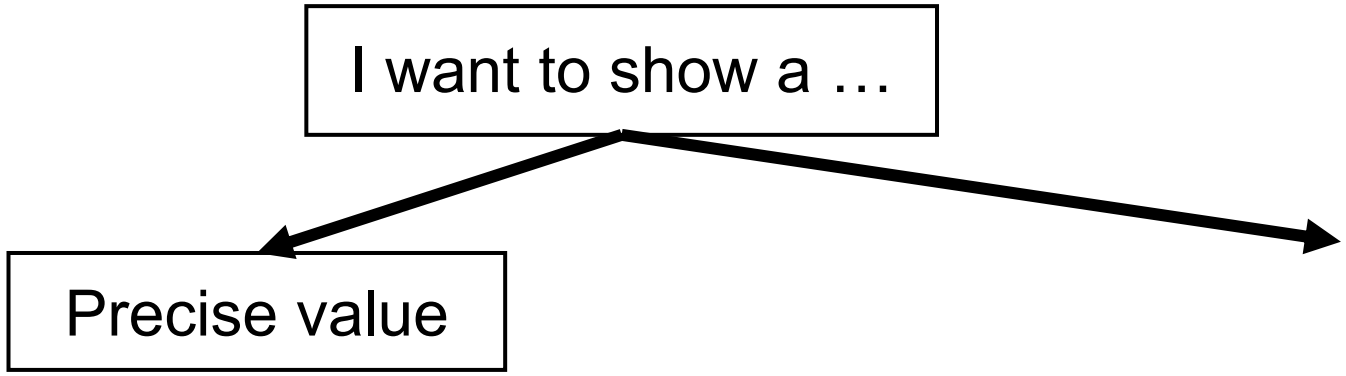

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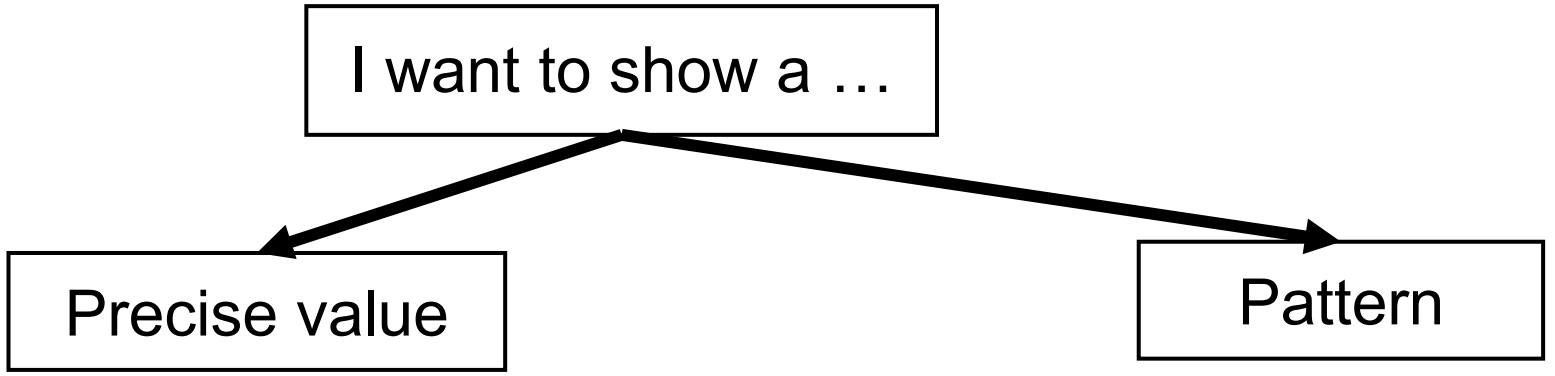

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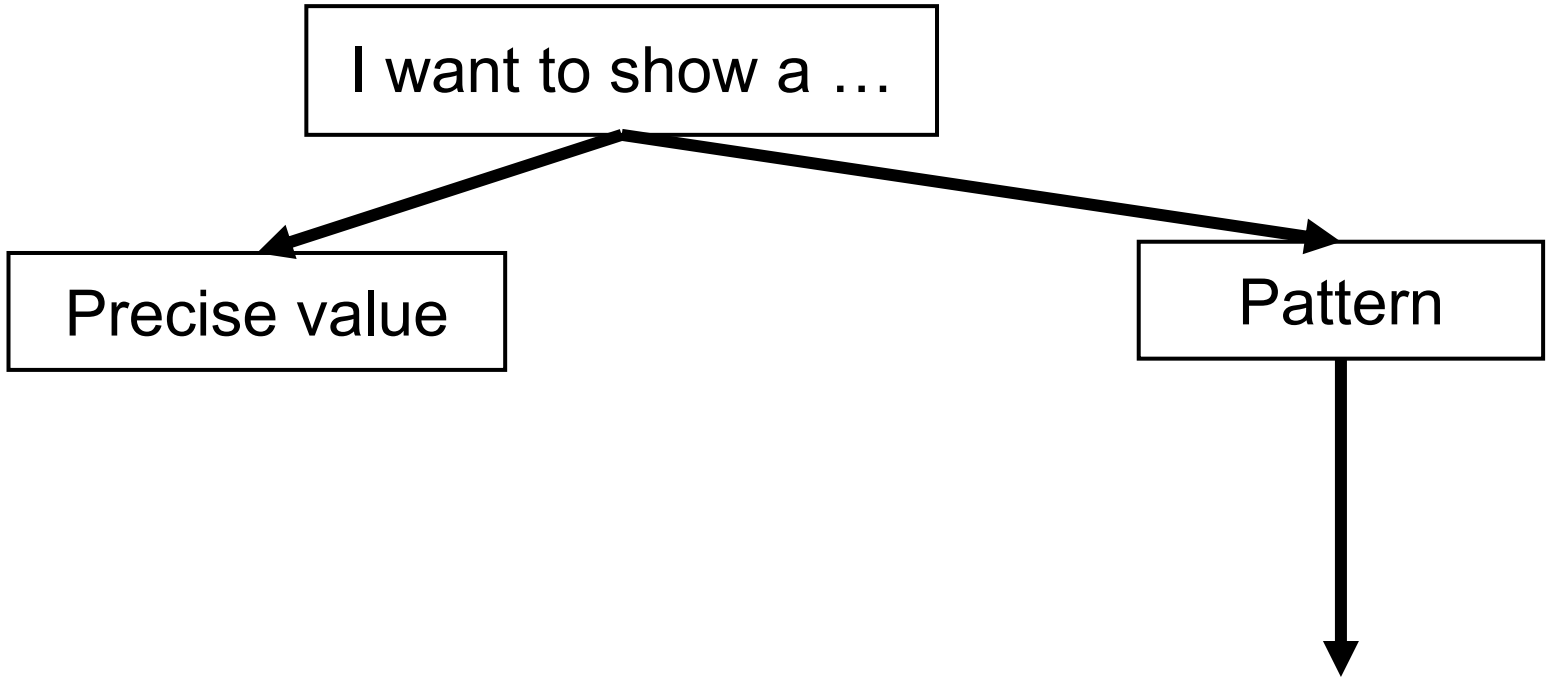

The three types of results – Decision tree

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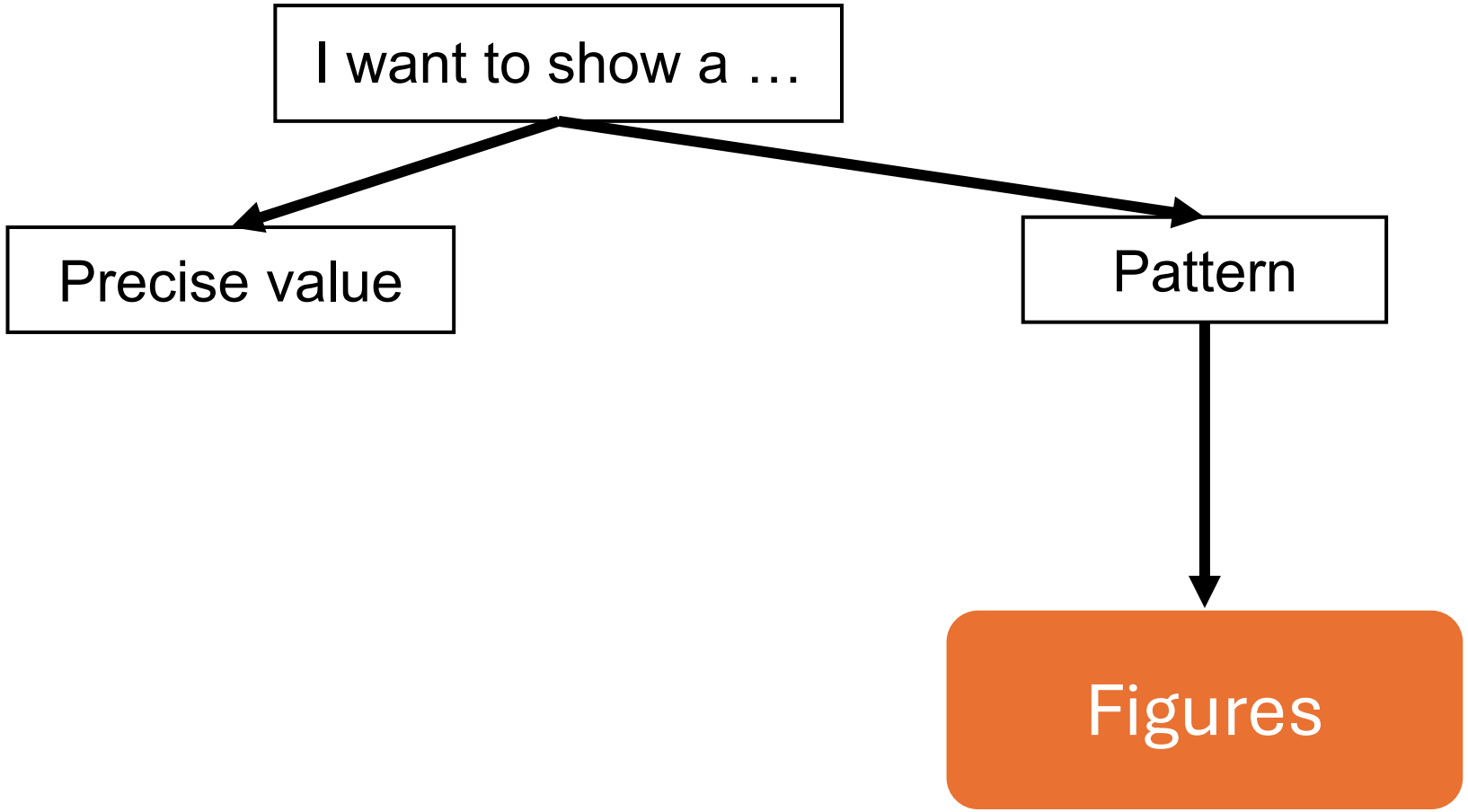

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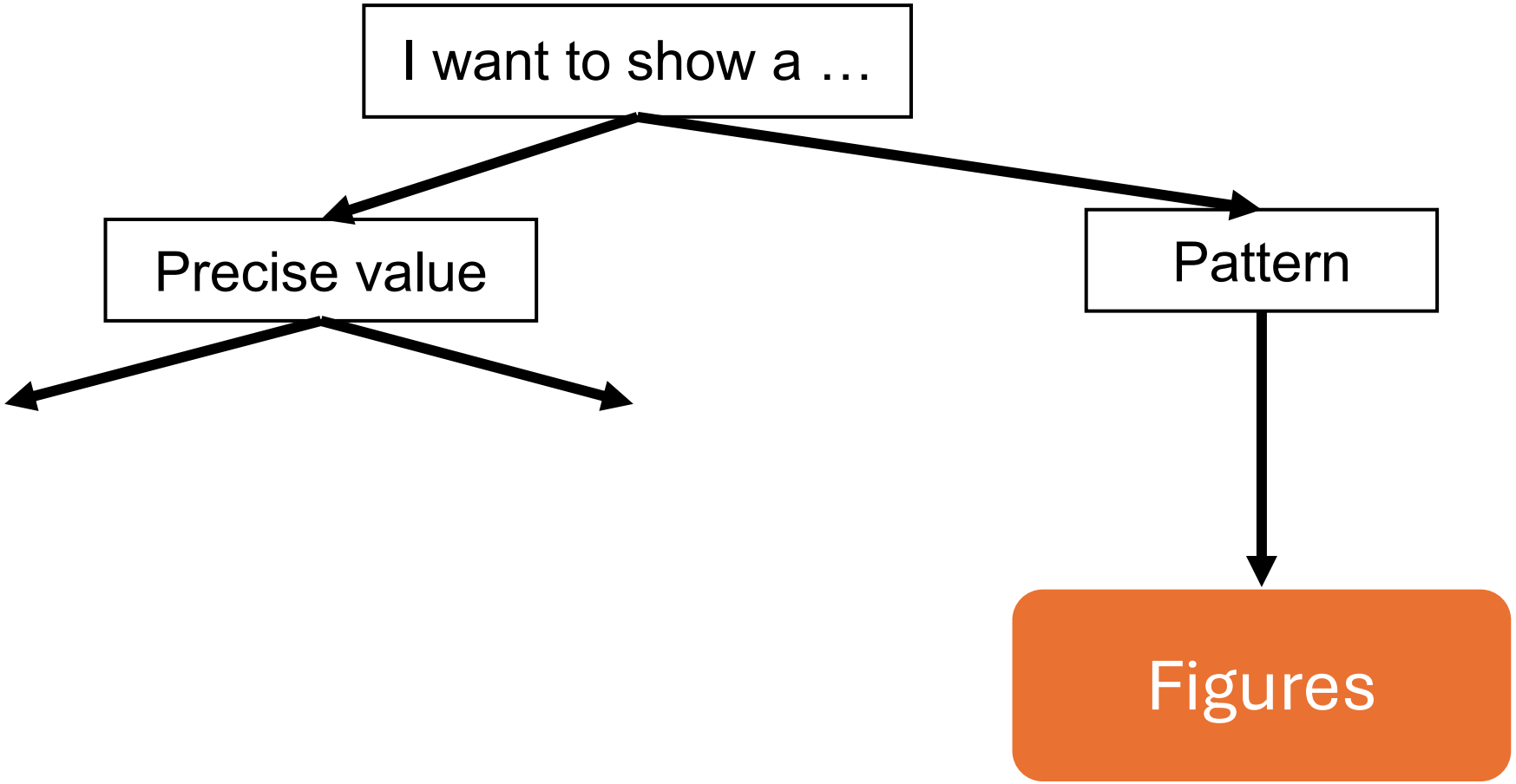

