

Παραγωγική Τεχνητή Νοημοσύνη: Generative AI

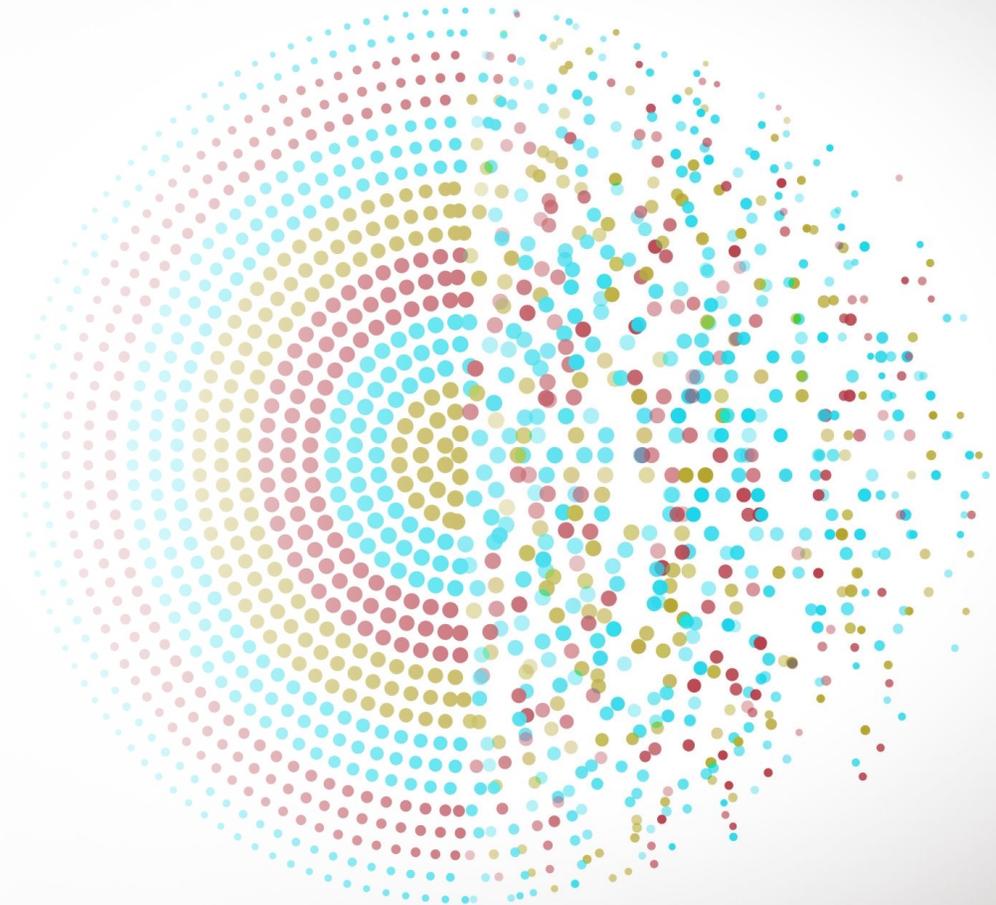
Κωνσταντίνος Καραμανής

The University of Texas at Austin & Archimedes/Athena RC

constantine@utexas.edu

<https://caramanis.github.io/>

Κωνσταντίνος Καραμανής



Search
(αναζήτηση) σε
βάση γνώσεων

Κωνσταντίνος Καραμανής

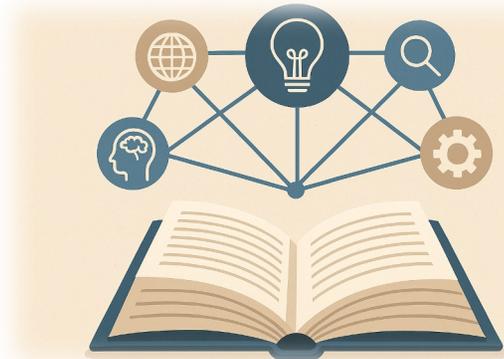




Ας θυμηθούμε τα
προηγούμενα...



