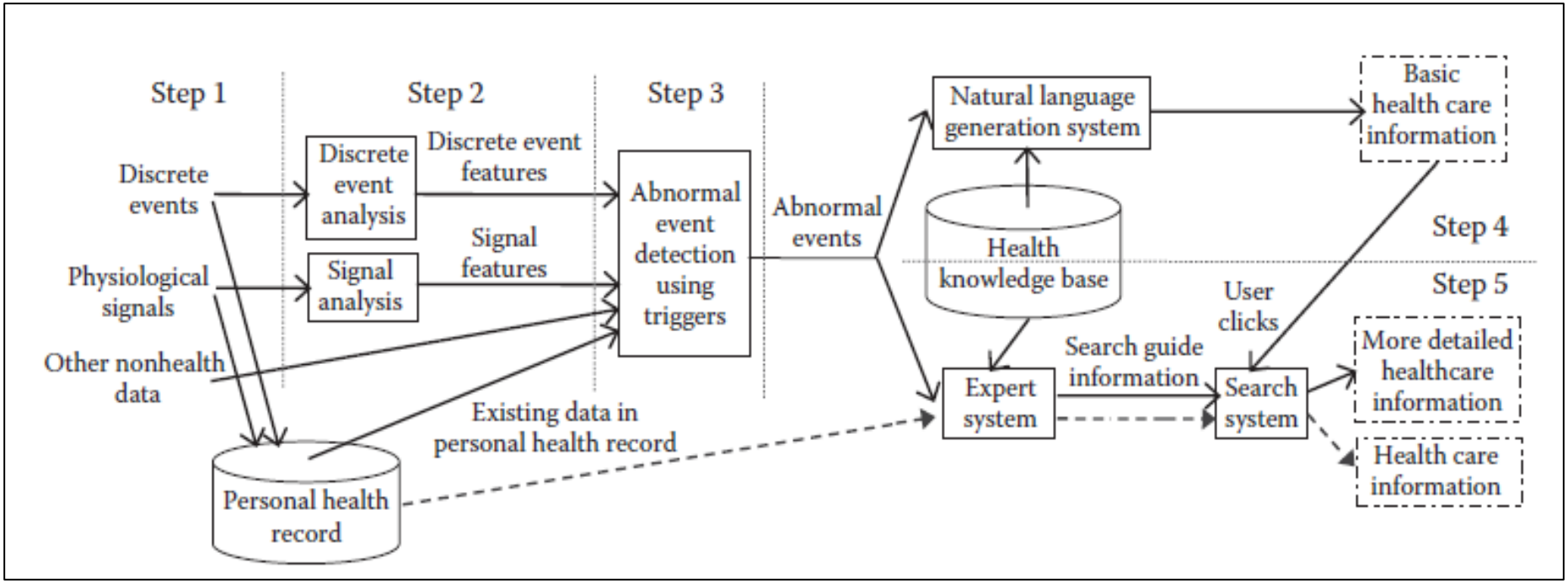
HAIMLC701 AI & ML in Healthcare

5.0		**Intelligent personal Health Record**	**04**
	5.1	Introduction, Guided Search for Disease Information, Recommending SCA's. Recommending HHP's , Continuous User Monitoring.	

Introduction- Intelligent Personal Health Record

- Web-based personal health records (PHRs) widely available through a Web interface but have limited intelligence
- **Gang Luo, Selena B. Thomas, and Chunqiang Tang** proposed the concept of an intelligent PHR (iPHR) using expert system ,Web search, Natural language generation , database trigger and signal processing technology into PHR
  - Provides comprehensive and personalized health care information
  - extensively uses health knowledge to
    - anticipate users' needs,
    - guide users to provide the most important information about their health condition,
    - automatically form queries, and
    - proactively push relevant health care information to users whenever their potential need for it is detected
- "health knowledge" to refer to all categories or types of knowledge related to health care, for example, disease diagnosis knowledge and nursing knowledge

