

Information Systems and the Knowledge Engineering Project

John H. Holmes, PhD, FACMI

Center for Clinical Epidemiology and Biostatistics
University of Pennsylvania School of Medicine



The Information Spectrum



Data

Information

Knowledge

Wisdom

The Information Spectrum: Data



Data

Information

Knowledge

Wisdom

**Symbols used to represent events
and their state, organized according to
formal rules and conventions**

The Information Spectrum: Information



Data

Information

Knowledge

Wisdom

**The cognitive state of awareness
(as being informed) given a representation
in physical form (data).**

The Information Spectrum: Knowledge



Data

Information

Knowledge

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The cognitive state beyond awareness that implies an active involvement and understanding and the ability to extend the level of understanding to meet life's contingencies

The Information Spectrum: Wisdom



Data

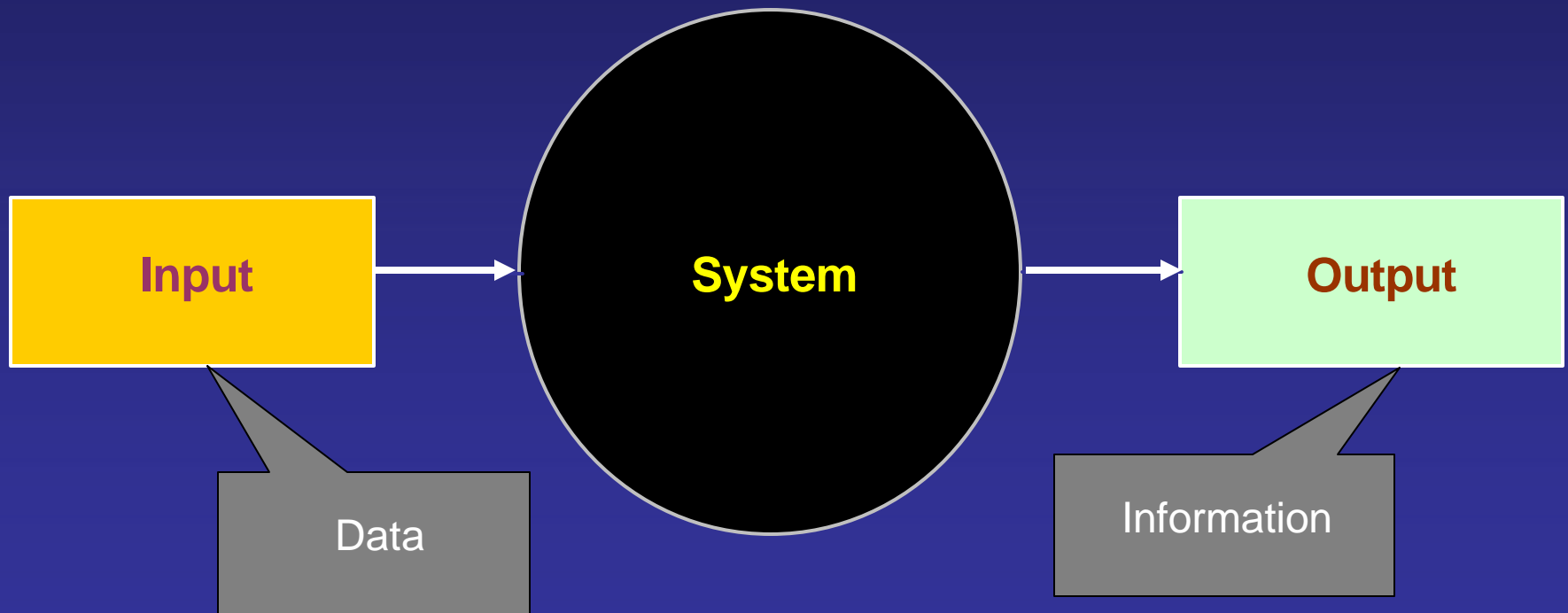
Information

Knowledge

Wisdom

Implies the application of knowledge as contained in human judgment centered around certain criteria or values that are generally accepted by a culture or a society