Search (αναζήτηση) σε βάση γνώσεων



Επιστημονικά περιοδικά που περιέχουν χιλιάδες δημοσιευμένα άρθρα για παθήσεις του ανοσοποιητικού συστήματος

Ερώτημα χρήστη (query):

«Ποιες είναι οι χρήσεις και πιθανές παρενέργειες του IL-23 inhibitor biologic Skyrizi;»

Η «σωστή» απάντηση;

Recall@K NDCG@K

Search (αναζήτηση) σε βάση γνώσεων

Πώς εκτιμούμε ποια είναι τα
σχετικά άρθρα στη βάση
γνώσεων;

Η «σωστή» απάντηση;

Recall@K NDCG@K



Επιστημονικά περιοδικά που περιέχουν χιλιάδες δημοσιευμένα άρθρα για παθήσεις του ανοσοποιητικού συστήματος

- 
1. Bag of Words
 2. TF-IDF/BM25

3. Semantic Search



Αναζήτηση σε Βάση Γνώσεων

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

Βάση Γνώσεων:



"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

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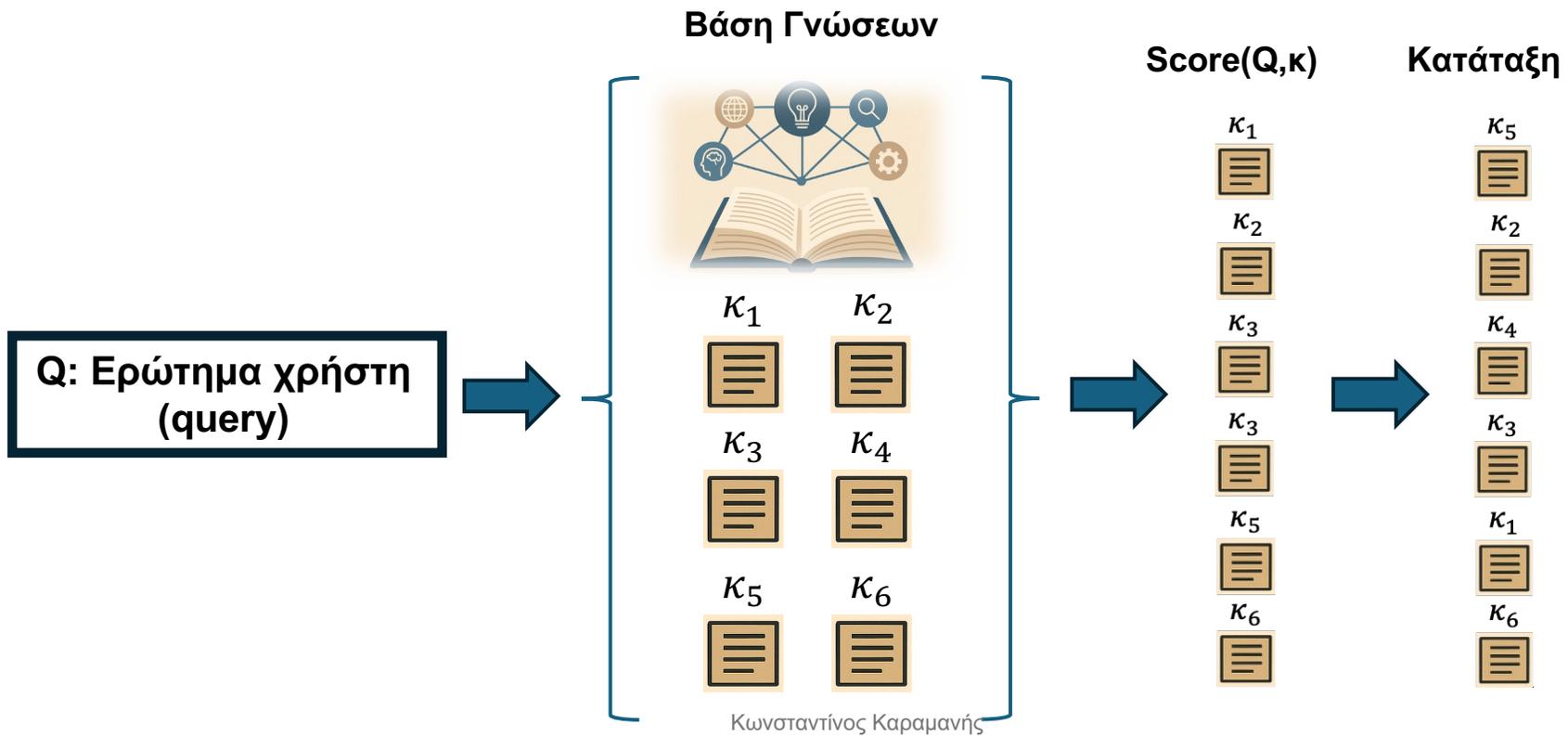
"Call center script: if patients report a new prescription, staff log a possible interaction and route to the pharmacist. The script does not mention cimetidine or any mechanism."