Introduction- Intelligent Personal Health Record



Architecture of the intelligent personal health record system

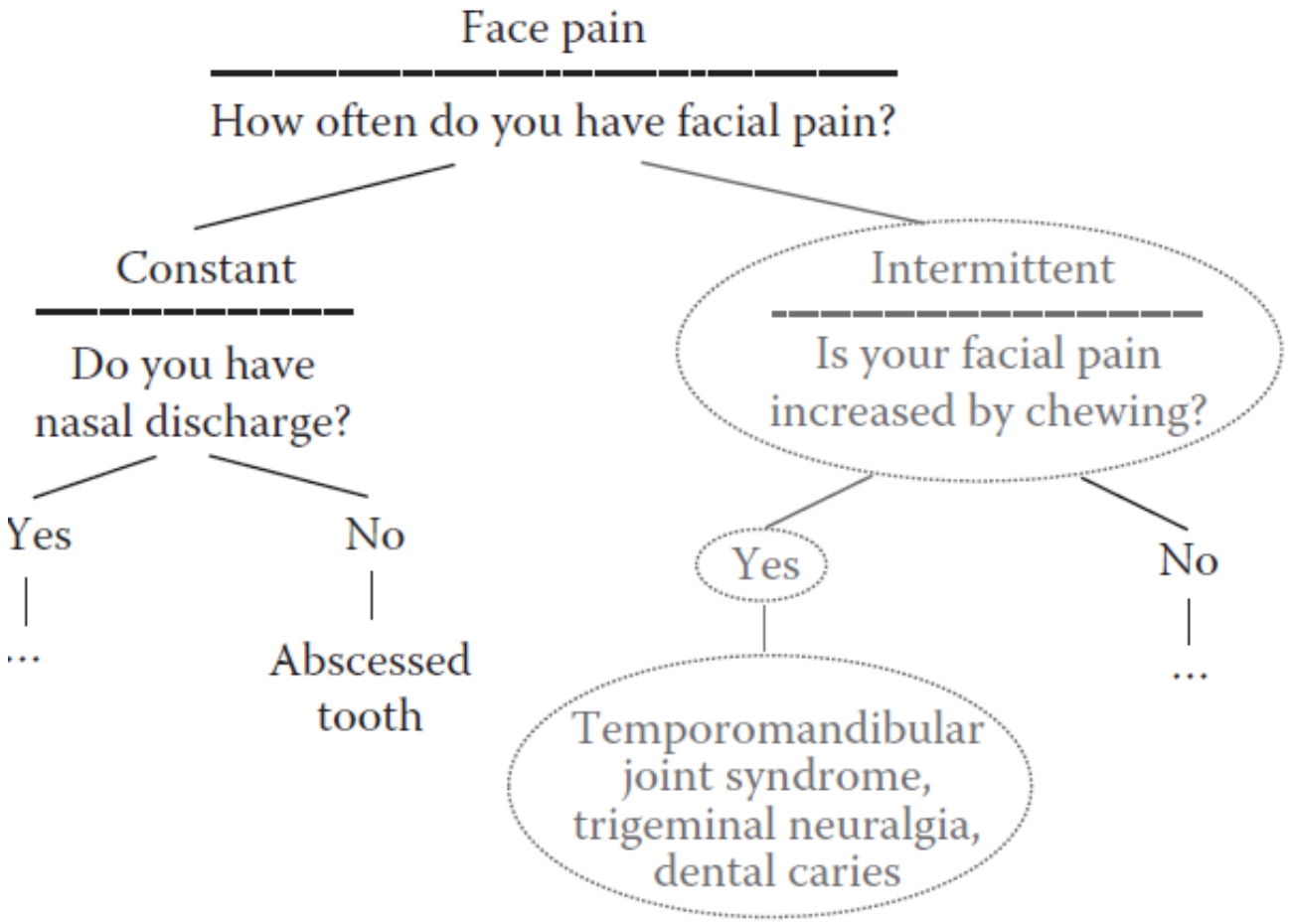
iPHR system

- iPHR system provides four functions covering almost 1000 health issues:
  - Guided search for disease information
  - Recommending self-care activities (SCAs)
  - Recommending home health products (HHPs)
  - Continuous user monitoring

