# *Galileo Ferraris' Contest*
comparing *data-driven* methodologies
for the *multi-physics* simulation of traction electrical machines
Awards Presentation

June 22, 2025

*Galileo Ferraris*

Three categories:

- **Novelty**: how the approach is able to provide useful design insights or novel contributions to the field, **scored by Advisory Board**.
- **Interpolation**: how the surrogate model is able to reconstruct the input-output relationship on a given motor type data-set, **quantitative**.
- **Extrapolation**: how the surrogate model trained on two data-sets is able to extrapolate its prediction on a new size of motor of the same typology assessing thus the *degree of innovation* of the surrogate algorithm, **quantitative**.

*Galileo Ferraris*

- **all teams procedures** have been processed and ranked
- **quantitative** scoring is based on **Pareto ranking** after which a rating among peers is performed [1]
- only **academic** teams will receive money prizes
- **award-diversity**: a team can win only one prize

---

[1] Amin Ibrahim, Azam Asilian Bidgoli, Shahryar Rahnamayan, Kalyanmoy Deb, "A Novel Pareto-optimal Ranking Method for Comparing Multi-objective Optimization Algorithms", https://arxiv.org/abs/2411.17999

# Novelty

*Galileo Ferraris*

**Novelty** of the data-drive proposed approach *

- Is the Team using any specific preprocessing of data?
- Has the Team developed a specific method for the Contest or is it using standard libraries?
- Has the Team developed a hybrid version of different methodologies?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Ability** of the approach to provide useful design insights *

- Is the model "black-box" or some physics based rules are implemented?
- Is the Team using some technique to improve robustness?
- Is the Team using one single model or three different models for motor families A, B and C?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Efficient** use of the training data *

- Is the Team implementing any measure of the computational burden of its procedure?
- Has the Team implemented an adaptive tuning for its method parameters?
- Has the Team implemented some measures to minimize the surrogate problem size?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
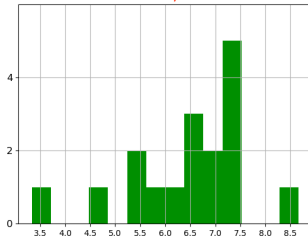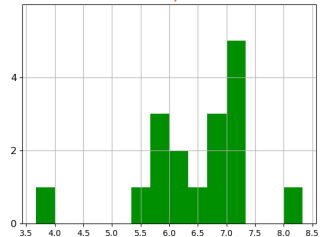
*Galileo Ferraris*

Awards

Novelty

Interpolation

Extrapolation

Galileo
Ferraris

|    | Novelty | Ability | Efficiency |
|----|---------|---------|------------|
| 1  | 5.5000  | 5.5000  | 5.0000     |
| 2  | 6.6667  | 6.6667  | 7.0000     |
| 3  | 7.3333  | 7.3333  | 6.3333     |
| 4  | 4.6667  | 5.6667  | 5.6667     |
| 8  | 5.5000  | 6.5000  | 6.0000     |
| 9  | 3.3333  | 3.6667  | 4.0000     |
| 11 | 7.0000  | 5.6667  | 7.3333     |
| 12 | 6.6667  | 5.6667  | 5.3333     |
| 13 | 7.3333  | 7.0000  | 6.3333     |
| 14 | 8.6667  | 7.0000  | 6.3333     |
| 15 | 5.6667  | 6.0000  | 5.6667     |
| 16 | 6.3333  | 6.6667  | 6.3333     |
| 18 | 7.0000  | 7.0000  | 7.0000     |
| 19 | 6.6667  | 6.6667  | 7.3333     |
| 20 | 7.3333  | 8.3333  | 7.0000     |
| 21 | 7.5000  | 6.0000  | 5.5000     |
| 25 | 7.5000  | 7.0000  | 7.0000     |
| 26 | 5.5000  | 5.5000  | 5.5000     |

*Galileo Ferraris*

Awards
Novelty
Interpolation
Extrapolation

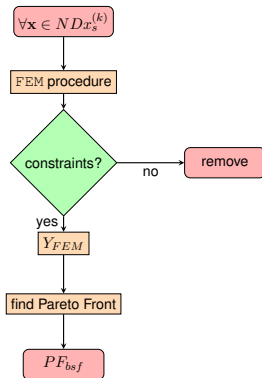| ranking | award | team | Name | front |
|---------|-------|------|------|-------|
| 1 | No (ind) | 20 | MELSUR (Japan) | 0 |
| 2 | 1 | 25 | SHIME-PARFAIT (Japan) | 0 |
| 3 | 2 | 14 | IEML (Iran) | 0 |
| 4 | 3 | 19 | McGill MagNets (Canada) | 0 |