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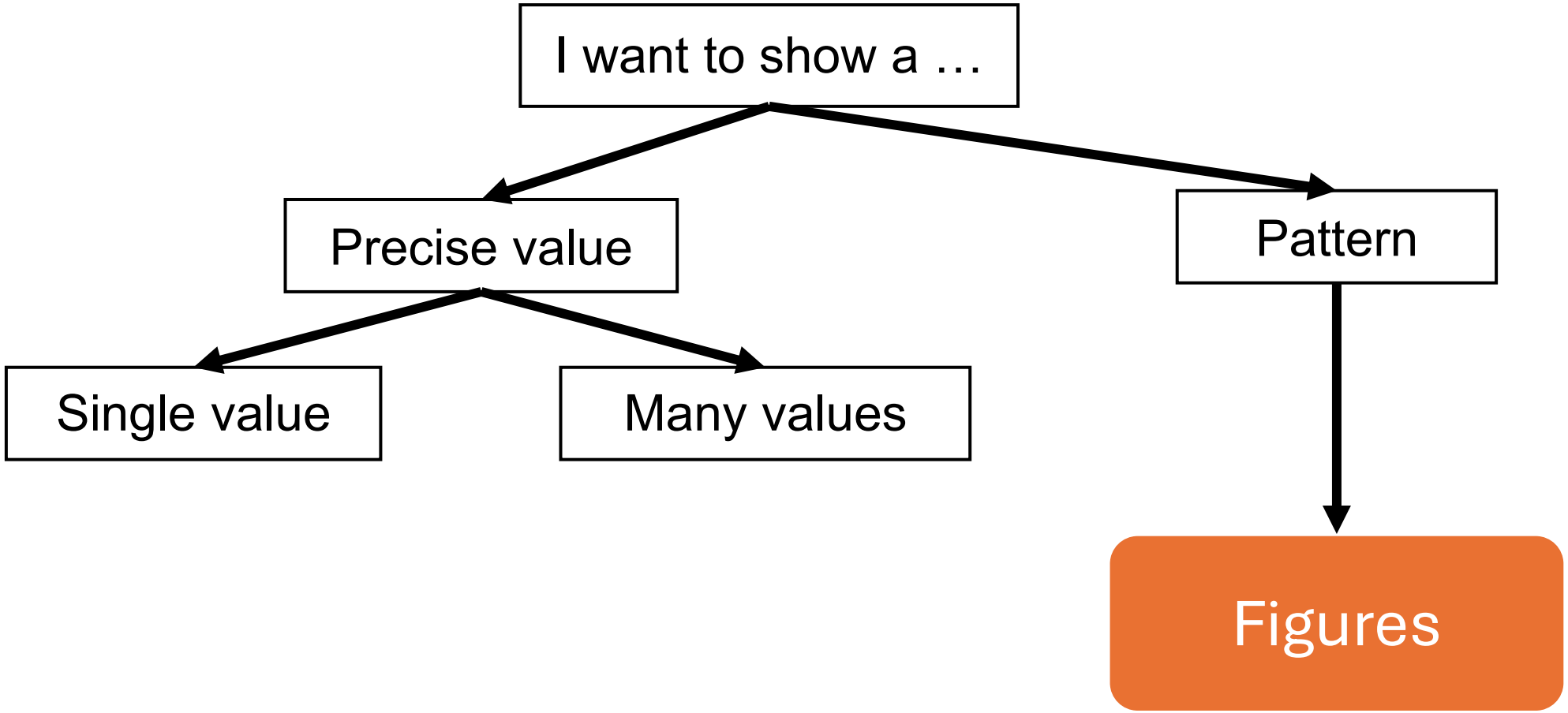

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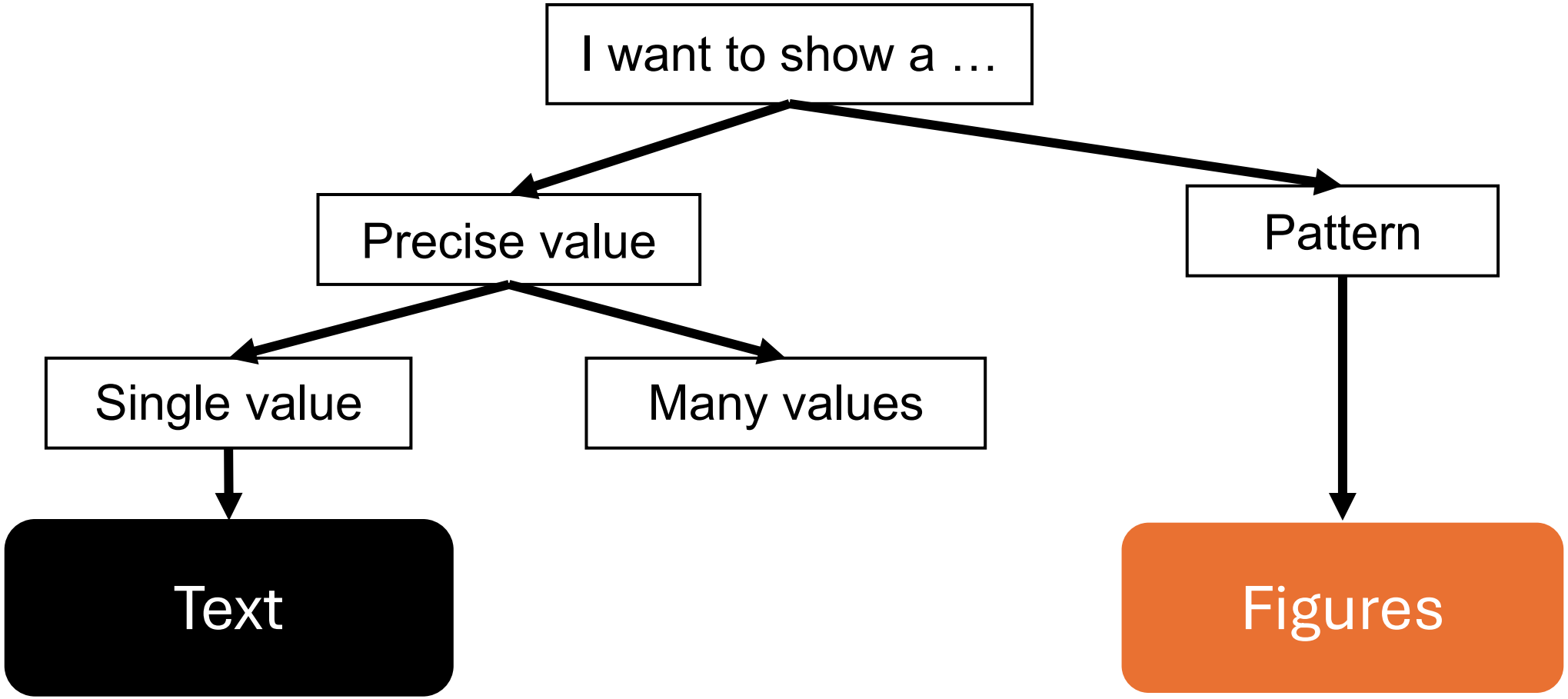

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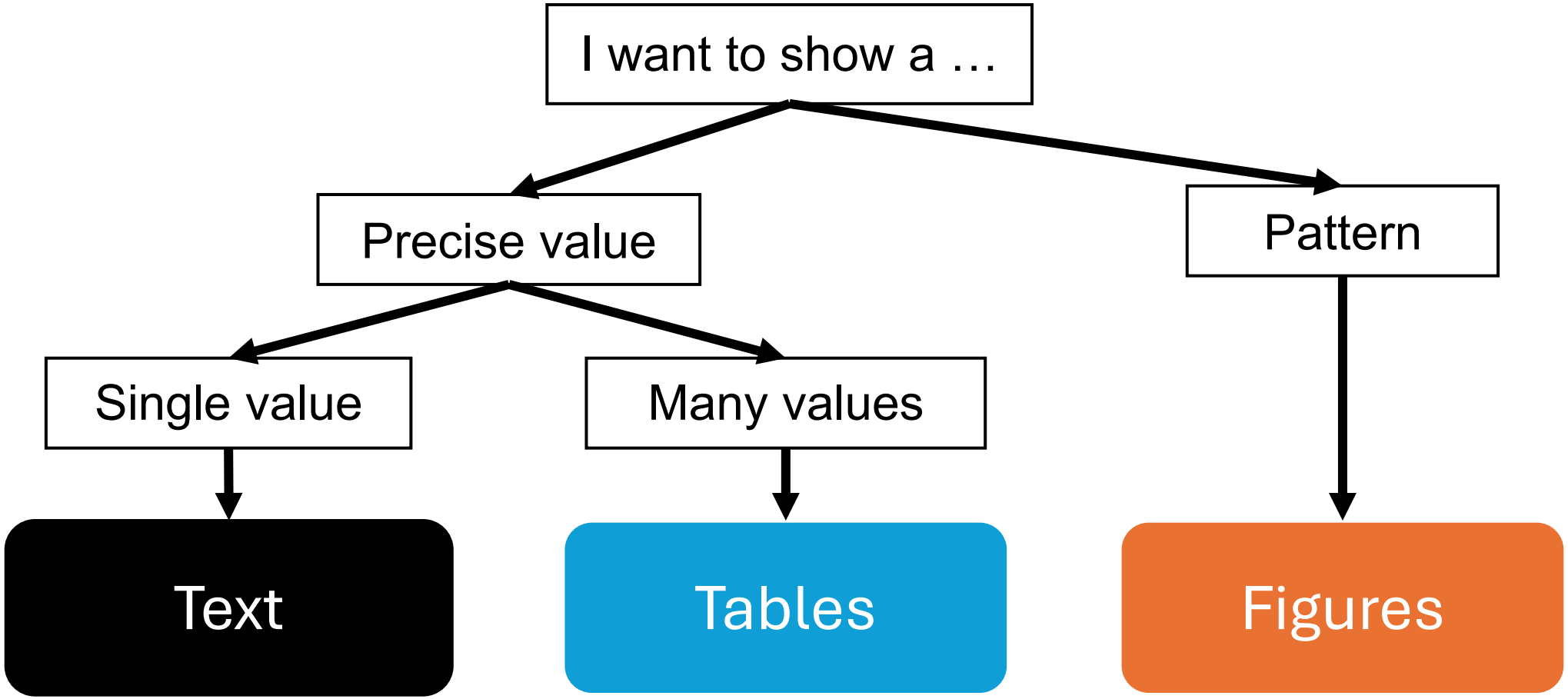

When to use text for a result?

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- 1-3 important numbers
- Simple comparisons

Example:

“Drag decreased from 81% to 61%.”

When to use a table?

Funded by the European Union

When to use a table?

Funded by the European Union

- **Text table**
  Goal: Comparing different groups
  Benefits: Summarize points and reduce word count in the main text

When to use a table?

Funded by the European Union

- **Text table**

  Goal: Comparing different groups

  Benefits: Summarize points and reduce word count in the main text

Table 1
Representative studies on multi-cylinder wakes and the fluidic pinball, highlighting configuration, Reynolds-number range, actuation strategy, and measurement approach. They are separated depending on whether experiments were performed, simulations were used, and if forces were directly measured.