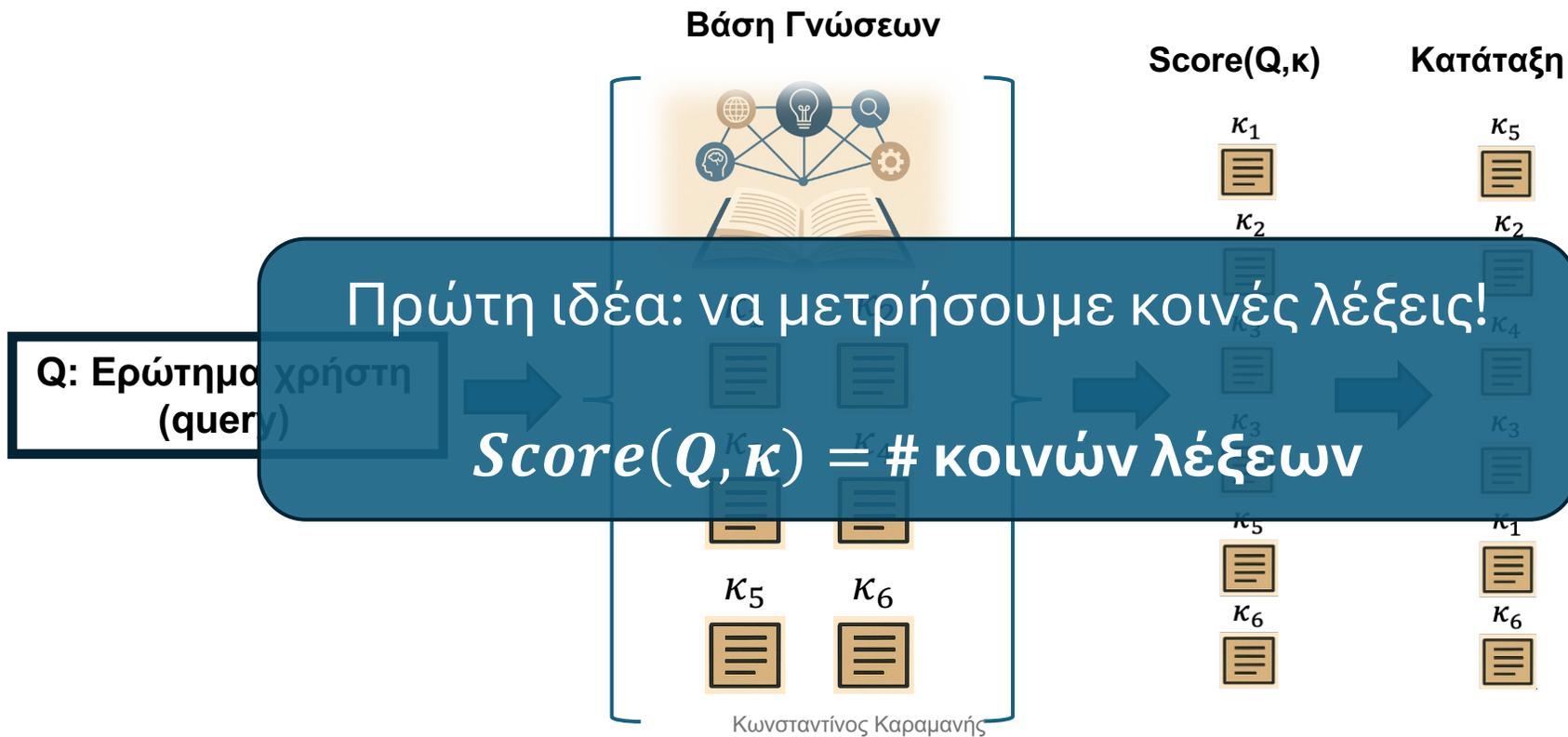
"Pharmacokinetic note: cimetidine increases plasma levels; monitoring recommended when co-administered."