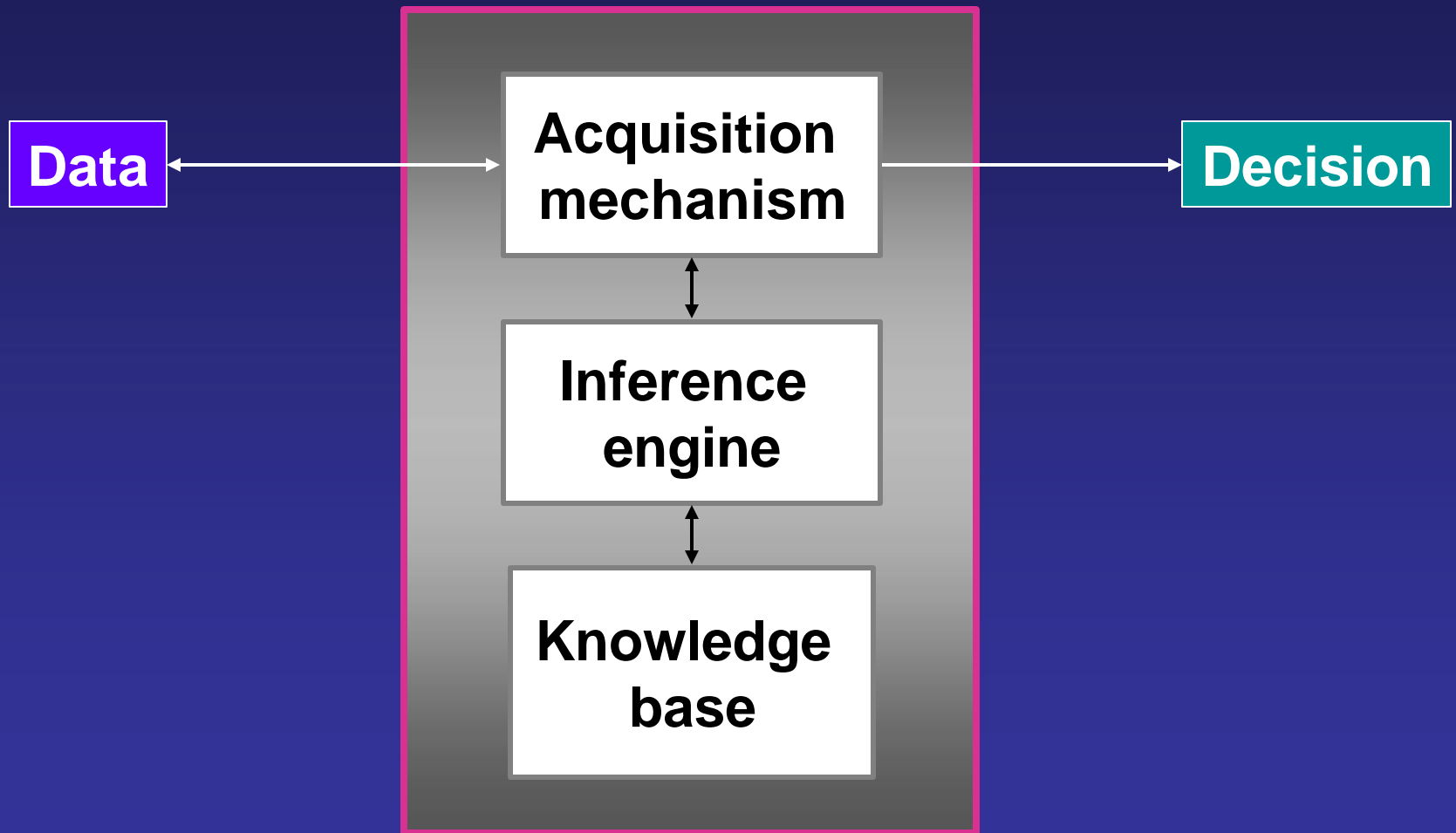
A Systems Approach to Information



So what about *knowledge systems*?

- Purpose
 - To provide support for decisions based on information
- Three components
 - Knowledge base
 - Acquisition mechanism
 - Inference engine

A simple knowledge-based system



Where does all this knowledge come from?