Reference	Configuration	*Re*	Control	Exp.	CFD	Forces
Achenbach [11]	1 cyl.	3×10^6	Roughness	✓	–	✓
Apelt et al. [12]	1 cyl.	10^4–5×10^4	Splitter plate	✓	–	✓
Lam and Cheung [5]	3 cyl., triangular	2100, 3500	–	✓	–	✓
Tokumaru and Dimotakis [13]	1 cyl.	15 000	Cyl. rotation	✓	–	✓
Kwon and Choi [14]	1 cyl.	$\sim 10^4$	Splitter plate	✓	–	✓
Sumner et al. [3]	2 cyl., staggered	850–1900	–	✓	–	–
Lam et al. [10]	4 cyl.	$\sim 10^4$	–	✓	–	–
Sumner [4]	2 cyl. multiple	10^2–10^5	–	✓	✓	✓
Bansal and Yarusevych [6]	3 cyl., triangular	2100	–	✓	–	–
Chen et al. [8]	3 cyl., triangular	50–300	–	–	✓	✓
Deng et al. [2]	Fluidic pinball	≤130	–	–	✓	✓
Raibaudo et al. [7]	Fluidic pinball	2200	Cyl. rotation	✓	–	–
Raibaudo and Martinuzzi [9]	Fluidic pinball	2200	Cyl. rotation	✓	–	–
Cornejo Maceda et al. [15]	Fluidic pinball	100	Cyl. rotation	–	✓	–
Present work	Fluidic pinball	9100	Cyl. rotation	✓	✓	✓

Rodriguez-Asensio *et al.* (2026)
ETFS

When to use a table?

Funded by the European Union

- **Data table**
  Goal: Compare groups

When to use a table?

Funded by the European Union

- **Data table**
  Goal: Compare groups

TABLE IV. Estimation error of the oncoming wind speed and velocity field by different cases from the velocity sensor. For details, see text.

Case	Oncoming velocity	Manifold type	Data type	Estimation type	$\hat{U}_\infty$ Error (%)	Error (%)
Case 1	Single	Full	Training	Interpolation	0	0
Case 2	Multiple	Full	Training	Interpolation	0	0
Case 3	Multiple	Coarse-grained	Training	Interpolation	0	0.551
Case 4	Multiple	Coarse-grained	Testing	Interpolation	0.643	1.922
Case 5	Multiple	Coarse-grained	Testing	Extrapolation	0.650	1.972

Hou *et al.* (2024)
Phys. Fluids

A little exercise on tables

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Table 5.2 Soil test K and mineralogy of soils (SD = Standard Deviation).

			mg K kg^{-1} soil		
Soil	Clay (g kg^{-1})	Silt (g kg^{-1})	WS	$CaCl_2$	NaTPB
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Precision and clutter

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Highlight data

Precision and clutter

Typical problems:

- Inclusion unnecessary or redundant information
- Omission of necessary data (reproductibility)

Stand-alone table

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When to use figures?

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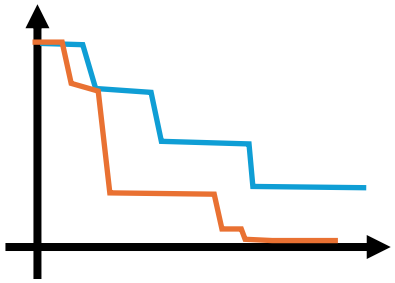
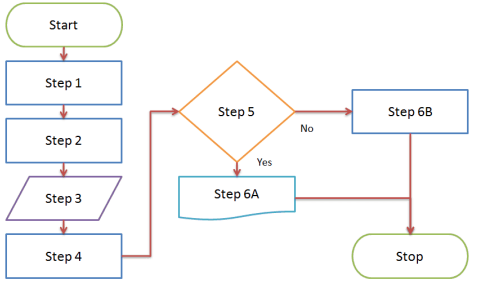
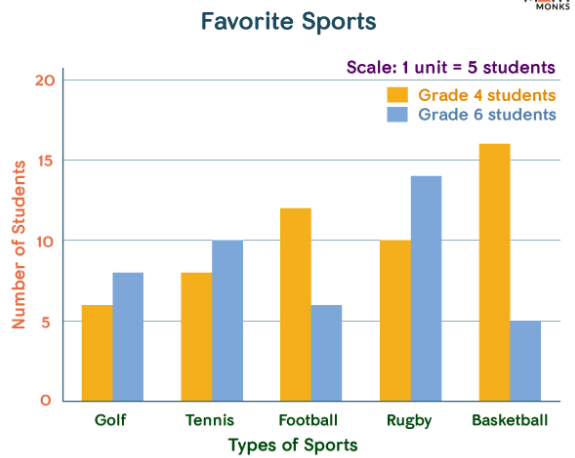
Photo



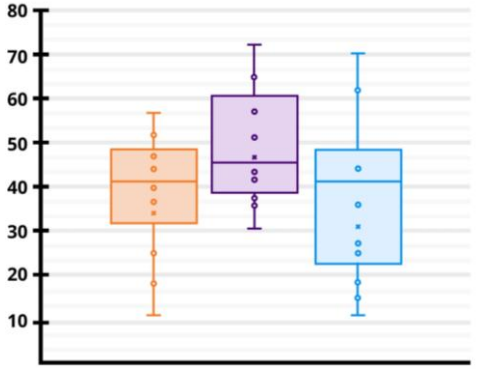
Line graph



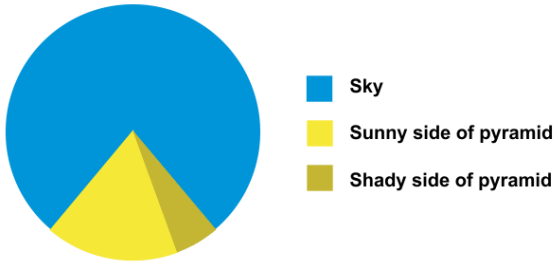
Flow chart



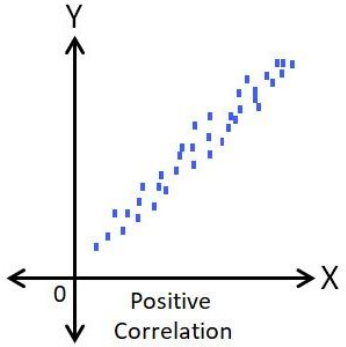
Bar graph



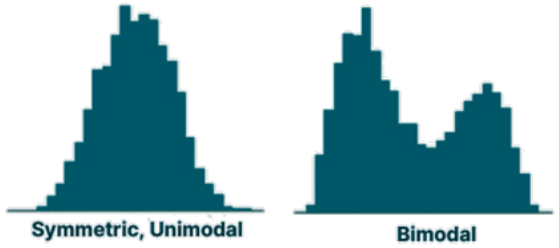
Box plot



Pie chart



Scatter plot



Histogram

When to use figures?

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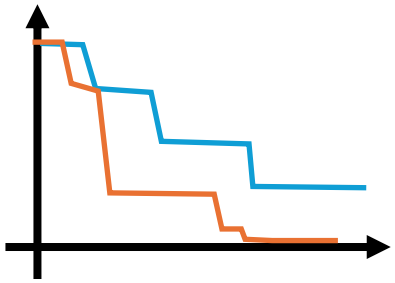
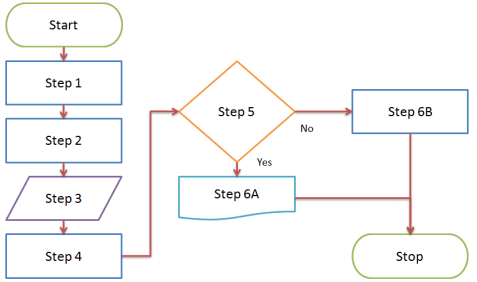
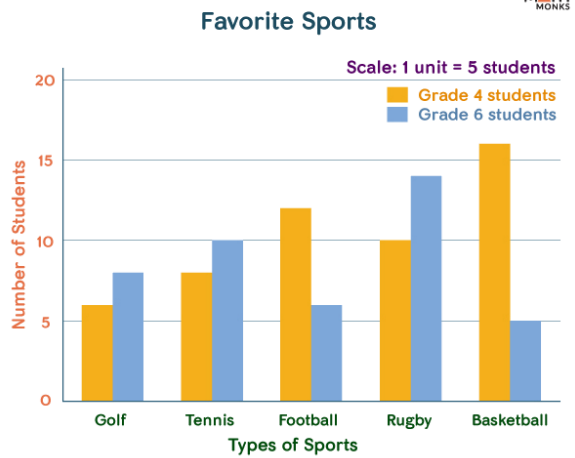
Photo



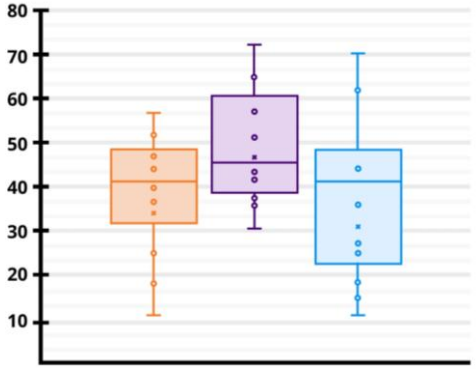
Line graph



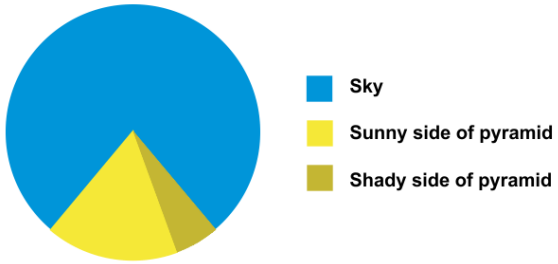
Flow chart



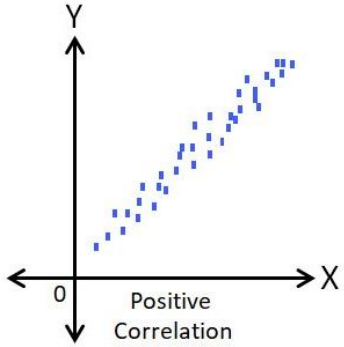
Bar graph



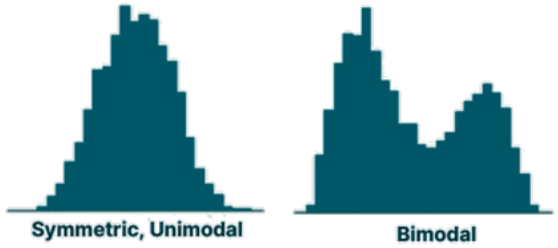
Box plot



Pie chart



Scatter plot



Histogram

See Ten Simple Rules for Better Figures by Rougier, Droettboom & Bourne (2014)