Με ποιο κριτήριο / αλγόριθμο θα μπορούσαμε να επιλέκουμε το 3ο αρχείο στη βάση γνώσεών μας;

Αναζήτηση σε Βάση Γνώσεων



Αναζήτηση σε Βάση Γνώσεων



Bag of Words Search: Πρώτη Ιδέα

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Βάση Γνώσεων:



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"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

$$Score(Q, \kappa) = \# \text{ κοινών λέξεων}$$

Κωνσταντίνος Καράμανης

Bag of Words Search: Πρώτη Ιδέα

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Βάση Γνώσεων:



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"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

Bag of Words Search: Πρώτη Ιδέα

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

1

Βάση Γνώσεων:



"FAQ page: how metformin works, how to take metformin and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."

2



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels, monitoring recommended when co-administered."

3

Bag of Words Search: Πρώτη Ιδέα

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

Βάση Γνώσεων:



"FAQ page: how metformin works, how to take metformin and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels, monitoring recommended when co-administered."

1

2

3

Bag of Words Search: Πρώτη Ιδέα

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

Βάση Γνώσεων:



"FAQ page: how metformin works, how to take metformin and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels, monitoring recommended when co-administered."

1

2

3

Bag of Words Search: Πρώτη Ιδέα

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

Βάση Γνώσεων:



"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment by a pharmacist."



"Call center script: if patients report a possible interaction, a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels, monitoring recommended when co-administered."

Αυτή η απλή μέθοδος φαίνεται να αποτυγχάνει.

Bag of Words Search: Πρώτη Ιδέα

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

Βάση Γνώσεων:



"FAQ page: how
metformin continu
during treatm



"Call center
interaction and fo
does not mention



"Pharmacokinetic
increasing plasma
administered."

Αυ
φαίν

Πώς μπορούμε να
καταλάβουμε ποιες
λέξεις έχουν διακριτική
ικανότητα;

Bag of Words Search: Πρώτη Ιδέα

Ερώτημα χρήστη (query): "I want to learn about cimetidine metformin interaction"

Βάση Γνώσεων:



"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and check for drug-drug interactions. The script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels, monitoring recommended when co-administered."

