Wearable Technologies and Applications (Wearable Informatics)

Winfree

Lecture 1

Wearable Informatics
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Defined: Information
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What is Wearable Informatics?

Definition

wear•a•ble

adjective

1. (especially of clothing) easy to wear; suitable for wearing: the simple tailoring make this a stylish and infinitely wearable collection — wearable pieces of jewelry.
2. denoting or relating to a computer or other electronic device that is small or light enough to be worn or carried on one's body: a wearable computer could monitor your heart rate and other bodily functions.

noun

1. an item that can be worn: one of the industry's leading manufacturers of fashion-forward wearables — the latest wearables are more durable and more mobile than laptop computers.

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What is Wearable Informatics?

Definition

in•for•mat•ics

plural noun

1. the science of processing data for storage and retrieval; informatics science

origin

- 1960s: from information + -ics, translating Russian **informatika**.

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What is Wearable Informatics?

Definition

in•for•ma•tion

noun

1. facts provided or learned about something or someone: a vital piece of information.
   - Law a formal criminal charge lodged with a court or magistrate by a prosecutor without the aid of a grand jury: the tenant may lay an information against his landlord.
2. what is conveyed or represented by a particular arrangement or sequence of things: genetically transmitted information.
   - Computing data as processed, stored, or transmitted by a computer.
   - (in information theory) a mathematical quantity expressing the probability of occurrence of a particular sequence of symbols, impulses, etc., as contrasted with that of alternative sequences.

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What is Wearable Informatics?

Definition

- "denoting or relating to a computer or other electronic device that is small or light enough to be worn or carried on one's body"
- "the science of processing data for storage and retrieval"
- Then: Wearable Informatics is the science of data storage, retrieval, and analysis from electronic or computer devices small enough to be worn"