Be creative

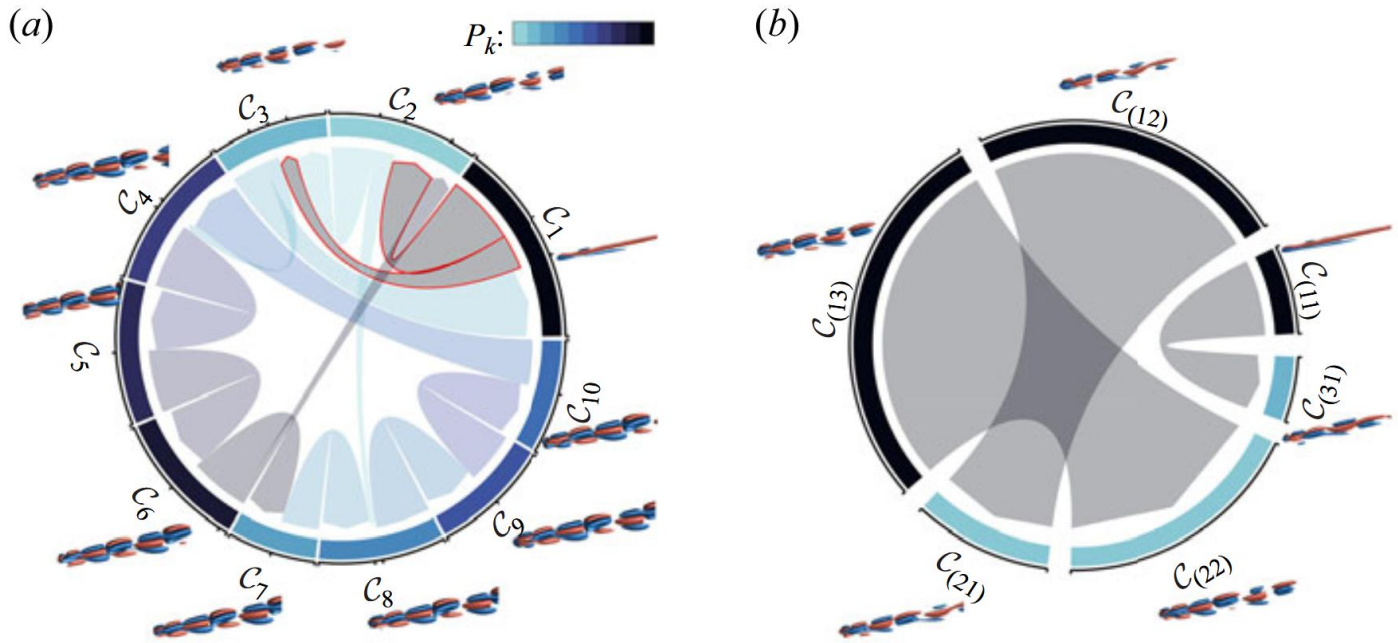
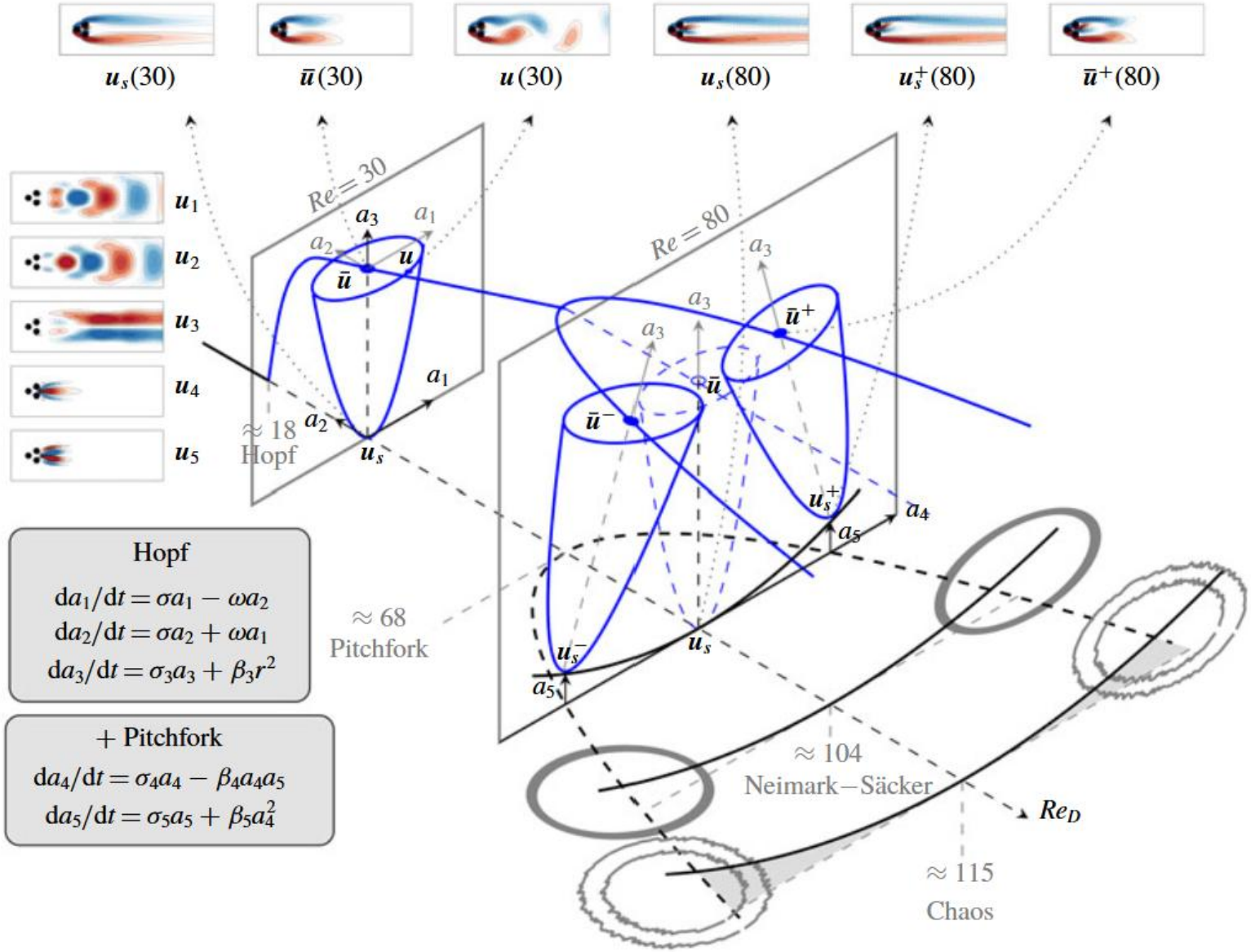


Figure 21. Transition diagram of the periodic flow at $Re = 300$. The centroids are depicted by the vortex distribution. The vortices are identified by the isosurfaces of z vorticity, with -1 for the negative vortices coloured in blue and 1 for the positive vortices coloured in red. The transition dynamics is depicted by the directed arrows, the size of the arrow tail represents the transition probability and the colour is consistent with the departure block. (a) Cluster transitions. Different blocks represent different clusters, the colour of the block represents the corresponding cluster probability distribution P_k, and the size of the block represents the cluster size $\boldsymbol{R^u}$. (b) Sub-cluster transitions of $\beta = 0.50$, with transitions specifically departing from $\mathcal{C}_1$, corresponding to the red-bordered cluster transition in (a). Blocks with the same colour belong to the same cluster, the colour still represents the cluster probability distribution P_k, and the size of each block represents the sub-cluster size $\boldsymbol{R}^{\boldsymbol{u}}_{sub}$.

Hou *et al.* (2024)
J. Fluid Mech.

Be creative

Funded by the European Union



Deng *et al.* (2020)
J. Fluid Mech.

Practical activity 1 – One value

Funded by the European Union

Dataset:

Maximum lift coefficient 1.42

How should this be presented?

Practical activity 1 – One value

Funded by the European Union

Dataset:

Maximum lift coefficient 1.42

How should this be presented?

Text

“The maximum lift coefficient increased to 1.42.”

Practical activity 2 – Few values

Funded by the European Union

Dataset:

Model	Accuracy (%)
A	92
B	94
C	95

How should this be presented?

Practical activity 2 – Few values

Funded by the European Union

Dataset:

Model	Accuracy (%)
A	92
B	94
C	95

How should this be presented?

Text

“Model C achieved the highest accuracy (95%), followed by Model B (94%) and Model A (92%).”

Practical activity 3 – Many exact values

Funded by the European Union

Dataset:

Reynolds number	Drag coefficient
100	1.12
200	0.97
500	0.76
1000	0.64
2000	0.55
5000	0.49

How should this be presented?

Practical activity 3 – Many exact values

Funded by the European Union

Dataset:

Reynolds number	Drag coefficient
100	1.12
200	0.97
500	0.76
1000	0.64
2000	0.55
5000	0.49

How should this be presented?

Table

Practical activity 4 – Trend

Funded by the European Union

Dataset:

Reynolds number	Drag coefficient
100	1.12
200	0.97
500	0.76
1000	0.64
2000	0.55
5000	0.49

How should this be presented?

Practical activity 4 – Trend

Funded by the European Union

Dataset:

Reynolds number	Drag coefficient
100	1.12
200	0.97
500	0.76
1000	0.64
2000	0.55
5000	0.49

How should this be presented?

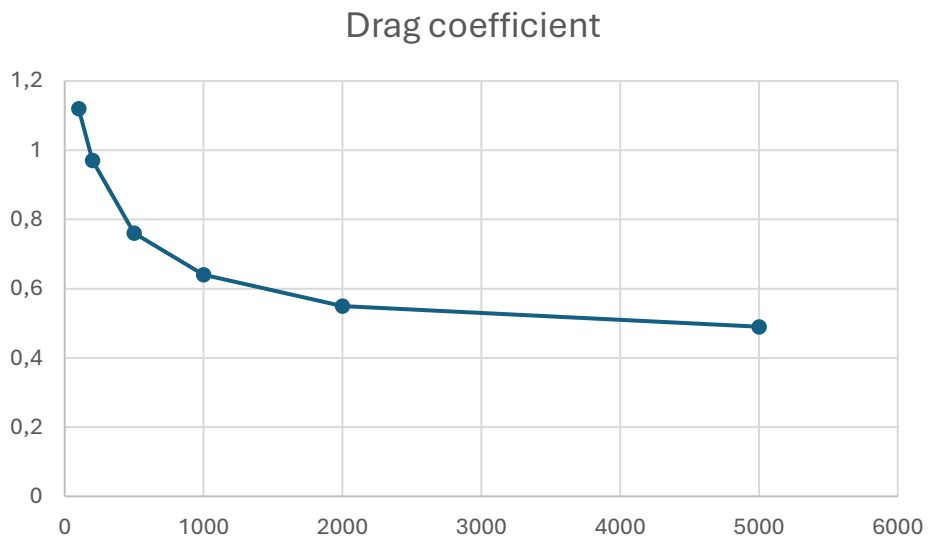
Figure

Practical activity 4 – Trend

Funded by the European Union

Dataset:

Reynolds number	Drag coefficient
100	1.12
200	0.97
500	0.76
1000	0.64
2000	0.55
5000	0.49



How should this be presented?

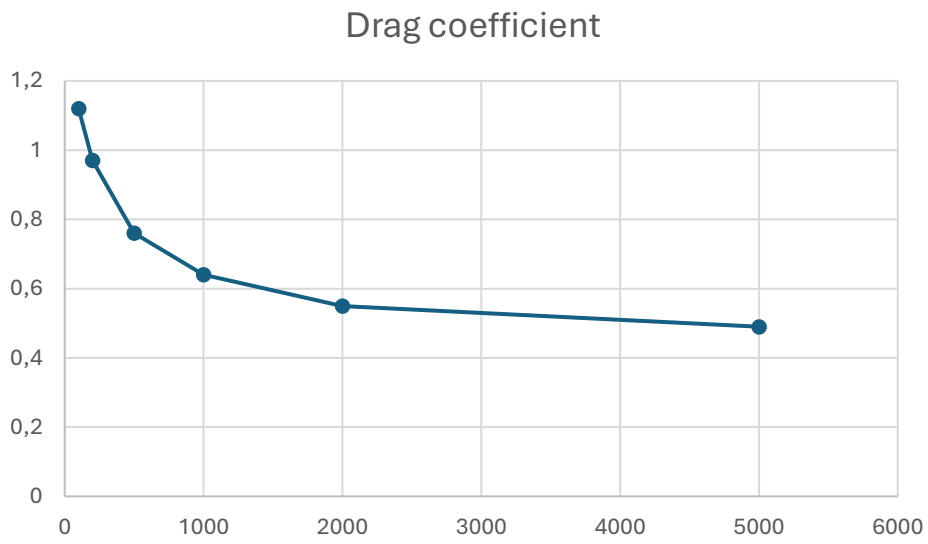
Figure

Practical activity 4 – Trend

Funded by the European Union

Dataset:

Reynolds number	Drag coefficient
100	1.12
200	0.97
500	0.76
1000	0.64
2000	0.55
5000	0.49



How should

Figure

The same data can be either a table or figure depending on the message.

Practical activity 5 – Comparing methods

Funded by the European Union

Dataset:

Grid size	Method A	Method B
1000	0,18	0,2
5000	0,05	0,12
10000	0,04	0,09
50000	0,035	0,07

How should this be presented?

Practical activity 5 – Comparing methods

Funded by the European Union

Dataset:

Grid size	Method A	Method B
1000	0,18	0,2
5000	0,05	0,12
10000	0,04	0,09
50000	0,035	0,07

How should this be presented?

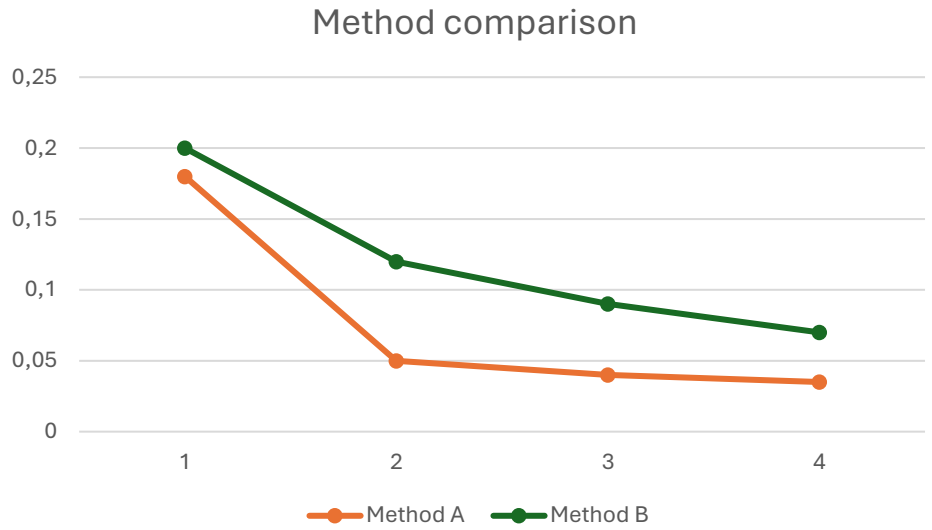
Figure

Practical activity 5 – Comparing methods

Funded by the European Union

Dataset:

Grid size	Method A	Method B
1000	0,18	0,2
5000	0,05	0,12
10000	0,04	0,09
50000	0,035	0,07



How should this be presented?