Ιδέα: οι λέξεις με
μεγαλύτερη διακριτική
ικανότητα είναι πιο σπάνιες

Bag of Words Search: Πρώτη Ιδέα

```
"Review paragraph: metformin lowers hepatic glucose output; the author adds that clinicians consider renal function and interaction flags, especially when treatment includes multiple agents."  
"Pharmacy handout: before refills, ask about interaction questions; it lists common warnings (alcohol, dehydration, contrast dye) and says metformin is usually well tolerated when treatment is stable."  
"Patient story: after starting metformin, the patient improved A1C; the narrative mentions an interaction screening at each visit but is mostly about motivation, meal planning, and staying on treatment."  
"Guideline excerpt: reassess treatment every few months; check labs, reinforce activity, and review interaction lists; metformin remains a baseline drug for many patients."  
"Clinician memo: lactic acidosis is rare; avoid metformin during acute illness; the memo repeats that interaction review is routine but does not describe any mechanism."  
"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."  
"Community brochure: programs support patients with reminders, coaching, and medication literacy; it encourages asking pharmacists about interaction risks when taking metformin and other drugs."  
"Case narrative: missed appointments complicated treatment; the clinician emphasized consistent metformin dosing and repeated interaction checks as new prescriptions were added over time."  
"Imaging note: pause metformin around iodinated contrast; the note frames this as an interaction-adjacent precaution tied to kidney stress and follow-up testing after treatment."  
"Lecture transcript: 'interaction' is a broad pharmacology term; the speaker mentions metformin in passing and stresses that interaction questions should be documented for patient safety."  
"Pharmacokinetic note (the one we want): cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."  
"Abstract: the study compared two treatment groups; it uses the word interaction once and metformin once, but otherwise stays generic about outcomes in patients."  
"Clinic checklist: confirm metformin, confirm allergies, and ask about interaction with any new medication; the checklist is repetitive but not specific about which drug interacts."  
"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."  
"Medication safety guide: always check for metformin interaction before prescribing new drugs; metformin interaction risks must be assessed; patients on metformin need interaction screening; metformin interaction protocols should be followed; never overlook potential metformin interaction."  
"Treatment protocol document: standard procedure involves checking metformin interaction with all concurrent medications; metformin interaction databases should be consulted; any metformin interaction concerns require immediate review; metformin interaction warnings are critical for patient safety."  
"Clinical reminder bulletin: metformin interaction metformin interaction metformin interaction-this bulletin emphasizes metformin interaction monitoring; staff must document every metformin interaction check; patient records must show metformin interaction assessment; all metformin interaction reports require follow-up."  
"Hospital policy manual: section on metformin interaction management; metformin interaction screening is mandatory; metformin interaction documentation requirements; metformin interaction reporting procedures; metformin interaction training modules; comprehensive metformin interaction guidelines."  
"Pharmacy training manual: metformin interaction protocols; metformin interaction safety checks; metformin interaction review process; metformin interaction documentation standards; metformin interaction assessment tools; metformin interaction guidelines for pharmacists."  
"Quality assurance checklist: verify metformin interaction screening completed; confirm metformin interaction documentation present; ensure metformin interaction alerts reviewed; check metformin interaction flags addressed; validate metformin interaction protocols followed."  
"Standard operating procedure: step one check metformin interaction; step two document metformin interaction; step three review metformin interaction; step four report metformin interaction; all metformin interaction steps mandatory."  
toy_query = "I want to learn about cimetidine metformin interaction"
```

arr about cimetidine metformin interaction

about

how metformin works, how to take metformin, and why
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plasma levels; monitoring recommended when co-
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Κωνσταντίνος Καραμανής

Bag of Words Search: Πρώτη Ιδέα

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toy_corpus = [  
"Clinic newsletter: patients with type 2 diabetes were reminded that medication, diet, and exercise work together; the article mentions metformin as a common start and notes that any new drug should prompt an interaction check during treatment review.",  
"Follow-up note: the nurse reviewed side effects and asked about supplements, alcohol, and prescriptions, explaining that interaction screening matters even for familiar medicines like metformin when treatment plans change.",  
"Educational summary: metformin is often first-line; the piece repeats that clinicians monitor kidney function and ask about interaction risks, because dehydration or other drugs can alter metformin safety in routine treatment.",  
"Research digest: a small study of patients on metformin discussed adherence and lifestyle; it briefly mentions interaction concerns but focuses on diet, sleep, and long-term treatment goals.",  
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continues; it in... on checks

metformin

script: if patient... g a possible
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Learn about cimetidine metformin interaction

how metformin works, how to take metformin, and why it continues; it includes a generic line about interaction checks during treatment but no examples.

Interaction

script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism.