Guided Search for Disease Information

- iPHR has an intelligent medical Web search engine called iMed
  - find disease information related to their health condition
  - use disease diagnosis knowledge and an interactive questionnaire to provide the most important information about their health condition and to automatically form queries
  - eliminates the challenge for users to come up with appropriate medical keyword queries on their own
  - uses diagnostic decision trees written by medical professionals
    - each diagnostic decision tree corresponds to either an objective sign (e.g., low blood pressure) or a subjective symptom (e.g., headache)
    - In a diagnostic decision tree, each node that is neither a leaf node nor the parent of a leaf node represents a question that iMed can ask.
    - Different child nodes of this node correspond to different answers to this question
    - The medical phrases in a leaf node are the topics (typically diseases) potentially relevant to the user's health condition

Guided Search for Disease Information



The diagnostic decision tree for the symptom "face pain."

Guided Search for Disease Information

- The user is first presented with a list of signs and symptoms, from which he/she selects the ones that he/she is currently having
- Then iMed asks questions related to these selected signs and symptoms and lists possible answers to these questions
- Based on the answers selected by the user, iMed navigates the corresponding diagnostic decision trees and eventually reaches multiple topics potentially relevant to the user's health condition
- For each of these topics, iMed automatically uses the topic name to form a query to retrieve some related Web pages
- Moreover, iMed presents a set of predetermined aspects (e.g., symptom, diagnosis, treatment, and risk factor)
- In this way, without the need to form any medical keyword query by himself/herself, the user can find disease information that is potentially related to his/her health condition

Recommending self-care activities (SCAs)

- SCA recommendation function is to use nursing knowledge presented in standardized nursing languages
- The nursing informatics community has systematically organized nursing knowledge into multiple standardized nursing languages
- At present, iPHR's knowledge base includes two such standardized nursing languages covering the entire nursing domain: the North American Nursing Diagnosis Association International (NANDA-I) nursing diagnoses and the Nursing Interventions Classification (NIC) nursing interventions
- A *NANDA-I nursing diagnosis* is a clinical judgment about individual, family, or community responses to actual or potential health problems
- A *NIC nursing intervention* is a treatment that can be performed to enhance patient/client outcomes

Recommending self-care activities (SCAs)

- Every nursing diagnosis usually links to 10 or more NIC nursing interventions
- Each nursing intervention includes multiple *care activities* that are used to implement it
- In this way, each health issue is connected to multiple care activities via the linkage provided by nursing diagnoses and nursing interventions
- Nurses, patients, and/or caregivers can perform these care activities to achieve desirable outcomes for this health issue
- For iPHR, we focus on SCAs that patients and caregivers can perform at home or in the community because iPHR is designed to be used by consumers