# Interpolation

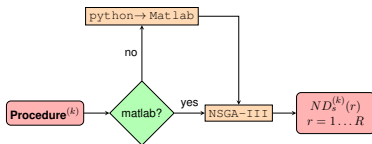**Galileo Ferraris**

Awards
Novelty
Interpolation
Extrapolation

On $PF_{bsf}$ evaluate metrics for all Teams
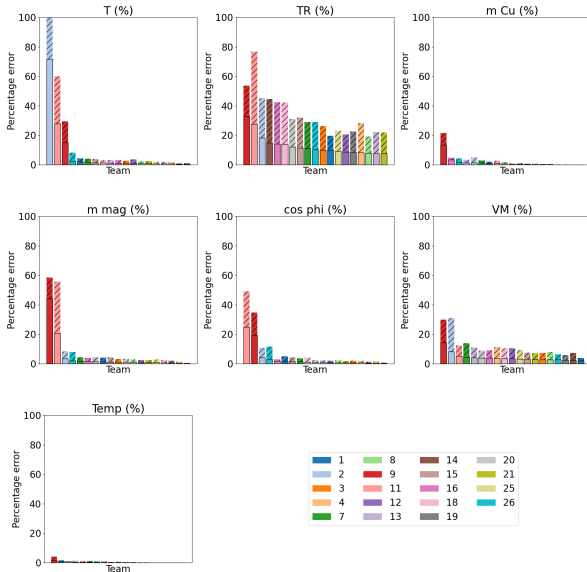
Galileo
Ferraris

Awards

Novelty

Interpolation

Extrapolation

| Team | Inno | IGD | HV |
|------|------|--------|--------|
| 1 | 99 | 0.6494 | 0.0150 |
| 2 | 85 | 0.2370 | 0.1307 |
| 3 | 93 | 0.1992 | 0.1772 |
| 4 | 96 | 0.1974 | 0.1728 |
| 7 | 96 | 0.1997 | 0.1692 |
| 8 | 92 | 0.2051 | 0.1720 |
| 9 | 74 | 0.2351 | 0.1299 |
| 11 | 73 | 0.2483 | 0.1227 |
| 12 | 92 | 0.2024 | 0.1697 |
| 13 | 94 | 0.1971 | 0.1652 |
| 14 | 95 | 0.1936 | 0.1728 |
| 15 | 93 | 0.1959 | 0.1732 |
| 16 | 86 | 0.2056 | 0.1663 |
| 18 | 91 | 0.1860 | 0.1683 |
| 19 | 92 | 0.1907 | 0.1698 |
| 20 | 93 | 0.1888 | 0.1750 |
| 21 | 96 | 0.2056 | 0.1729 |
| 25 | 92 | 0.1965 | 0.1716 |
| 26 | 90 | 0.1964 | 0.1637 |
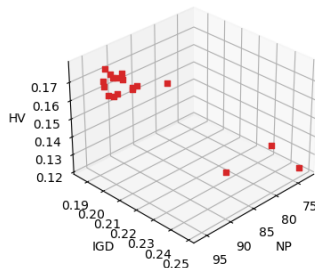
*Galileo Ferraris*

Awards

Novelty

Interpolation

Extrapolation

| ranking | award | team | Name | front |
|---------|-------|------|------|-------|
| 1 | No (ind) | 20 | MELSUR (Japan) | 0 |
| 2 | 1 | 4 | CREATORs (Germany) | 0 |
| 3 | 2 | 21 | MLotors (India) | 0 |
| 4 | 3 | 3 | CAD Lab Team (Italy) | 0 |