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ask about cimetidine metformin interaction

how metformin works, how to take metformin, and why it continues; it includes a generic line about interaction checks

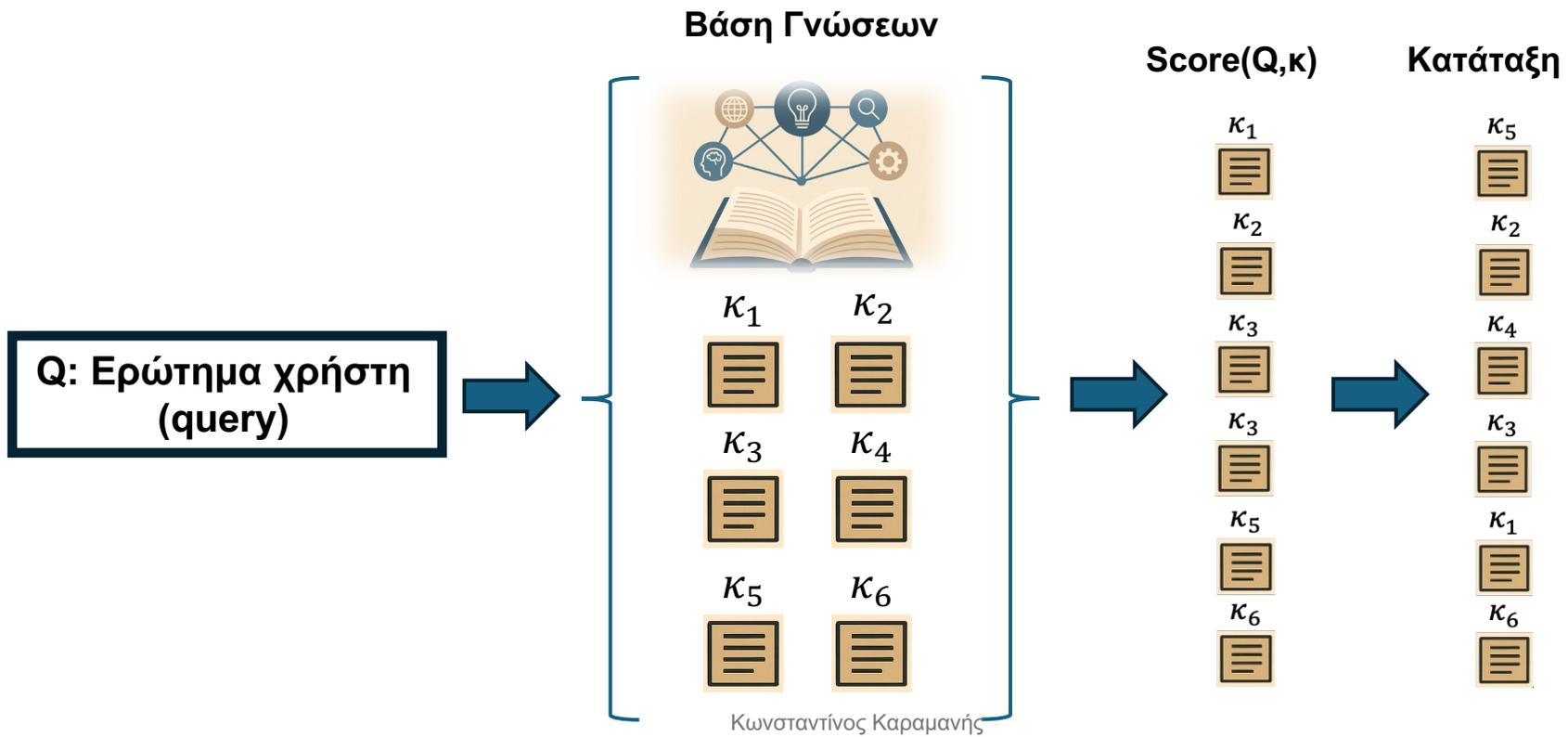
cimetidine

script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism.

Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered.