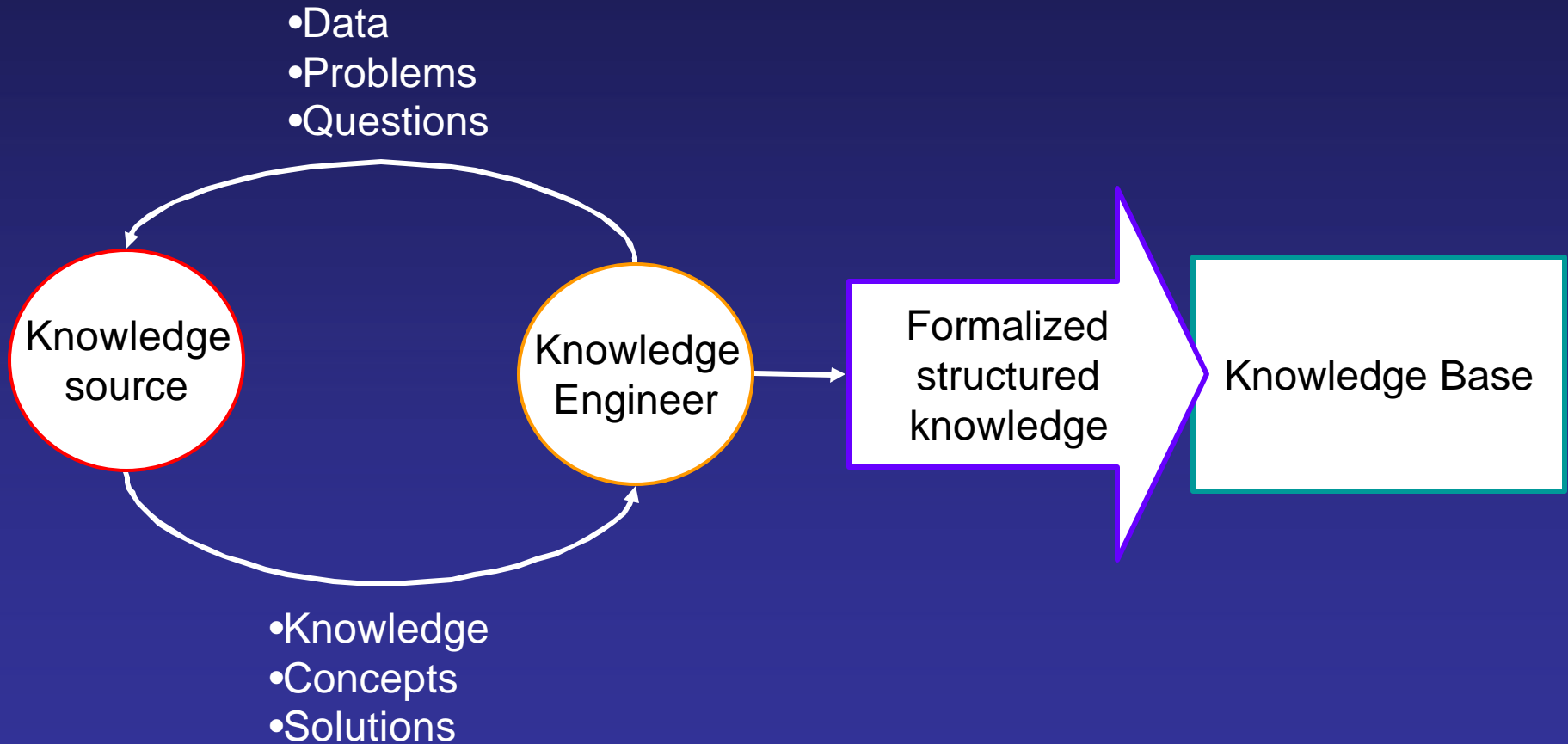
- Experts
- Evidence
- Continuous interaction between users and knowledge-based systems

And how do we get this knowledge?

Knowledge Engineering

- Knowledge acquisition
 - Large-scale task of eliciting, representing, coding, testing, and validating knowledge
- Knowledge elicitation
 - The component of knowledge acquisition where knowledge is collected from human sources