# Extrapolation
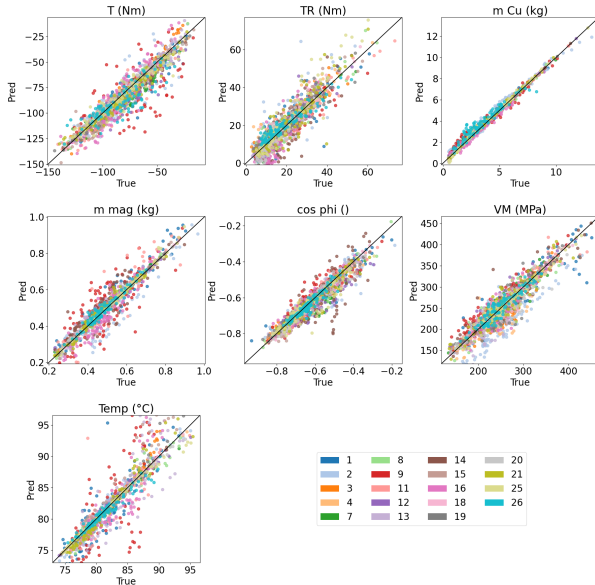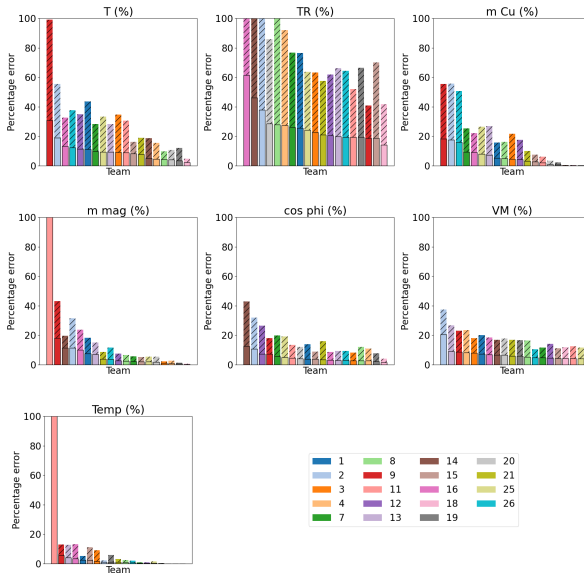
Galileo
Ferraris

Awards

Novelty

Interpolation

Extrapolation

Galileo
Ferraris

Awards

Novelty

Interpolation

Extrapolation

| Team | Inno | IGD | HV |
|------|------|--------|--------|
| 1 | 52 | 0.1810 | 0.2070 |
| 2 | 89 | 0.1612 | 0.2384 |
| 3 | 96 | 0.1601 | 0.2427 |
| 4 | 97 | 0.1521 | 0.2568 |
| 7 | 100 | 0.1571 | 0.2577 |
| 8 | 96 | 0.1511 | 0.2553 |
| 9 | 69 | 0.1736 | 0.2290 |
| 11 | 77 | 0.1631 | 0.2447 |
| 12 | 96 | 0.1493 | 0.2411 |
| 13 | 95 | 0.1757 | 0.2314 |
| 14 | 94 | 0.1683 | 0.2501 |
| 15 | 89 | 0.1544 | 0.2521 |
| 16 | 97 | 0.1661 | 0.2457 |
| 18 | 96 | 0.1538 | 0.2612 |
| 19 | 95 | 0.1544 | 0.2535 |
| 20 | 93 | 0.1558 | 0.2688 |
| 21 | 92 | 0.1518 | 0.2568 |
| 25 | 95 | 0.1554 | 0.2433 |
| 26 | 89 | 0.1638 | 0.2314 |
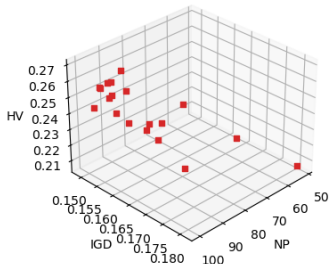
*Galileo Ferraris*

| ranking | award | team | Name | front |
|---------|-------|------|------|-------|
| 1 | 1 | 18 | ManTriS (Italy) | 0 |
| 2 | No (1$^{st}$ Int) | 4 | CREATORs (Germany) | 0 |
| 3 | 2 | 8 | ELECTA (Belgium) | 0 |
| 4 | 3 | 12 | GTB-ULille (France) | 0 |

*Galileo Ferraris*

| Ranking | Team | Front |
|---|---|---|
| 1 | 20 | 0 |
| 2 | 4 | 0 |
| 3 | 21 | 0 |
| 4 | 3 | 0 |
| 5 | 14 | 0 |
| 6 | 18 | 0 |
| 7 | 1 | 0 |
| 8 | 15 | 1 |
| 9 | 19 | 1 |
| 10 | 7 | 1 |
| 11 | 13 | 1 |
| 12 | 8 | 2 |
| 13 | 25 | 2 |
| 14 | 26 | 2 |
| 15 | 12 | 3 |
| 16 | 16 | 4 |
| 17 | 2 | 5 |
| 18 | 9 | 5 |
| 19 | 11 | 6 |

| Ranking | Team | Front |
|---|---|---|
| 1 | 18 | 0 |
| 2 | 4 | 0 |
| 3 | 8 | 0 |
| 4 | 12 | 0 |
| 5 | 7 | 0 |
| 6 | 20 | 0 |
| 7 | 21 | 0 |
| 8 | 19 | 1 |
| 9 | 15 | 1 |
| 10 | 16 | 1 |
| 11 | 3 | 1 |
| 12 | 25 | 2 |
| 13 | 14 | 2 |
| 14 | 11 | 2 |
| 15 | 2 | 3 |
| 16 | 13 | 3 |
| 17 | 26 | 4 |
| 18 | 9 | 5 |
| 19 | 1 | 6 |

*Galileo Ferraris*

- certificates will be provided to all teams taking part in the final part of the contest
- winners will be contacted for money prize by Politecnico di Torino administration
- post contest publication, authored by all contributors, showing methodologies and results . . .
- . . .

# Thank you!!!