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Google Search Popularity

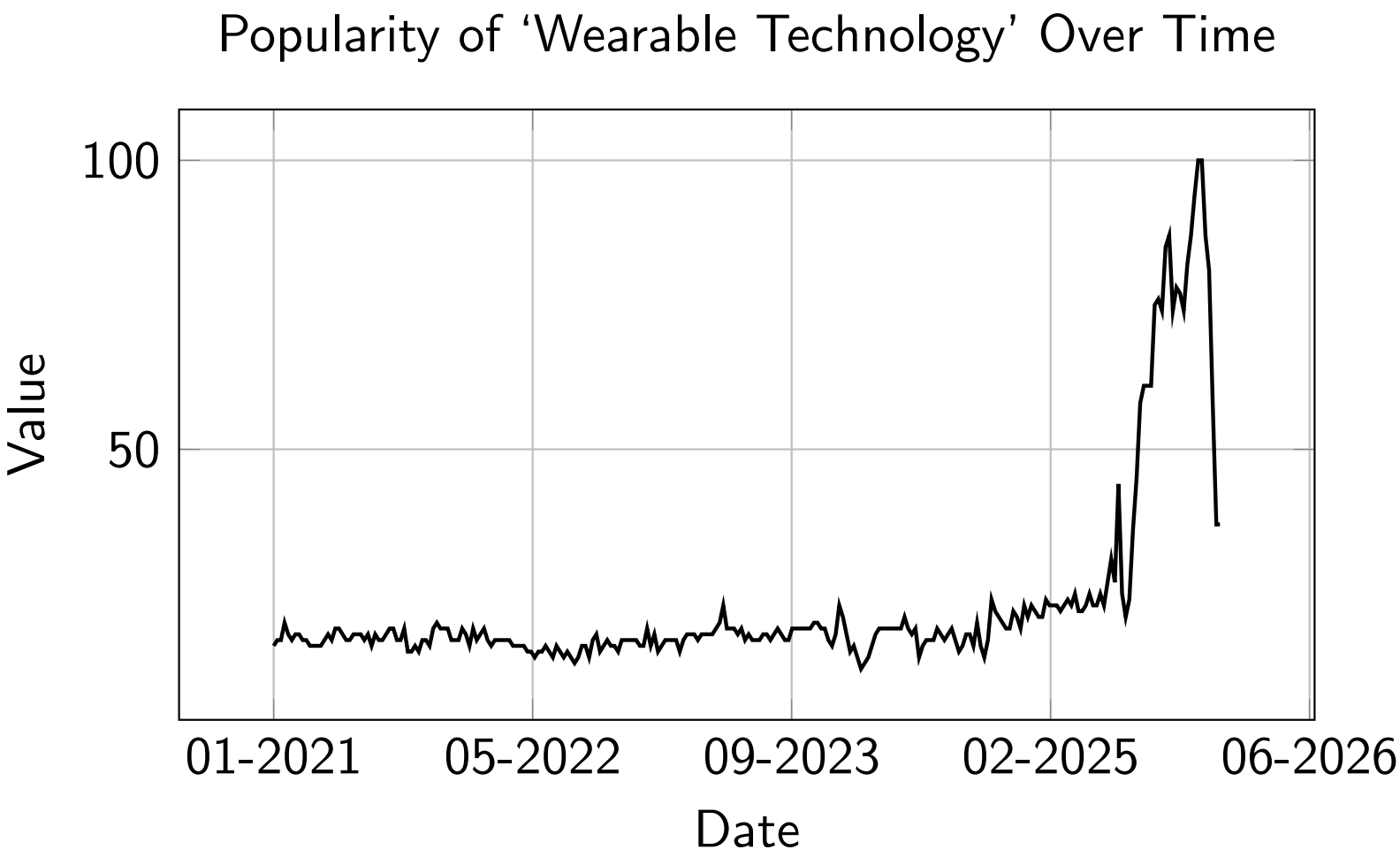

Figure: Time Series Data Visualization

Related Search Topics

- Technology (100)
- Watch (68)
- Health (63)
- Wearable computer (59)
- Sensor (52)
- Artificial intelligence (46)
- Data (39)
- Physical fitness (27)
- Smartwatch (24)
- Medicine (23)
- Sleep (23)

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Why?

- Use group data to:
  - Gain scale
    We can do analyses based on high resolution data sets, such as minute level observations (1440 minutes in a day), or even second level (86,400 seconds in a day)!
  - Gain new insights
    As researchers, and as end users, we have never before had access to so much data. Consider how much data we would have with 20 participants in a study that last 16 weeks (193M seconds worth)... What about all Fitbit users (large n), there are over 120 million of them![1]
  - Make decisions
    With this much data, we can make new comparisons between groups of people, especially when looking at health outcomes.

[1] https://electroiq.com/stats/fitbit-statistics/

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Why? You!

- Use personalized data to:
  - Make decisions
    Imagine taking the findings of 120 million users and using that to personalize health care recommendations or guidance.

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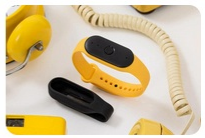
Current Headlines

Amazon On The Future For $50 AI Wearable That Listens To Conversations
Forbes | 4 hours ago
You won't find it on Amazon's store just yet, but it sounds like the tech giant has big plans for subsidiary Bee's $50 listening AI band.



Why Amazon bought Bee, an AI wearable | TechCrunch
TechCrunch | 2 hours ago
Amazon explains where its **wearable** Bee fits in and whether it will merge with Alexa.

Robotic puppy, AI, wearable technology on display at CES media preview
Las Vegas Review-Journal | 8 days ago
A robotic puppy is among the products thousands of CES attendees will see at multiple trade-show venues across Las Vegas starting Tuesday morning.

Can a Brain-Sensing Gaming Headset Finally Make Me a Pro Player?
gizmodo.com | 6 hours ago
I tried out Neurable and HyperX's new EEG gaming headset to become the best esports player I never wanted to be.

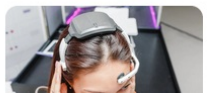
Japanese scientists' 'living skin' implant glows to warn of illness
The Messenger | 7 hours ago
The next generation of **wearable** health devices has been successfully trialled in mice by scientists in Japan.

AI pendants back in vogue at CES after early setback
RTE Online | 13 hours ago
Pendants and brooches packed with artificial intelligence abounded at CES 2026, using cameras and microphones to watch and listen through the day like a vigilant personal assistant.

Technology can be a great tool for boosting your health, but motivation is the foundation of sustained change
phillyvoice.com | 23 hours ago
Before buying a **wearable** or exercise app, take time to identify the inspiration and structure needed to build — and maintain — new habits in 2026.

Watch your fitness: six of best tech wearables to help you achieve your goals
Irish Daily Mirror | 1 day ago
From screen-free trackers to high-end adventure sport watches, we've got you covered for your 2026 health and fitness drive

The Neurotechnology Shift: how next-generation wearables interface with the brain itself
The Conversation en Español | 5 days ago



Undergraduate Course Objectives

Students who complete the undergraduate section of this course in good standing should be able to demonstrate the following advanced competencies:

1. Select, assess, and apply techniques appropriate to the application of wearable technologies for healthcare and wellness applications;
2. Synthesize, apply, and evaluate offline data analysis and machine learning techniques on large-scale data sets collected by wearable technologies;
3. Identify, interpret, and critically explain the significance of open research areas in wearable technologies and their applications in health-driven research;
4. Evaluate the applicability of wearable technologies in the commodity market.