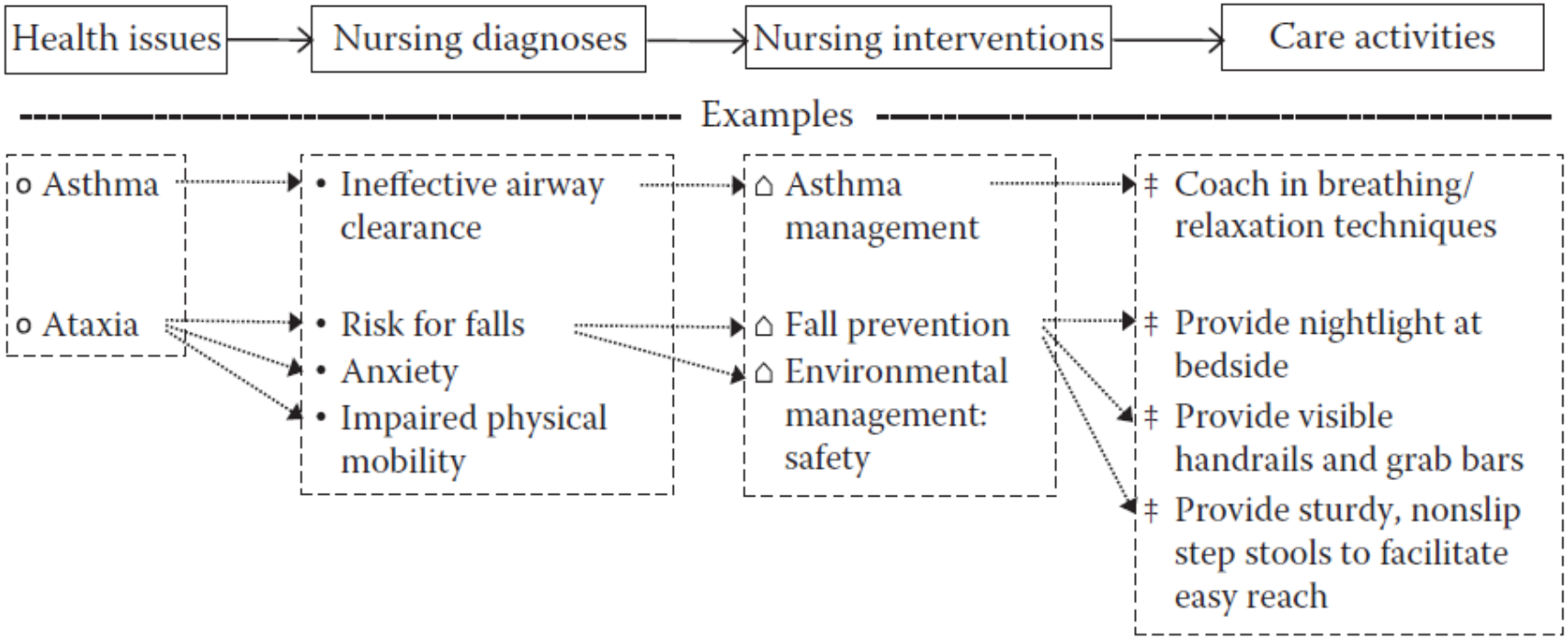
Recommending self-care activities (SCAs)

- iPHR automatically extracts from PHR the user's current health issues (e.g., diseases), uses the linkage method to find all of his/her linked SCAs
- An SCA can have one or more aspects. For each aspect of a nontrivial SCA, a hyperlink is added to the displayed Web page. Also, a precompiled phrase is stored in iPHR's knowledge base as the SCA search guide information of this aspect
- If the user clicks this hyperlink, iPHR will submit this phrase as a query to a large-scale health Web search engine
- Then by reading the search results returned by this search engine, the user can find various, detailed implementation procedures

Recommending self-care activities (SCAs)

- For example, the health issue “asthma” links to the SCA “coach in breathing/relaxation techniques.”
- For the breathing aspect of this SCA, the precompiled phrase “asthma breathing techniques” retrieves the following top results:
  - (1) the Buteyko method for breathing (http://www.correctbreathing.com/),
  - (2) two new breathing exercises for asthma (http://www.sciencedaily.com/releases/2008/05/080528095853.htm),
  - (3) a video teaching the pranayama breathing method for asthma (http://www. youtube.com/watch?v=vplrJtp3zB4), and
  - (4) the book *Reversing Asthma: Breathe Easier with this Revolutionary New Program*, with a chapter on teaching breathing techniques (http://www.amazon.com/Reversing-Asthma-Breathe-Revolutionary-Program/dp/0446673633).

Recommending self-care activities (SCAs)



Linking health issues to care activities.