Figure

Dataset:

Var A	Var B
3,45	7,30
8,87	11,37
1,92	5,61
3,18	6,60
7,97	10,65
8,19	13,09
8,22	13,00
5,97	8,38
1,42	4,53
10,55	13,06
10,49	12,89
6,67	9,80
8,59	11,46
4,29	7,04
2,13	6,77
1,80	3,52
8,28	12,99
1,31	5,04
4,63	6,91
5,44	9,78

How should this be presented?

Dataset:

Var A	Var B
3,45	7,30
8,87	11,37
1,92	5,61
3,18	6,60
7,97	10,65
8,19	13,09
8,22	13,00
5,97	8,38
1,42	4,53
10,55	13,06
10,49	12,89
6,67	9,80
8,59	11,46
4,29	7,04
2,13	6,77
1,80	3,52
8,28	12,99
1,31	5,04
4,63	6,91
5,44	9,78

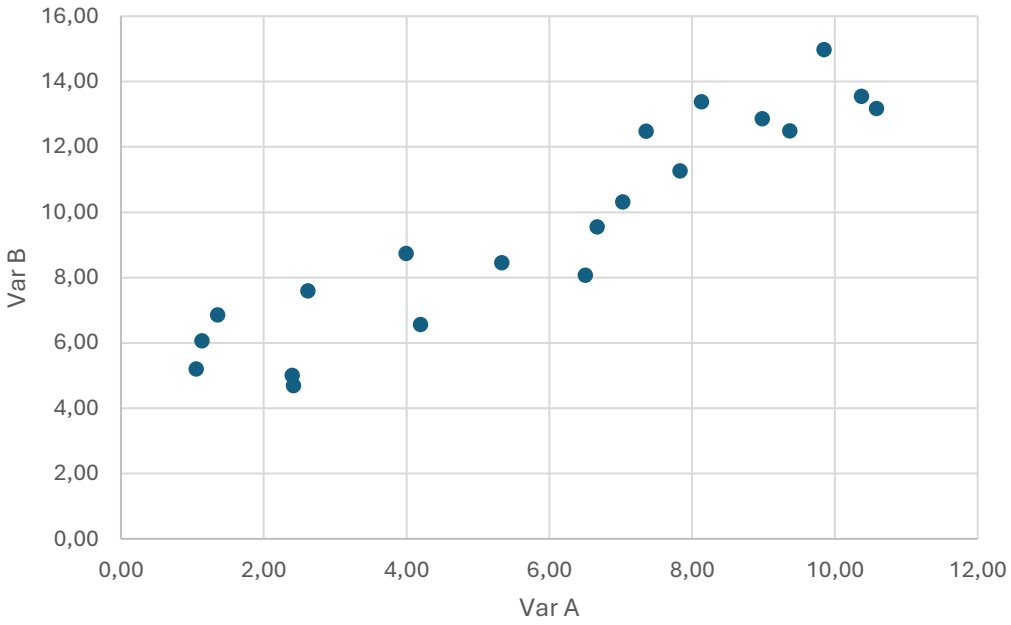
Figure

How should this be presented?

Dataset:

Var A	Var B
3,45	7,30
8,87	11,37
1,92	5,61
3,18	6,60
7,97	10,65
8,19	13,09
8,22	13,00
5,97	8,38
1,42	4,53
10,55	13,06
10,49	12,89
6,67	9,80
8,59	11,46
4,29	7,04
2,13	6,77
1,80	3,52
8,28	12,99
1,31	5,04
4,63	6,91
5,44	9,78

Figure



How should this be presented?

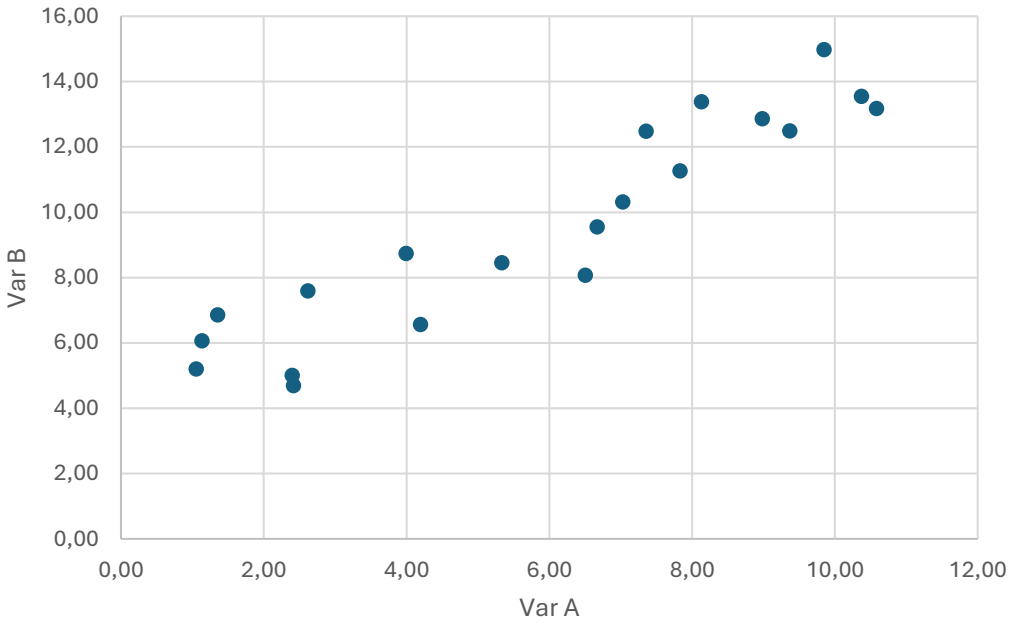
Practical activity 6 – Scatter plot

Funded by the European Union

Dataset:

Var A	Var B
3,45	7,30
8,87	11,37
1,92	5,61
3,18	6,60
7,97	10,65
8,19	13,09
8,22	13,00
5,97	8,38
1,42	4,53
10,55	13,06
10,49	12,89
6,67	9,80
8,59	11,46
4,29	7,04
2,13	6,77
1,80	3,52
8,28	12,99
1,31	5,04
4,63	6,91
5,44	9,78

Figure



How should this be presented?

Dataset:

1000 measurements

D
4,04
4,06
4,06
2,88
3,95
2,92
4,64
3,76
3,39
3,55
2,98

How should this be presented?

Dataset:

1000 measurements

D
4,04
4,06
4,06
2,88
3,95
2,92
4,64
3,76
3,39
3,55
2,98

Figure

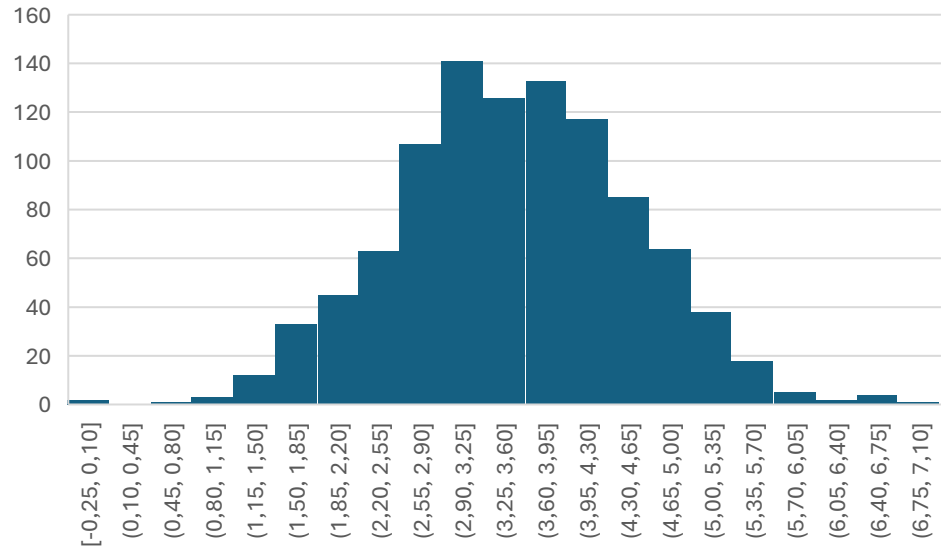
How should this be presented?

Dataset:

1000 measurements

D
4,04
4,06
4,06
2,88
3,95
2,92
4,64
3,76
3,39
3,55
2,98

Figure



How should this be presented?

Practical activity 7 – Statistical distribution

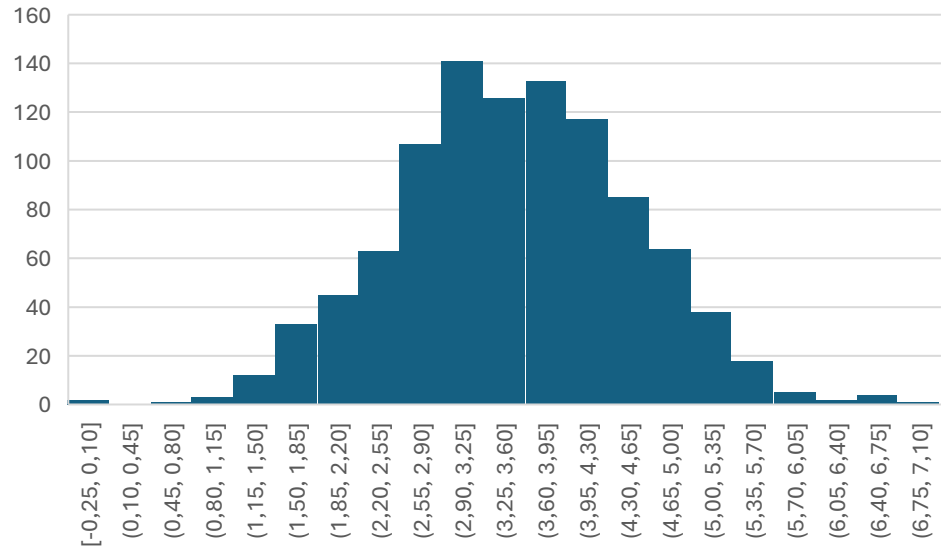
Funded by the European Union

Dataset:

1000 measurements

D
4,04
4,06
4,06
2,88
3,95
2,92
4,64
3,76
3,39
3,55
2,98

Figure



How should this be presented?

Funded by the European Union

Dataset:

Algorithm – 2 parameters

100 runs for each set of parameters

How should this be presented?

Dataset:

Algorithm – 2 parameters

100 runs for each set of parameters

Figure

How should this be presented?

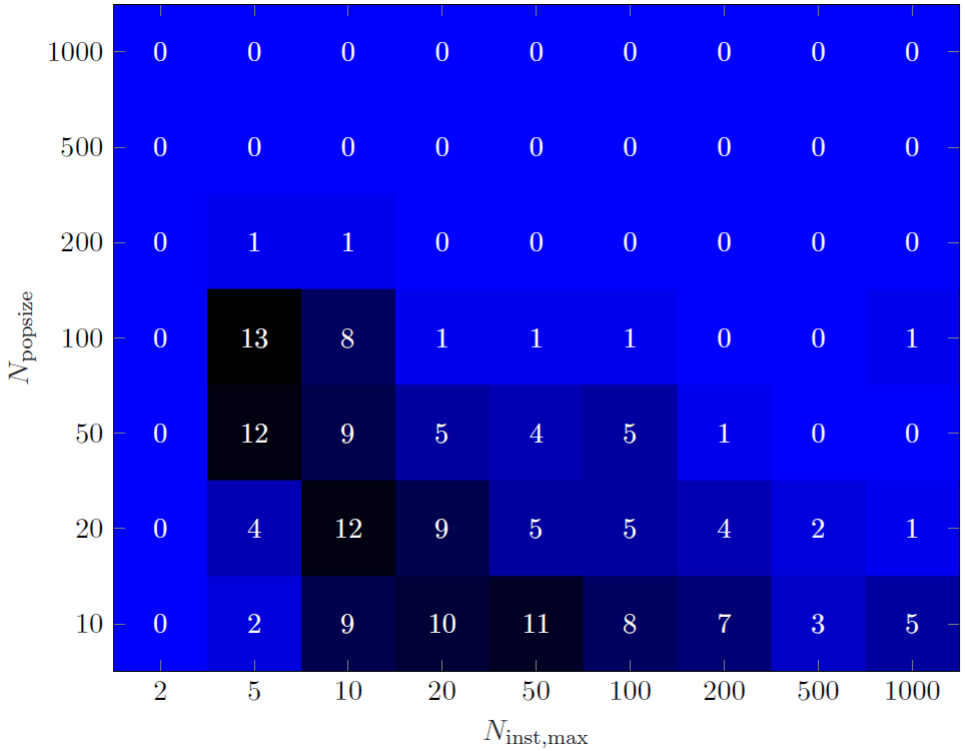
Dataset:

Algorithm – 2 parameters

100 runs for each set of parameters

How should this be presented?

