# Cybersecurity in Computer Science Curricula of Federal Educational Institutions in Southern Brazil

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# Motivation

- Data generation is growing rapidly, increasing risks (Bourgeois *et al.*, 2019).
- Brazil is heavily impacted by cyber losses (Bruce *et al.*, 2024), with 1/3 of its companies losing over US$1 million in 2025 (PwC, 2025).
- A Lack of specialists weakens prevention and response (ISC2, 2023, 2024).

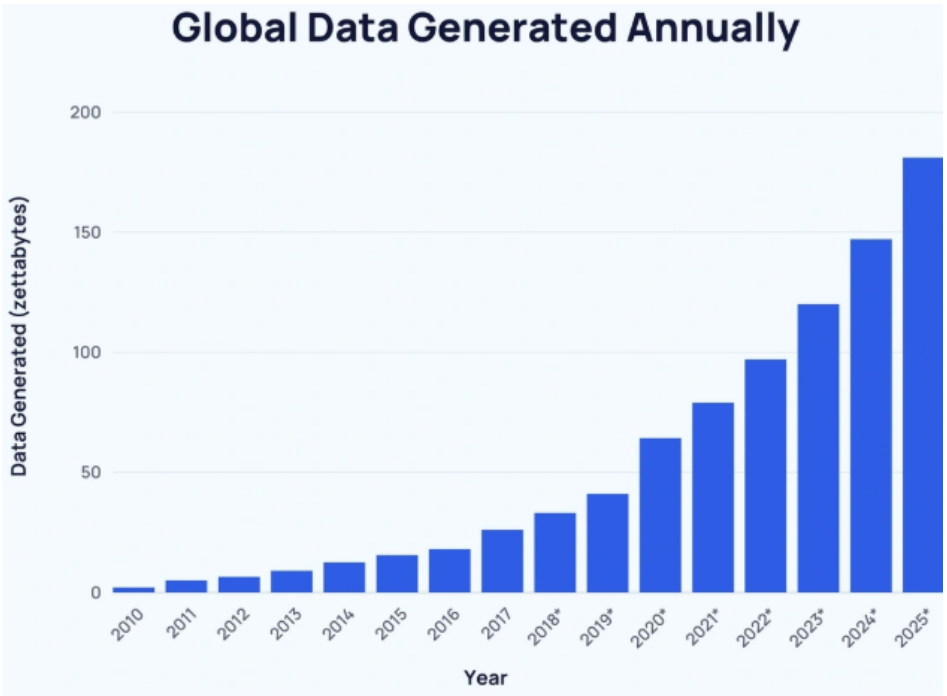


Figure: Amount of Data Created Daily. Source (Duarte, 2025).

# Problem & Justification

- A **cybersecurity culture** depends on **continuous training** (Bishop, 2025).
- **Formal education** broadens **awareness** and promotes **good** digital **practices** (Kuforiji, 2025).
- **Curriculum guidelines** require **competencies** to **identify and mitigate risks** (Ministério da Educação, 2016).
- It is not yet known **how cybersecurity is addressed in curricula** in the South.
  - **Traditional programs** and a wide range of federal offerings.
- **Focus on Computer Science** – CS due to its more generalist background.

# Objectives

- **Map the Cybersecurity courses** in the curricula of federal CS programs in the South.
- Verify **mandatory/elective status**, **offering semester**, and **workloads**.
- **Identify patterns**, **gaps**, and regional **particularities**.

# Related Works

- Abu-Taieh (2017) proposes an essential body of knowledge in Cybersecurity.
- Jesus Cristani *et al.* (2020) analyze Information Systems Programs in Brazil; most have at least one mandatory course on the topic.
- Meireles and Tomaz (2025): validate the method and find solid Security coverage in Southeast degrees, but it is limited in teacher training.

- A focused view of Southern Brazil is lacking; this work offers an **initial step** toward filling that gap.

# Method

- Identification of federal institutions in the Southern region via e-MEC.
- Collection of the most recent available curriculum (October 2025).
- Analysis of syllabi to verify Cybersecurity-related content.
  - Searched terms: *segurança* (security) , *criptografia* (cryptography), *confidencialidade* (confidentiality), *integridade* (integrity), etc.

- This is an exploratory analysis; it does not aim to provide a comprehensive mapping, but rather to establish an **initial basis** for broader future studies.

# Limitations

- Dependence on available syllabi.
- Course titles do not always reflect the actual content.
- Searched terms may not be exhaustive.
- Lack of information on whether courses are actually offered every year.
- Lack of information on workload hours (class hours vs. clock hours).