Recommending self-care activities (SCAs)

- It is not uncommon for a person to have multiple health issues simultaneously (e.g., comorbidities)
- In this case, an SCA that is suitable for a single health issue can become undesirable in the presence of another health issue- called contraindication in health care
- For instance, the health issue cancer is a contraindication for the SCA massage because massage increases lymphatic circulation and hence may potentially facilitate the spread of cancer through the lymphatic system
- In the case where the user has multiple health issues simultaneously, iPHR uses a hierarchical propagation method based on the medical terminology of the International Classification of Diseases (ICD-10) to automatically detect contraindicated SCAs so that they will not be recommended to the user

Recommending home health products (HHPs)

- iPHR automatically recommend HHPs based on the user's health issues
- use both nursing knowledge and treatment knowledge and to extend the language modeling method in information retrieval to combine and rank HHPs retrieved by multiple queries
- iPHR uses both nursing knowledge and treatment knowledge to obtain HHP search guide information
- For each SCA, a set of phrases is precompiled as its HHP search guide information and stored in iPHR's knowledge base
- Each such phrase provides one way of retrieving HHPs related to this SCA. For each health issue (e.g., disease, symptom, surgery), a set of HHP search guide phrases is precompiled using disease/symptom treatment knowledge and stored in iPHR's knowledge base
- These treatment-based HHP search guide phrases can bridge the semantic gap between the literal meaning and the underlying medical meaning of the health issue

Recommending home health products (HHPs)

- iPHR automatically extracts from the PHR the user's current health issues and uses the linkage to find all of his/her linked SCA
- Combining together the HHP search guide information for these SCAs and the treatment-based HHP search guide phrases precompiled for these health issues, we obtain the complete set of search guide information
- iPHR submits each search guide phrase in this set as a query to a vertical search engine to retrieve relevant HHPs
- On each search result Web page, a navigation hierarchy based on product categories is displayed on the left side
- Recommended HHPs are displayed sequentially on the right side

< Medical supplies and equipment
  < Daily living aids
    * Bath and body aids (797)
    * Low vision aids (633)
    * Medication aids (178)
    * Ramps (157)
    * Low strength aids (137)
    * Eating and drinking aids (77)
    * Dressing aids (42)
    * Hearing aids (28)
    * Telephones (27)
    * Hearing aid accessories (12)
    * Others (46)

A sample navigation hierarchy constructed for the health issue ataxia.

Continuous User Monitoring

- iPHR can perform continuous user monitoring and proactively push personalized, relevant health care information to users whenever their potential need for it is detected
- The main idea of this continuous user monitoring function is to combine techniques from multiple computing areas, including expert systems, Web search, natural language generation, database triggers, and signal processing, to make iPHR active
- More specifically, triggers are precompiled by health care professionals and stored in iPHR's knowledge base
- The concept of triggers was originally developed in the database field [24] and is extended here to fit the purpose of our specific iPHR application. Each trigger corresponds to a unique abnormal event that may have a potential health impact
- Based on the user's health condition, iPHR automatically determines which triggers will be used. iPHR keeps collecting, processing, and analyzing the user's health data from various sources

Continuous User Monitoring

- Whenever a trigger fires, signaling the occurrence of an abnormal event, iPHR recognizes that the user needs to be aware of the related, personalized health care information and automatically pushes this information to the user
- At trigger compilation time, for each abnormal event, health care professionals use their health knowledge to perform the following four actions:
  - Compile the corresponding trigger
  - Compile a template of basic health care information related to this abnormal event
  - For the content included in this template, mark one or more items that they anticipate some iPHR users would want to know more about
  - For each such marked item, compile a set of phrases that can be used to retrieve its detailed information as its search guide information

Continuous User Monitoring

Significant weight loss is detected, as you have lost >5% of your weight in the past month. This is particularly problematic as you also have COPD.

COPD patients often experience weight loss, which is associated with increased risks of mortality, disability, and handicap.

COPD patients experiencing weight loss may need nutritional therapy. (Click here to view related food and nutritional supplements.) Since weight loss in COPD patients is often accompanied by muscle wasting, nutritional therapy may only be effective if it is combined with anabolic stimuli such as exercise.

URE 24.5
example of basic personalized health care information provided by iPHR.