Figure



Practical activity 8 – Multidimensional data

Funded by the European Union

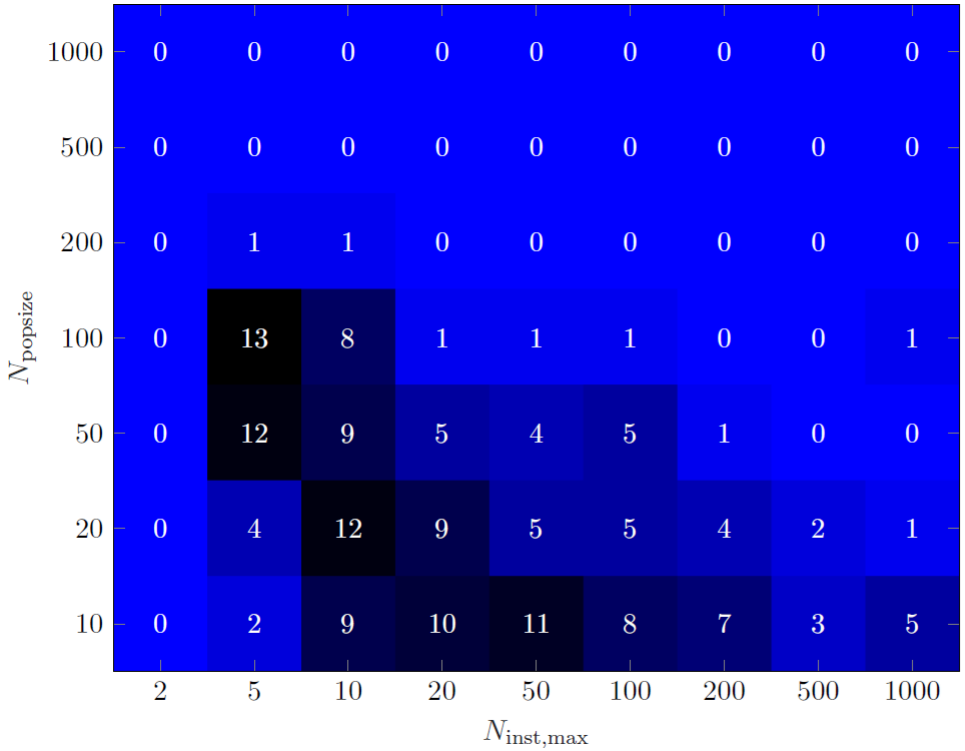
Dataset:

Algorithm – 2 parameters

100 runs for each set of parameters

How should this be presented?

Figure



Dataset:

Algorithm – 3 parameters

Such as $p_a + p_b + p_c = 1$

p_a goes from 0 to 1 by step of 0.1

p_b goes from 0 to 1 by step of 0.1

100 runs for each set of parameters

How should this be presented?

Dataset:

Algorithm – 3 parameters

Such as $p_a + p_b + p_c = 1$

p_a goes from 0 to 1 by step of 0.1

p_b goes from 0 to 1 by step of 0.1

100 runs for each set of parameters

How should this be presented?

Figure

Dataset:

Algorithm – 3 parameters

Such as $p_a + p_b + p_c = 1$

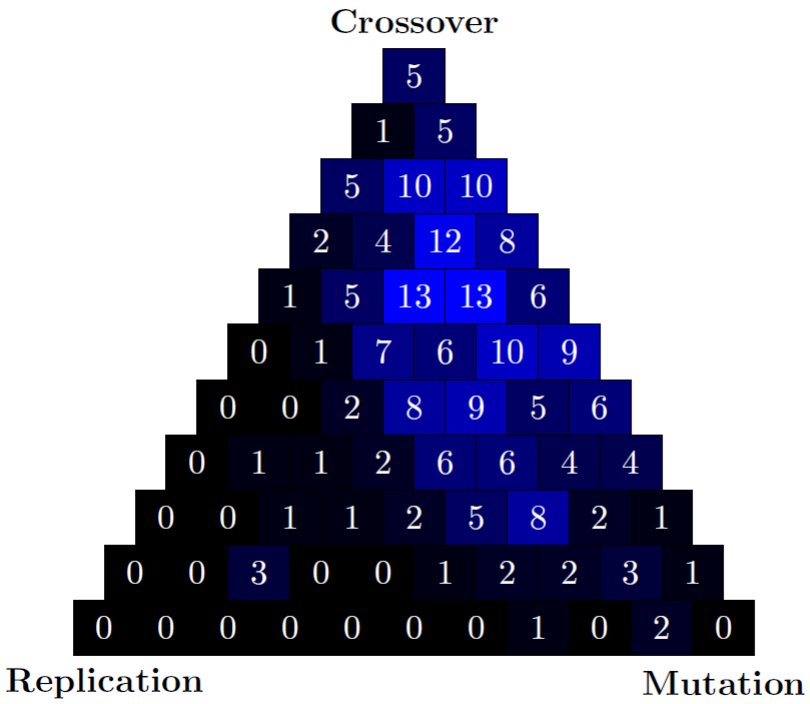
p_a goes from 0 to 1 by step of 0.1

p_b goes from 0 to 1 by step of 0.1

100 runs for each set of parameters

How should this be presented?

Figure



Practical activity 8 – Multidimensional data (2)

Funded by the European Union

Dataset:

Algorithm – 3 parameters

Such as $p_a + p_b + p_c = 1$

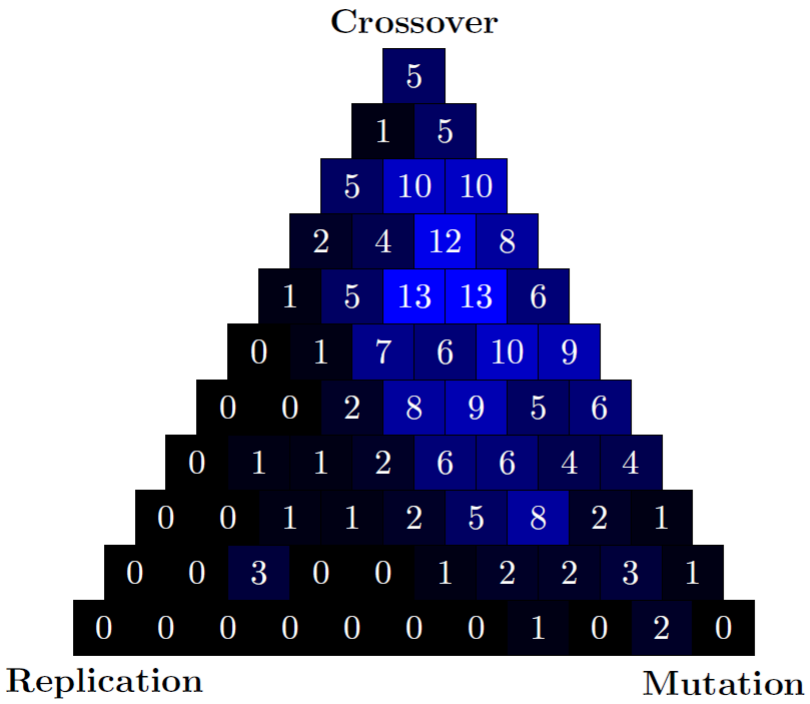
p_a goes from 0 to 1 by step of 0.1

p_b goes from 0 to 1 by step of 0.1

100 runs for each set of parameters

How should this be presented?

Figure



Dataset:

Case	Value
A	10.21
B	10.22
C	10.19
D	10.20
E	10.18
F	10.21
G	10.20
H	10.19

Table or figure?

Dataset:

Case	Value
A	10.21
B	10.22
C	10.19
D	10.20
E	10.18
F	10.21
G	10.20
H	10.19

Table or figure?

Text

The measured values were nearly constant (10.18-10.22).

Practical activity 9 – Trap

Funded by the European Union

Dataset:

Case	Value
A	10.21
B	10.22
C	10.19
D	10.20
E	10.18
F	10.21
G	10.20
H	10.19

Table or figure?

Text

The measured values were nearly constant (10.18-10.22).

Funded by the European Union

Dataset:

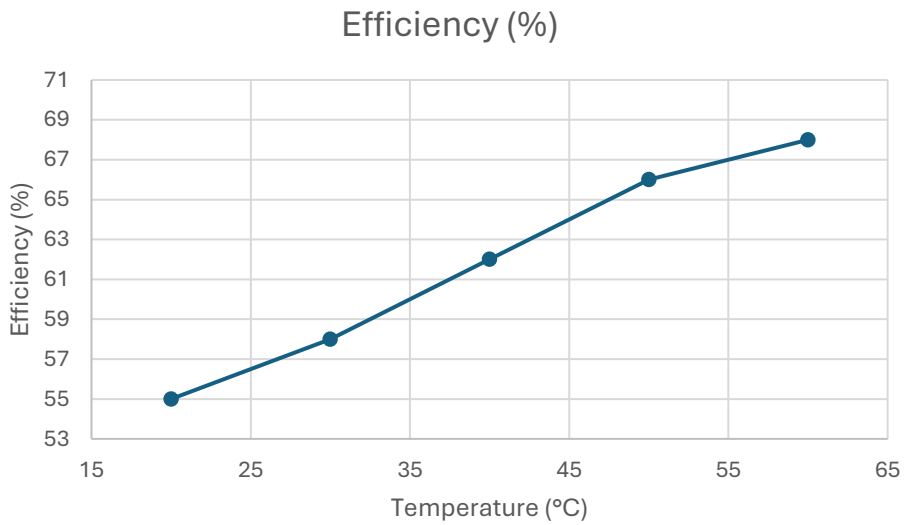
Temperature (°C)	Efficiency (%)
20	55
30	58
40	62
50	66
60	68

How should this be presented?

Dataset:

Temperature (°C)	Efficiency (%)
20	55
30	58
40	62
50	66
60	68

Figure

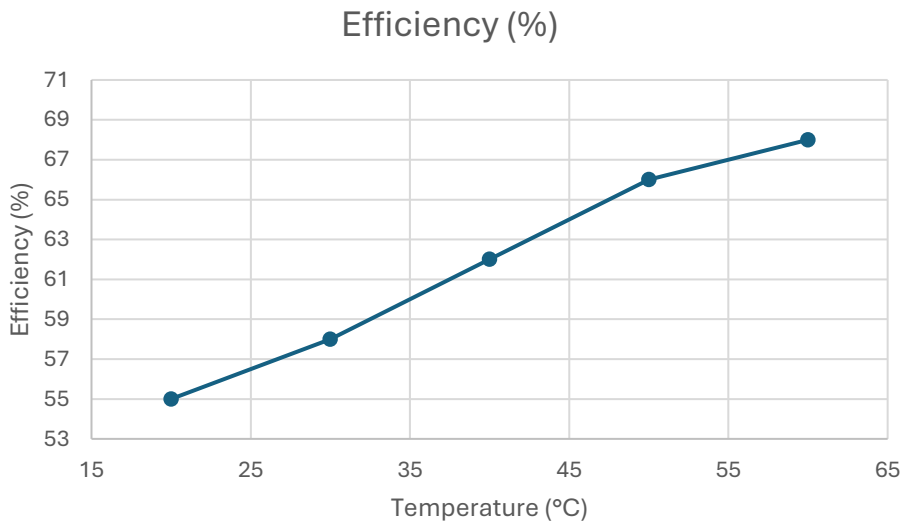


How should this be presented?

Dataset:

Temperature (°C)	Efficiency (%)
20	55
30	58
40	62
50	66
60	68

Figure



How should this be presented?

Text

"*Efficiency increased from 55% to 68% as temperature rose from 20°C to 60°C.*"

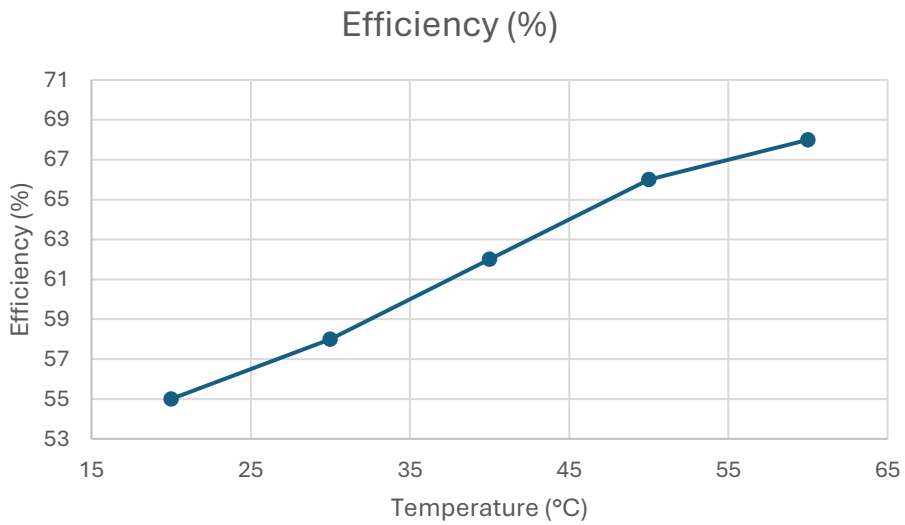
Practical activity 10 – Research question

Funded by the European Union

Dataset:

Temperature (°C)	Efficiency (%)
20	55
30	58
40	62
50	66
60	68

Figure



How should this be presented?