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Graduate Course Objectives

Students who complete the graduate section of this course in good standing should be able to demonstrate the following advanced competencies:

1. Select, assess, and apply techniques appropriate to the design and implementation of wearable technologies for healthcare and wellness applications, including specialized communication protocols and data structures and storage techniques;
2. Synthesize, apply, and evaluate online and offline data analysis and machine learning techniques on large-scale data sets collected by wearable technologies;
3. Identify, interpret, and critically explain the significance of open research areas in wearable technologies and their applications in health-driven research;
4. Evaluate the applicability of wearable technologies in the commodity and research.

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Who am I?

Kyle N. Winfree, PhD
Associate Professor
Faculty of Informatics,
Computer Science, and Electrical
Engineering in the School of Informatics,
Computing, and Cyber Systems
Joined NAU in Fall of 2015
AD of Undergrad Programs 2019-2022
AD of Grad Programs 2022-2025

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Formal Education and Training

- NIH mHealth Training Institute Fellow
- Post-doc at Univ. of Delaware, PD intervention and assessment (SEnsole)
- Ph.D. at Univ. of Delaware in Biomechanics and Movement Science
  1.5 years focused on stroke rehabilitation robotics (ALEX)
  2.5 years dissertation on Parkinson's disease rehabilitation (PDShoe)
- M.S.E. at Univ. of Pennsylvania in Robotics, thesis on haptics (iTorqU)
- US Geological Survey Astrogeology Branch, studied polar ice on Mars
- B.S. at **Northern Arizona University** in Physics

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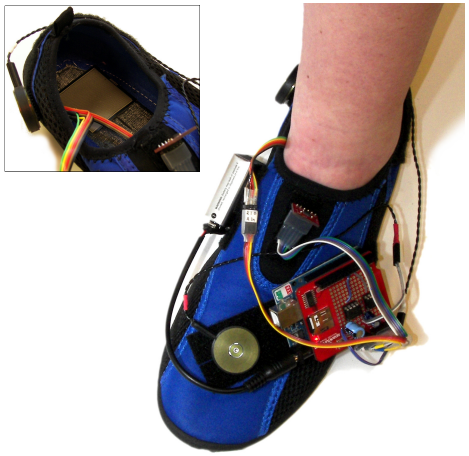
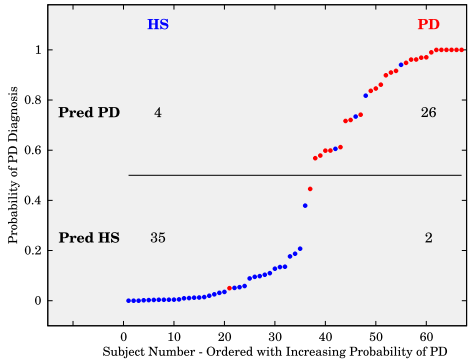
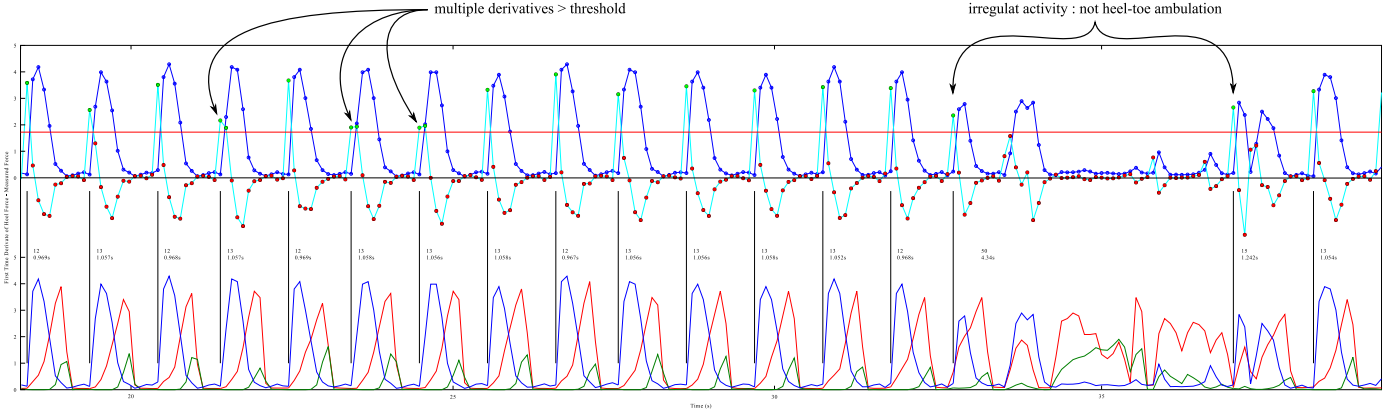
PhD / Post Doc Topic: PDShoe / Sensole