Κωνσταντίνος Καραμανής

Αναζήτηση σε Βάση Γνώσεων



Αναζήτηση σε Βάση Γνώσεων



Αναζήτηση σε Βάση Γνώσεων

Βάση Γνώσεων

Score(Q,κ)

Κατάταξη

TF-IDF: Term Frequency, Inverse Document Frequency

$$\frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

Q: Ερ



Κωνσταντίνος Καραμανής



TF.IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

"I want to learn about cimetidine metformin interaction"



"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

$$TF - IDF = \frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

TF.IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

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- "FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."
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- "Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

$$TF - IDF = \frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

$$TF = \frac{1}{26} \quad IDF = \log \frac{26}{9} \quad TF.IDF \approx 0.0588$$

Εμφανίζεται σε 9 από 26 κείμενα

Αριθμός λέξεων στο κείμενο

TF.IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

"I want to learn about cimetidine metformin interaction"

- "FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."
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$$TF - IDF = \frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

$$TF = \frac{1}{26} \quad IDF = \log \frac{26}{9} \quad TF.IDF \approx 0.0588$$

$$TF = \frac{1}{26} \quad IDF = \log \frac{26}{25} \quad TF.IDF \approx 0.0022$$

TF.IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

"I want to learn about cimetidine metformin interaction"

"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."

Call center script: If patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."

"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

$$TF - IDF = \frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

$$TF = \frac{1}{26} \quad IDF = \log \frac{26}{9} \quad TF.IDF \approx 0.0588$$

$$TF = \frac{1}{26} \quad IDF = \log \frac{26}{25} \quad TF.IDF \approx 0.0022$$

$$TF = \frac{3}{26} \quad IDF = \log \frac{26}{25} \quad TF.IDF \approx 0.0066$$

$$\text{Total TF - IDF} \approx 0.0676$$

TF.IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

"I want to learn about cimetidine metformin interaction"



"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

$$TF - IDF = \frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

$$TF = \frac{1}{31} \quad IDF = \log \frac{26}{25} \quad TF.IDF \approx 0.0018$$

$$TF = \frac{1}{31} \quad IDF = \log \frac{26}{25} \quad TF.IDF \approx 0.0018$$

$$TF = \frac{1}{31} \quad IDF = \log \frac{26}{2} \quad TF.IDF \approx 0.119$$

$$\text{Total TF - IDF} \approx 0.1226$$

TF.IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

"I want to learn about cimetidine metformin interaction"



"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note **cimetidine** reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."

$$TF - IDF = \frac{\text{Συχνότητα της λέξης στο κείμενο}}{\log(\text{Συχνότητα κειμένων με την λέξη})}$$

$$TF = \frac{1}{14} \quad IDF = \log \frac{26}{2} \quad TF.IDF \approx 0.264$$

$$\text{Total TF - IDF} \approx 0.264$$

TF-IDF: Term frequency, Inverse document frequency

Ερώτημα χρήστη (query):

"I want to learn about cimetidine metformin interaction"



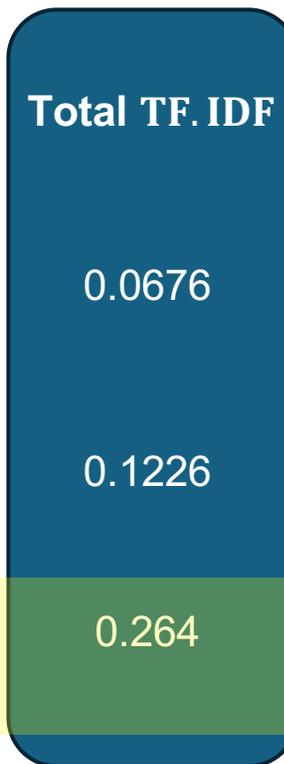
"FAQ page: how metformin works, how to take metformin, and why metformin continues; it includes a generic line about interaction checks during treatment but no examples."



"Call center script: if patients report a new prescription, staff log a possible interaction and route the metformin question to pharmacy, but the script does not mention cimetidine or any mechanism."



"Pharmacokinetic note: cimetidine reduces renal tubular secretion, increasing plasma levels; monitoring recommended when co-administered."



TF-IDF: Term frequency, Inverse document frequency

Ερώτημα

"I want to le
metformin i



"FAQ
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"Pharm
secretion, increasing plasma levels; monitoring
recommended when co-administered."

Όλα όσα έχουμε δει απαιτούν ακριβείς αντιστοιχίσεις όρων.

Η επόμενη ιδέα: αναζήτηση με σημασιολογικές ενσωματώσεις