Text

"*Efficiency increased from 55% to 68% as temperature rose from 20°C to 60°C.*"

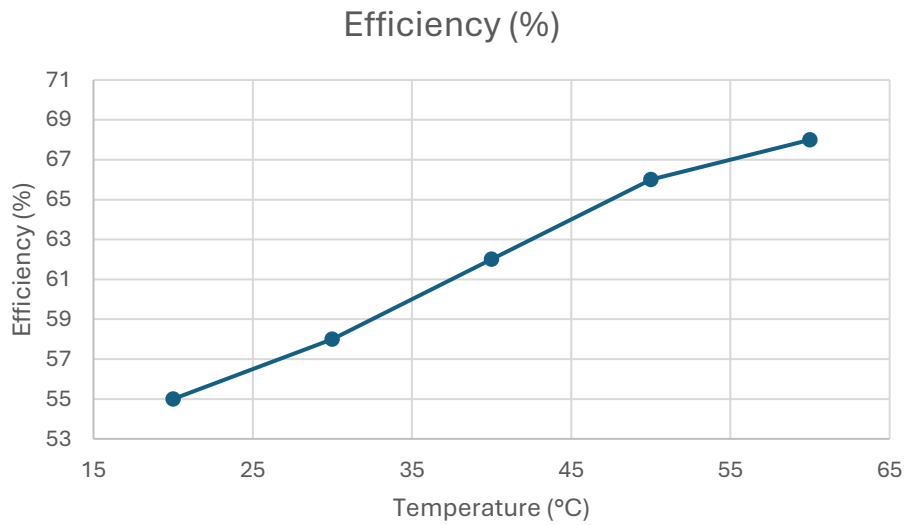
Practical activity 10 – Research question

Funded by the European Union

Dataset:

Temperature (°C)	Efficiency (%)
20	55
30	58
40	62
50	66
60	68

Figure



How should this be presented?

Text

"*Efficiency increased from 55% to 68% as temperature rose from 20°C to 60°C.*"

The message determines the format

How to write the results section?

Writing a paper – My recipe

Funded by the European Union

Writing a paper – My recipe

Funded by the European Union

1. Target your audience

Writing a paper – My recipe

Funded by the European Union

1. Target your audience
2. Write a message statement (Choice of the type of paper)

   The one you mention to your colleagues when you read a paper

Writing a paper – My recipe

Funded by the European Union

1. Target your audience
2. Write a message statement (Choice of the type of paper)

   The one you mention to your colleagues when you read a paper
3. Brainstorming (things you can talk about)

Writing a paper – My recipe

Funded by the European Union

1. Target your audience
2. Write a message statement (Choice of the type of paper)

   The one you mention to your colleagues when you read a paper
3. Brainstorming (things you can talk about)
4. Minimal story with 10 statements

Writing a paper – My recipe

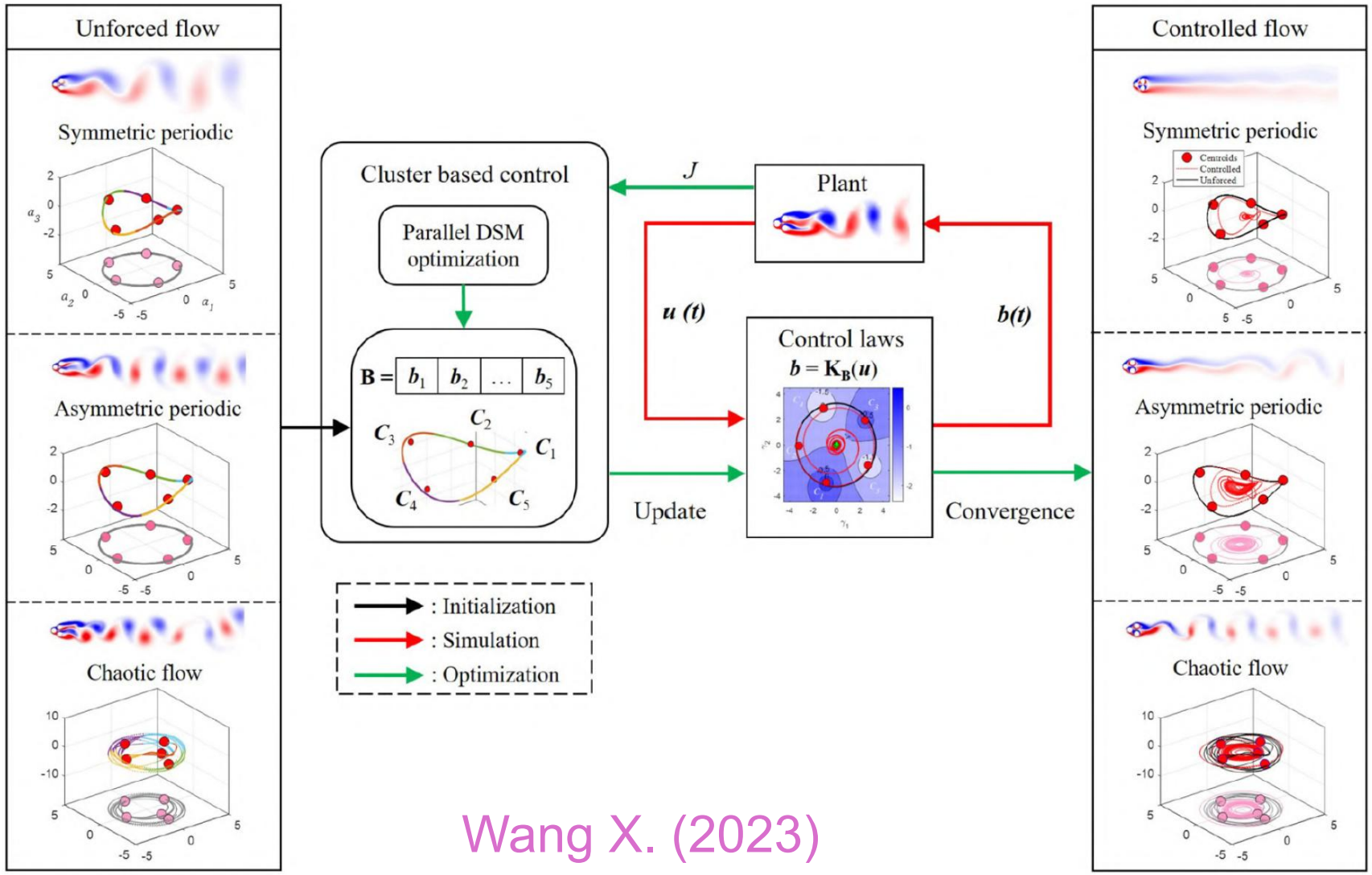
Funded by the European Union

1. Target your audience
2. Write a message statement (Choice of the type of paper)

   The one you mention to your colleagues when you read a paper
3. Brainstorming (things you can talk about)
4. Minimal story with 10 statements
5. 1 summary figure

Writing a paper – My recipe

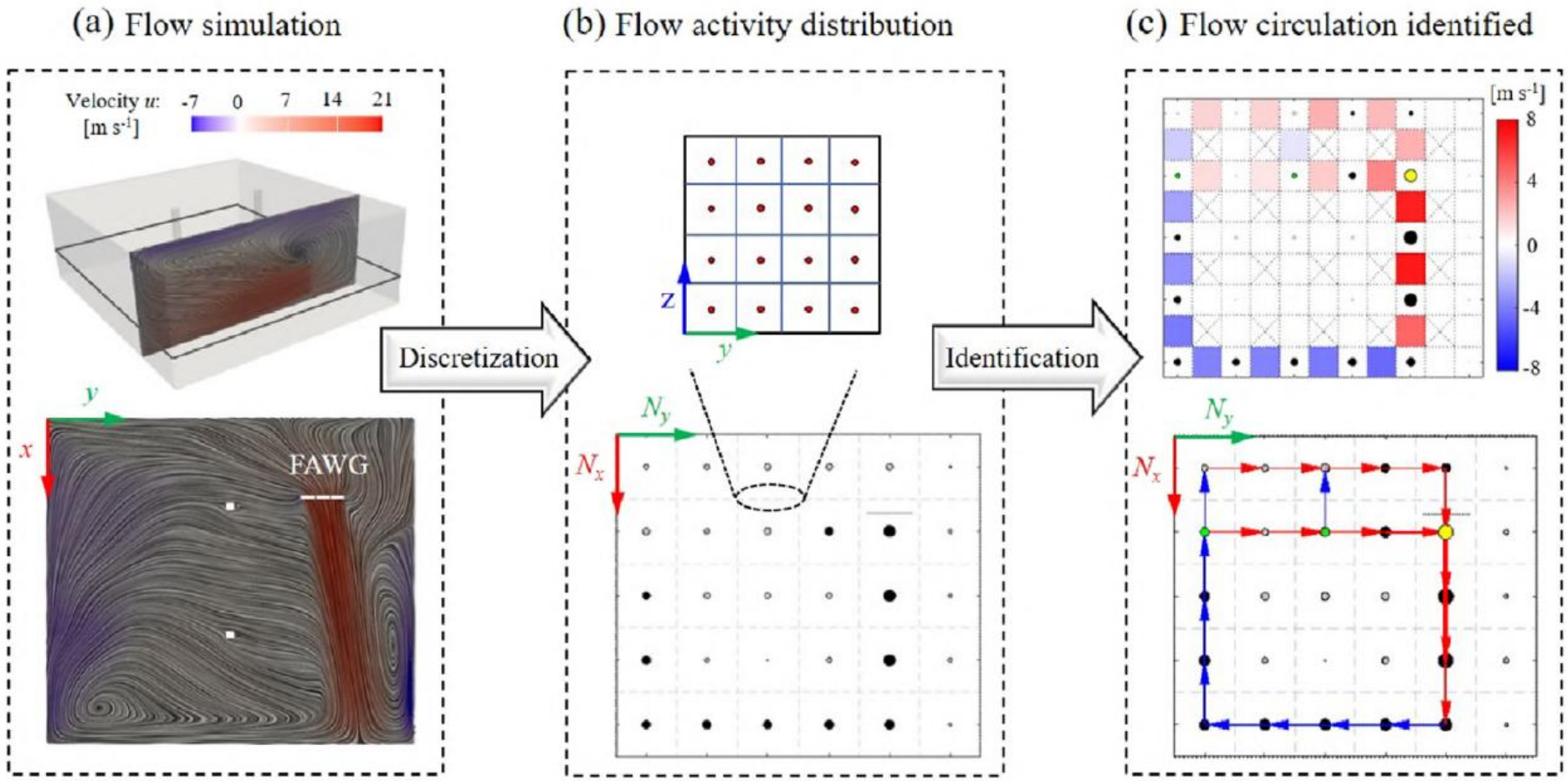
Funded by the European Union



Wang X. (2023)
Phys. Fluids

Writing a paper – My recipe

Funded by the European Union



Wang X. (2024)
Phys. Fluids

Writing a paper – My recipe

Funded by the European Union

6. Train of figures (configuration, method, results)
7. Skeleton
    a. Structure of the paper (all sections, all figures). Sections Results+discussion ?
    b. Choose clear, unequivocal and expressive notations
8. Fill with bullet points and sort the figures and tables to connect a story
9. Discuss with co-authors

    What data should appear and what data should go as supplementary material.
10. Write the paper.

Questions to ask one self for the drafting process

Funded by the European Union

Answer the four questions below, in English even if it is not your first language, for the results you want to turn into a paper.

Writing Scientific Research Articles: Strategy and Steps, 1st edition. By M. Cargill and P. O'Connor. Published 2009 by Blackwell Publishing, ISBN 978-1-4051-8619-3 (pb) and 978-1-4051-9335-1 (hb)

Questions to ask one self for the drafting process

Funded by the European Union

Answer the four questions below, in English even if it is not your first language, for the results you want to turn into a paper.

1. **What do my results say?**

   Two sentences maximum, a very brief summary of the main points, no background!

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   Two sentences maximum, a very brief summary of the main points, no background!

2. **What do these results mean in their context?**

   What conclusions can be drawn from these results?