INF632
(EE499/EE599)

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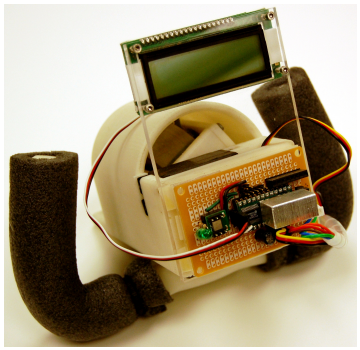
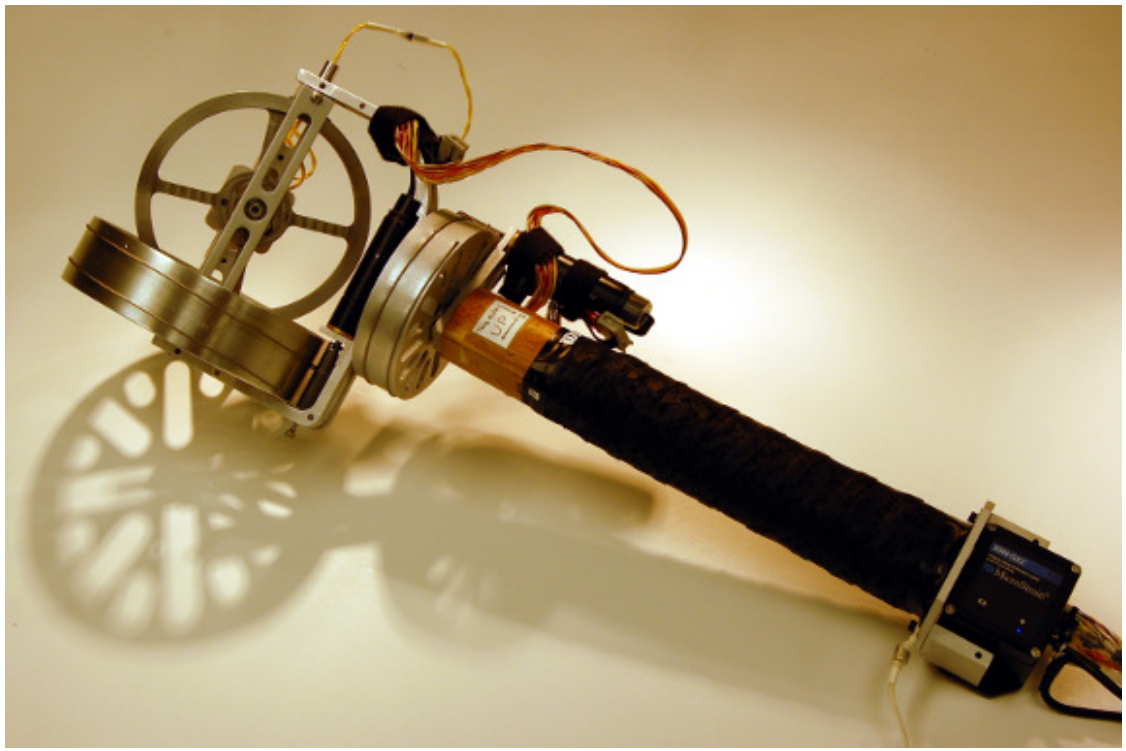
MS Thesis : iTorqU





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Research interests

- Impact of Faculty Behaviors on Student-Faculty Rapport: A Multi-Institutional Study (2025)
- Optimizing Feature Extraction Methods Using Class Similarity Ratio for EMG-Based Hand Gesture Classification (2025, PhD Student)
- Ready, Set, Move! Tracking Children's Modified Ride-On Car Use With a Custom Data Logger (2023)
- Impact of Different Exercise Modalities on the Human Gut Microbiome (2021)
- Optimizing Student-Faculty Rapport for the Engineering Classrooms: Dimensioning the Behaviors that Matter (2020)
- The Development of an IoT Instrumented Bike: for Assessment of Road and Bike Trail Conditions (2018, PhD Student)
- Modeling Clinically Validated Physical Activity Assessments Using Commodity Hardware (2017)
- A novel method of assessing dietary behavior using a wrist-worn accelerometer (2017)

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How do you contact me?