# Sample Programs

- 20 programs identified; 19 Development Programs analyzed.
- Balanced distribution: PR (6), SC (7), RS (7).

- Balanced network: 9 Federal Institutes and 11 Universities.
- Pedagogical Programs indicate that their structure is reasonably up-to-date: 78.95% have been updated in the last 5 years.

# Cybersecurity Courses (overview)

- 22 courses with "*segurança*" (security) in the title.
- 9 mandatory / 13 optional: electives predominate.
- Strong diversity of names (16): suggests distinct approaches among institutions.
- Some course names:
  - *Cibersegurança* (Cybersecurity)
  - *Ciência de Dados para Segurança* (Data Science for Security)
  - *Segurança em Redes de Computadores* (Security in Computer Networks)
  - *Segurança de Sistemas* (Systems Security)
  - *Tópicos em Segurança Computacional* (Topics in Computer Security)

# Related Disciplines (partial content)

- 99 curricular components partially address cybersecurity topics.

Table: Most frequently offered Security-related course components.

| Rank | Course Component | Appearances |
|---|---|---|
| #1 | Database II, Database 2 or Advanced Database | 10 |
| #2 | Computer Networks II or Computer Networks 2 | 9 |
| #3 | Operating Systems, Operating Systems I, or Operating Systems "A" | 6 |
| #4 | Internet of Things | 5 |
| #5 | Web Development II | 4 |

- Cybersecurity **is present**, but in **non-uniform** ways.

# Related Disciplines (partial content)

- Distributed systems (from Pedagogical Development Program, in portuguese):
  1. *Transações distribuídas, interoperabilidade, consciência de contexto, **segurança e privacidade**, adaptabilidade, metamodelo de ambientes e descoberta de recursos aplicados à computação em grade, computação em nuvem, computação ubíqua e computação móvel.*
  2. *Problemas Básicos em Computação Distribuída: comunicação, coordenação e sincronização de processos. Exclusão Mútua, Difusão de Mensagens. Transações Distribuídas. **Tolerância a Faltas**. Exemplos de Sistemas Distribuídos. Memória Compartilhada. Computação ubíqua. Middleware para a concepção de sistemas distribuídos.*

# Mandatory Offer, Course Workload and phase

- 55 mandatory courses and 44 electives in total.
- All programs include at least one mandatory course covering security (fully or partially).
  - Electives may reveal curricular priorities and dependence on specialized faculty who may not always be available.
- Workloads ranging from 30 to 80 hours: high variability.
- Most courses are offered in the final phases.
  - This may reflect a dependency on technical prerequisites (networks, operating systems, programming).

# Key Findings, Interpretation & Implications

- Security-related content is distributed inconsistently across curricula.
  - Course titles and descriptions vary widely, showing little standardization.
- Security courses typically appear only in the final stages of the degree.
  - Security remains peripheral, not a core part of most programs.
- The number of instructors in Security may limit how consistently and how deeply the topic is taught.
- **Risk**: students may graduate with a superficial understanding of the area.
- **Opportunity**: treat Security as a required component integrated across all stages of the program.
  - May already be happening!

# Conclusion

- There is an institutional effort, but with great variability.
- 22 specific courses and 99 Cybersecurity-related courses show reasonable interest.
  - Only one program does not have security (fully or partially) covered in a mandatory course.
- Cybersecurity needs to be more central in the curriculum.
  - It certainly depends on specialized teachers!

# Future Work

- Compare curricula with NICE, CESeg/SBC, and ACM/IEEE guidelines.
- Expand the analysis to include public and private institutions in the South.
- Study of the national Federal Network to map trends.
- Investigate teacher profiles and their influence on course offerings.
- Investigate sub-areas covered by the Development Programs (cryptography, authentication, etc.).

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# Thank you!

https://github.com/ricardodelarocha/Research/blob/main/Computer-Science-Curricula/

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# Search by sub-areas (cryptography)

- No results for courses offered in a foreign language.

- Data on the **cryptography** subfield:
  - 21 courses were found across 16 programs.
    - PR: 7 courses; 5 programs;
    - RS: 8 courses; 5 programs; and
    - SC: 6 courses; 6 programs.
  - 11 mandatory and 10 optional
    - Uniform distribution among the states.
    - In only ten courses the topic is covered in a mandatory way.
    - Again, the topic can be approached in a cross-cutting manner.
  - Workload between 60 and 72 hours
    - **outlier**: 40 hours (IFSC)
  - Courses between 4th and 10th semesters; most of them taught in 7th and 8th.

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