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Questions to ask one self for the drafting process

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Answer the four questions below, in English even if it is not your first language, for the results you want to turn into a paper.

1. **What do my results say?**

   Two sentences maximum, a very brief summary of the main points, no background!

2. **What do these results mean in their context?**

   What conclusions can be drawn from these results?

3. **Who needs to know about these results?**

   Who specifically forms the audience for this paper you are going to write?

Writing Scientific Research Articles: Strategy and Steps, 1st edition. By M. Cargill and P. O'Connor. Published 2009 by Blackwell Publishing, ISBN 978-1-4051-8619-3 (pb) and 978-1-4051-9335-1 (hb)

Questions to ask one self for the drafting process

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Answer the four questions below, in English even if it is not your first language, for the results you want to turn into a paper.

1. **What do my results say?**

   Two sentences maximum, a very brief summary of the main points, no background!

2. **What do these results mean in their context?**

   What conclusions can be drawn from these results?

3. **Who needs to know about these results?**

   Who specifically forms the audience for this paper you are going to write?

4. **Why do they need to know?**

   What contribution will the results make to ongoing work in the field?

   Or, what will other researchers be missing if they haven't read your paper?

Writing Scientific Research Articles: Strategy and Steps, 1st edition. By M. Cargill and P. O'Connor. Published 2009 by Blackwell Publishing, ISBN 978-1-4051-8619-3 (pb) and 978-1-4051-9335-1 (hb)

What is the purpose of the result section?

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- Explain findings ?

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- Explain findings ?
- Interpret findings ?

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- Interpret findings ?
- Discuss implications ?

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- **Report the findings !**

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- **Report the findings !**
- Interpretation > Discussion

Results = Facts
Discussion = Meaning

Structure of a paragraph

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- Start with the main finding

  “Turbulence intensity increased with Reynolds number.”

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- Present supporting evidence

  “The value increased from 3.2% to 8.7%.”

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- Refer to tables/figures

  “(Figure 5)”

Structure of a paragraph

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- Start with the main finding

  “Turbulence intensity increased with Reynolds number.”

- Present supporting evidence

  “The value increased from 3.2% to 8.7%.”

- Refer to tables/figures

  “(Figure 5)”

- Move logically through research questions

  “A similar trend was observed for pressure fluctuations.”

Structure of a paragraph

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- Start with the main finding

  “Turbulence intensity increased with Reynolds number.”

- Present supporting evidence

  “The value increased from 3.2% to 8.7%.”

- Refer to tables/figures

  “(Figure 5)”

Finding → Evidence → Figure/Table → Transition

Start with the message, not the figure

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Typically

“Figure 4 shows the velocity profiles” **Weak**

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Typically

“Figure 4 shows the velocity profiles” **Weak**

Or

“Figure 4 presents the results obtained”

Start with the message, not the figure

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Typically

“Figure 4 shows the velocity profiles” **Weak**

Or

“Figure 4 presents the results obtained”

Instead write:

“The velocity deficit decreases downstream (Figure 4).”

Strong

Report observations, not explanations

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“The pressure drop increased by 35%.”

“The pressure drop increased because stronger vortices formed.”

Report observations, not explanations

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“The pressure drop increased by 35%.”

Belongs to the Results section

“The pressure drop increased because stronger vortices formed.”

Belongs in the Discussion section

Use numbers strategically

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“The error decreased significantly”

Too vague

Use numbers strategically

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“The error decreased significantly”

Too vague

“The error decreased from 12.43% to 10.11% to 8.74% to 7.32% to 6.95%.”

Too many numbers

Use numbers strategically

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“The error decreased significantly”

Too vague

“The error decreased from 12.43% to 10.11% to 8.74% to 7.32% to 6.95%.”

Too many numbers

“The error decreased by approximately 45%, from 12.4% to 6.9%.”

Precise information

Organize by research questions, not by experiments

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We have data for

Experiment A

Experiment B

Experiment C

Organize by research questions, not by experiments

Funded by the European Union

We have data for

Experiment A

Experiment B

Experiment C

Structure:

Research question 1:
Does method X improve accuracy?

Research question 2:
Under what conditions does improvement occur?

Research question 3:
Why does performance deteriorate?

Organize by research questions, not by experiments

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We have data for

Experiment A

Experiment B

Experiment C

Structure:

Research question 1:
Does method X improve accuracy?

Research question 2:
Under what conditions does improvement occur?

A paper is a synthesis not a report

Dos and don’ts for writing Results

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Try to

1. Lead with the finding
2. Support with evidence
3. Refer to figures/tables
4. Follow research questions
5. Save interpretation for the Discussion

Avoid

1. Figure-by-figure narration
2. Repeating all values
3. Explaining mechanisms too early
4. Mixing Results and Discussion randomly
5. Making readers search for the key message

Key steps

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Research question

Key steps

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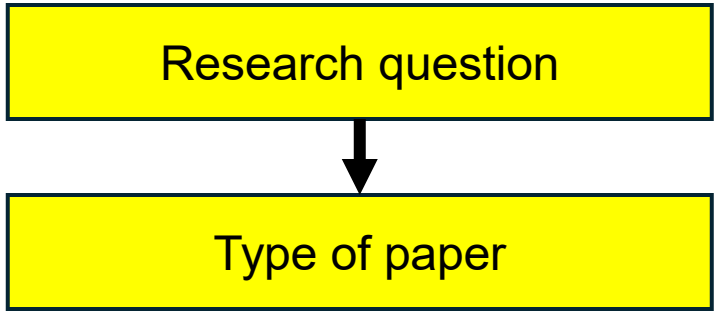

Key steps

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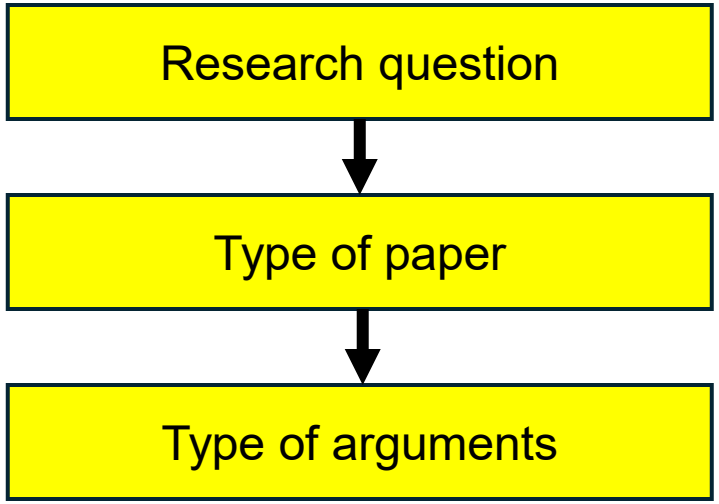
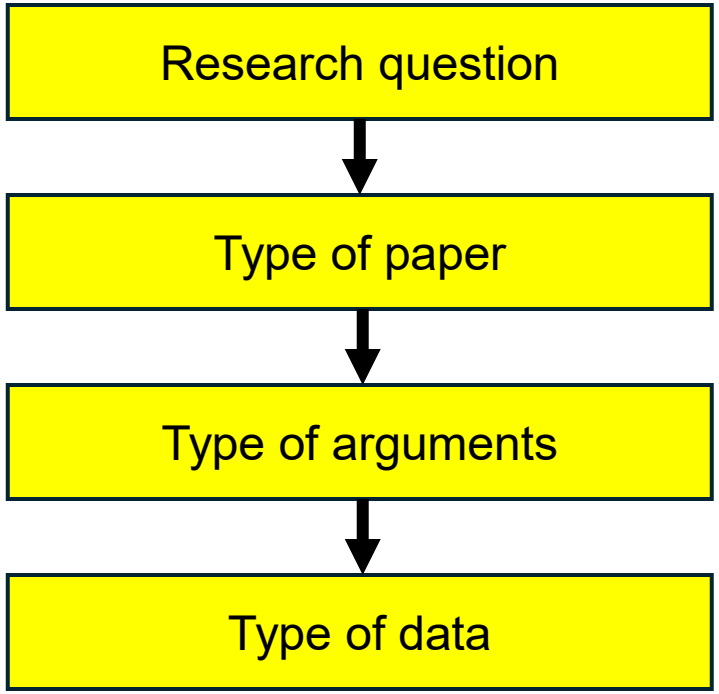


Key steps


Research question
Type of paper
Type of arguments
Type of data

Key steps

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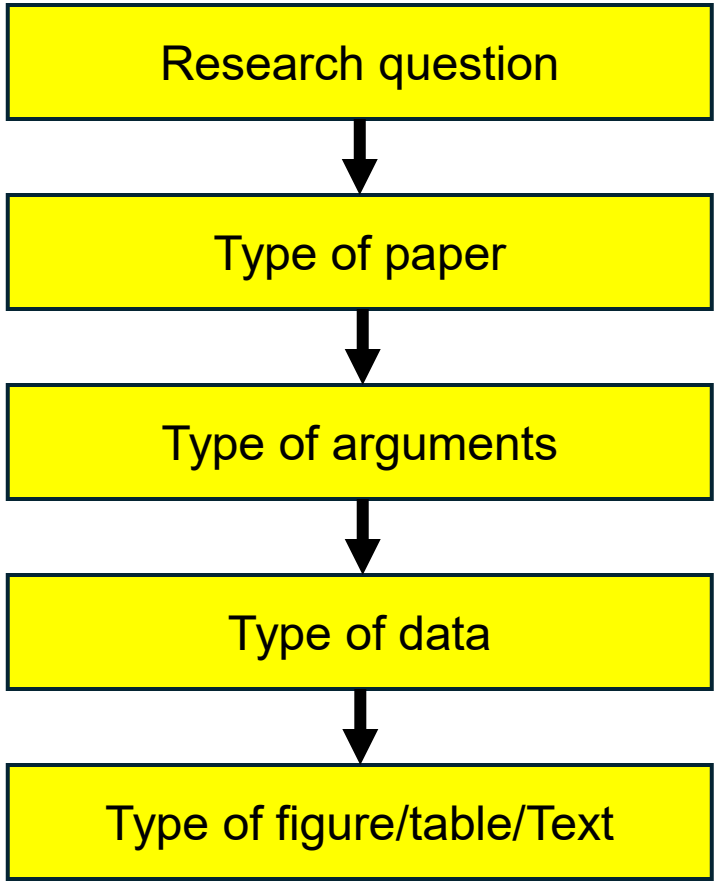

Key steps

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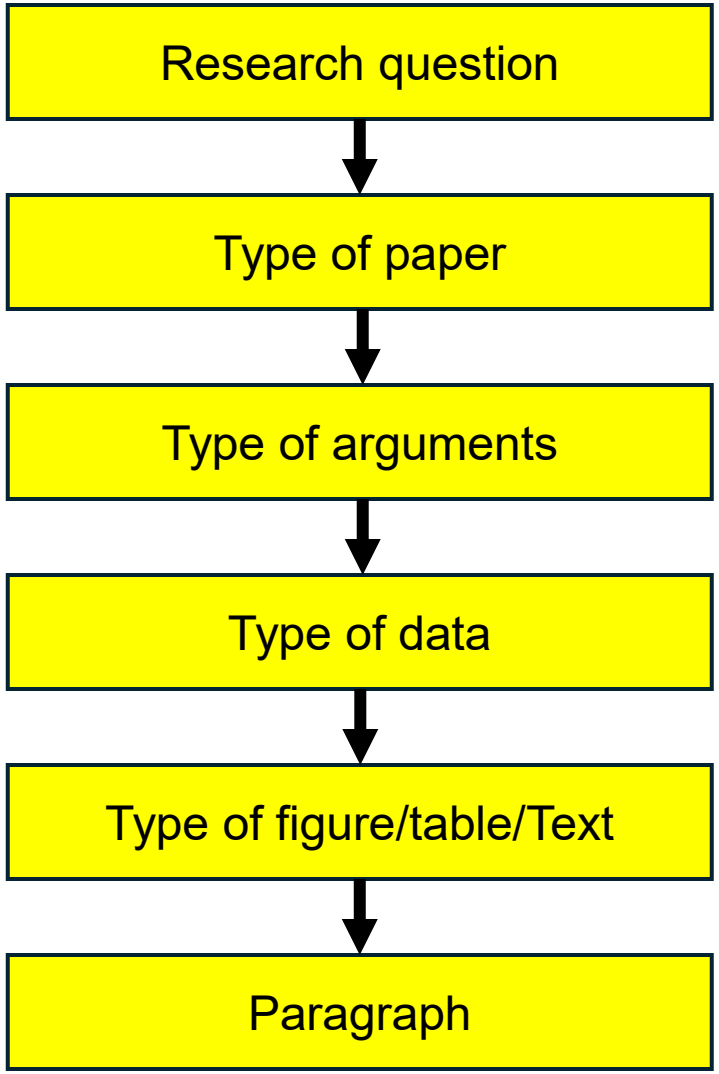

Thank you for your attention

Any questions?