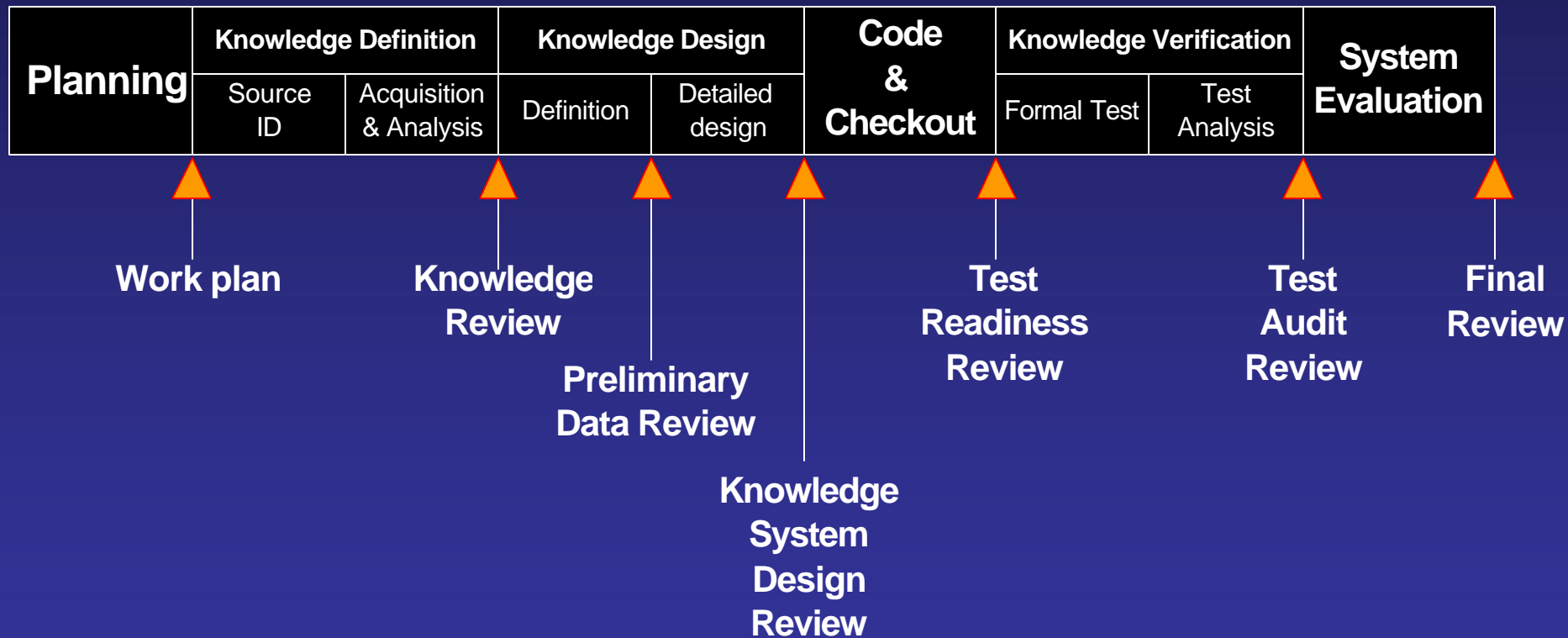
Knowledge engineering in a nutshell



The knowledge engineering paradox

- The more competent domain experts become, the less able they are to describe the knowledge they use to solve problems
 - Experts tend to state conclusions and reasoning in broad terms
 - Experts make complex judgements rapidly
 - Experts cannot easily articulate steps to problem definition and solution
 - Experts rely on “intuition” or hunches

A Knowledge-Based System Development Life Cycle



Some methods for knowledge acquisition

- On-site observation
- Problem discussion
- Prototypical problem description
- Problem analysis using protocols
- Knowledge refinement using the system
- System examination
- System validation

The Knowledge Engineering Project Goals

- Define opportunities for improved clinical decision support and data visualization
- Develop a knowledge-based system with a user-centered design
 - Focus on usability testing within the non-linear workflow of clinicians in a complex clinical setting
- *Verify* the system
 - Ensure accurate knowledge representation
- *Validate* the system
 - Ensure that the system performs its intended tasks

Objectives

1. Perform a needs assessment and knowledge acquisition project to identify aspects of critical care best suited to CDS by prioritizing processes and transactions for the highest potential of reducing cognitive load
2. Identify phenotypic data universal to critical care and integral to the support of CDS and incorporate phenotypic data entry into a clinician-centric user interface
3. Develop the user interface to accept integrated data from the ICE data aggregator environment and incorporate the VISAGE query tool

Long-term objectives

1. Integrate CDS systems within the data visualization system to measure usability, usefulness, and sensitivity and specificity of triggers within a simulated clinical environment
2. Measure consistency of interface usability across implementation sites
3. Experiment with translating complex analysis and clinical modeling tools into the interface in a simulated environment
4. Incrementally integrate those that provide meaningful situational awareness while also providing significant cognitive support to the clinician within the workflow of the ICU

Methods

Mixed-methods, triangulation approach to derive and verify candidate rules for CDS systems

- ***Needs Assessment***
 - Ethnographic observations in ICUs to map data transactions that make up distributed workflow.
- ***Knowledge Acquisition***
 - Machine learning methods to discover knowledge in clinical data, including the application of decision tree induction and rule discovery algorithms that derive candidate rules for CDS
- ***Verification of candidate rule set***
 - Expert panel review of candidate rules derived from machine learning and ethnographic observations.
 - Cognitive burden
 - Quantity of data
 - Potential to positively affect patient care process
 - Pertinence to accepted evidence-based guidelines
- ***Dictionary of Data Elements for Inpatient and Critical Care Systems***
 - Determination of universally available and easily collected phenotypic data for clinical decision support

Significance

- Prior work on data visualization has focused on helping providers trend data of similar types (labs, vital signs, medications)
 - The needs of critical care require more than just recognizing trends
- The recognition of simultaneous trends in heterogeneous data sources prompts need for in-depth search through complex data
- The innovation of the project is to help providers observe possible associations among a diverse set of clinical actions and events