Email: kyle.winfree@nau.edu
Canvas: Better than email, send me a message on Canvas. That will pop up on my phone. I do NOT have email on my phone.
Office: SICCS Room 204
In-Person: Come see me in my office, stop me in the hallway, chat with me on a campus bus, etc. I prefer in-person discussions for anything more than a 2 minute question / response.
Cell Phone: 928.853.0114 *(please use this sparingly)*

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Canvas and Git

- Due dates for assignments will be on Canvas
- Submission of assignments will be "linked" on Canvas (UG: Google Drive or GitHub, G: GitHub)
- Materials for class will be on GitHub/kylewinfree/inf632-spring2026
  - Source for all course materials will also be in Canvas. Graduate Students: I expect that you will typeset your assignment submissions; use this source to help you with LaTeX.

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Course Materials

- No text book will be required.
- You will need to purchase the materials to create a wearable device. This material list will be provided; expect costs to be approximately that of a textbook.
- Students in the undergraduate section have the option of completing the research project with off-the-shelf devices and may not need to purchase materials.

See the syllabus for recommended readings, including those that are available for free online.

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Grading

Graduate and Undergraduate students will be assessed with different rubrics (expectations). The weight of each assignment is also different between these groups, owing to these different expectations.

Table: Assessments and related fractional percentage of final grade.

Assessment	Undergraduate	Graduate
Attendance and in-class participation	10%	10%
Homework Assignments (3)	45%	30%
Research Project: Literature Review	5%	10%
Research Project: Questions and Hypotheses	10%	10%
Research Project: Device Design and Implementation	5%	10%
Research Project: Methods Plan	5%	5%
Research Project: Analysis	5%	10%
Research Project: Discussion of Findings	10%	10%
Research Project: In-Class Presentation	5%	5%
Total	100%	100%

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Participation Matters!

I assume you are hear with the intention to learn something. With that assumption, then let's consider the following from J. E. Stice, "Using Kolb's Learning Cycle to Improve Student Learning," Engineering Education, pp. 291-296, February 1987.

Retention	What one ...	Class Activity
10%	reads	Readings
26%	hears	Lectures
30%	sees	Figures, Drawings, Slides
50%	sees and hears	Lectures with Visuals
70%	says	Asking questions, Discussing papers
90%	says while doing	Hands-on activities, Project demos

So come to class, for every lecture, every lab, and every project "office" hours!

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Office Hours

Class is on Tuesday and Thursday
It seems like Thursday afternoon, Friday morning, or Monday might be good office hours candidates.
So let's survey you!

Thursday 12:45-2:00	?
Thursday 2:30-3:45	?
Friday 9:00-10:15	?
Friday 10:00-11:15	?
Monday 1:00-2:15	?
Monday 2:00-3:15	?

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Schedule

See the syllabus for a complete and readable version =)

Table: Tentative Course Schedule.

Week of	Content
Jan 12	Course expectations, setup (GitHub or Google Drive), and peer introductions (come prepared to introduce yourself with something you learned this past semester or summer). Start your assigned reading — this should become habit!
January 19	Dimensions of functionality Haptic interfaces *NAU is closed on Monday in observance of MLK Day*
January 26	Health research and trends in wearable health monitoring Analysis, comparative testing
February 2	Introduction of the **Research Project** Research methods for studies
February 9	Literature review, finding the gap in knowledge, forming a hypothesis No class on Thursday!
February 16	Statistical learning methods (applied) — regression, logistic regression, over fitting, neural nets
February 23	Statistical learning methods (applied) — support vector machines, decision trees, k-means, k-nearest neighbors
March 2	Device design Sensing
March 9	Spring Break! No class.
March 16	Soldering lab Arduino Part 1 Device design review (everyone shares)

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Who are you?

1. Your name
2. Are you an Undergrad, Grad MS, Grad PhD, or... ?
3. Your Major
4. What might come after said degree?
5. Are you enrolled for credit or auditing?
6. Why are you here?
7. What are your research interests?
8. What is something you learned this past semester or summer?

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