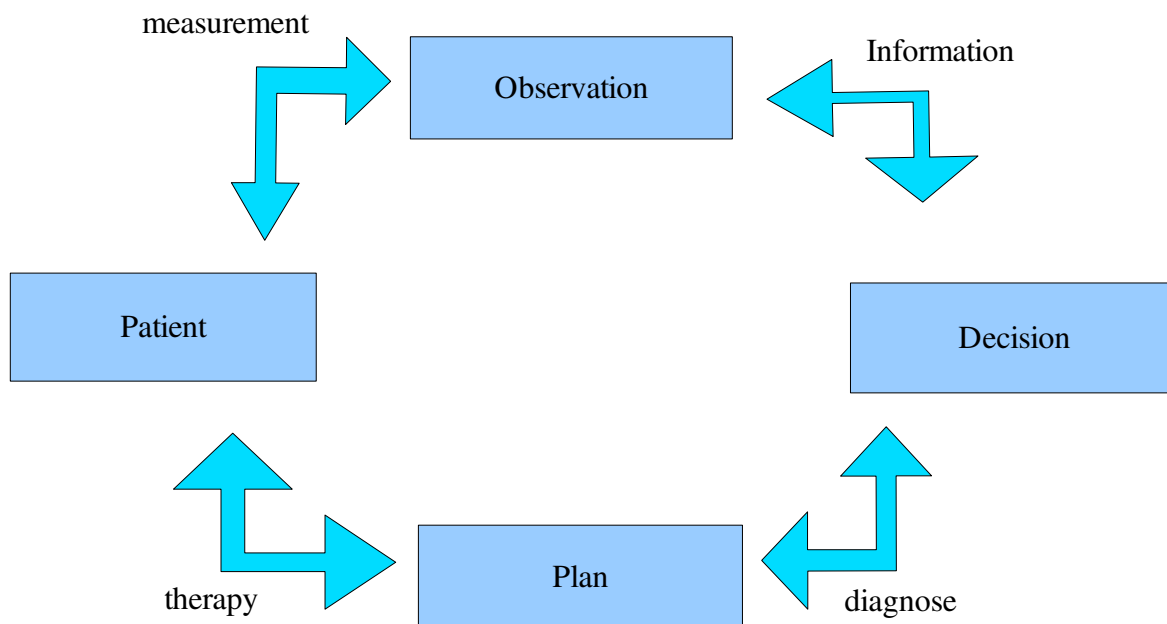


# Computerunterstützte Diagnoseverfahren und Therapieplanung – Zusammenfassung

## ***Diagnostic Therapeutic Cycle:***



## ***Guideline vs. Protocol:***

Protocol reflects local circumstances and are very specific. = local definition of a specific care process (i.e. Guideline).

## ***Clinical Pathways (integrated Care Pathways):***

plans supporting the implementation of guidelines and protocols.

## ***Care Plans:***

provides roadmap for all (i.e. Guidelines and protocols for nurses, etc.)

## ***Evidence-Based Guideline:***

Developed are systematic retrieval and appraisal of research data. If it is EXPLICIT, it also projects the harm, costs, utilization, benefits in various contexts (social, ethical, financial, etc.). Moreover, Evidence-Based Medicine integrates individual clinical expertise with the best available external clinical evidence from systematic research ( e.g. a guideline, protocol, etc.).

**Guideline (best practice) ↔ Standard (implementation strategy) ↔ Protocol (local)!!!**

**Guideline Properties:**

- Validität
- Reliabilität
- Reproduzierbarkeit
- Repräsentativität (alle relevanten Disziplinen)
- Anwendbarkeit (Zielgruppe ist definiert)
- Flexibilität (Definition von Ausnahmen, Einbeziehen des Patienten)
- Klarheit (präzise, formatiert?)
- Dokumentation (Quellen, Methoden, Annahmen, Mitarbeiter,...)
- Überprüfbarkeit (planmäßig und Anwendbarkeitsprüfung[Akzeptanz])
- Rentabilität

**Computerized Guideline Tasks:**

- Decision making
- Action sequencing
- Setting Goals (specific patient state)
- Data interpretation
- action refinement (divide and conquer)

**Guideline Modelling:**

- Rule-Based (Help, Arden/MLM)
- Augmented Decision Analysis (Logic & Decision Tables)
- Multi-Steps Guidelines (hierarchical → Task-Based Paradigm, procedural&declarative, e.g. Asbru, DILEMMA, EON, GLIF, Prology, PROforma)

**Diagnostic System:**

Is a DSS designed to integrate medical knowledge base, patient data, and an inference model.

**Planning (Sequence of ordered actions):**

Progression Planner: from *initial state* to *goal*

Regression Planner: from *goal* to *initial state*

Planning Strategies:

- linear

- non-linear
- progression
- regression
- hierarchical
- reactive
- mixed-initiative

#### Plan Management:

- Definition
- Tasks
- Applications/Examples

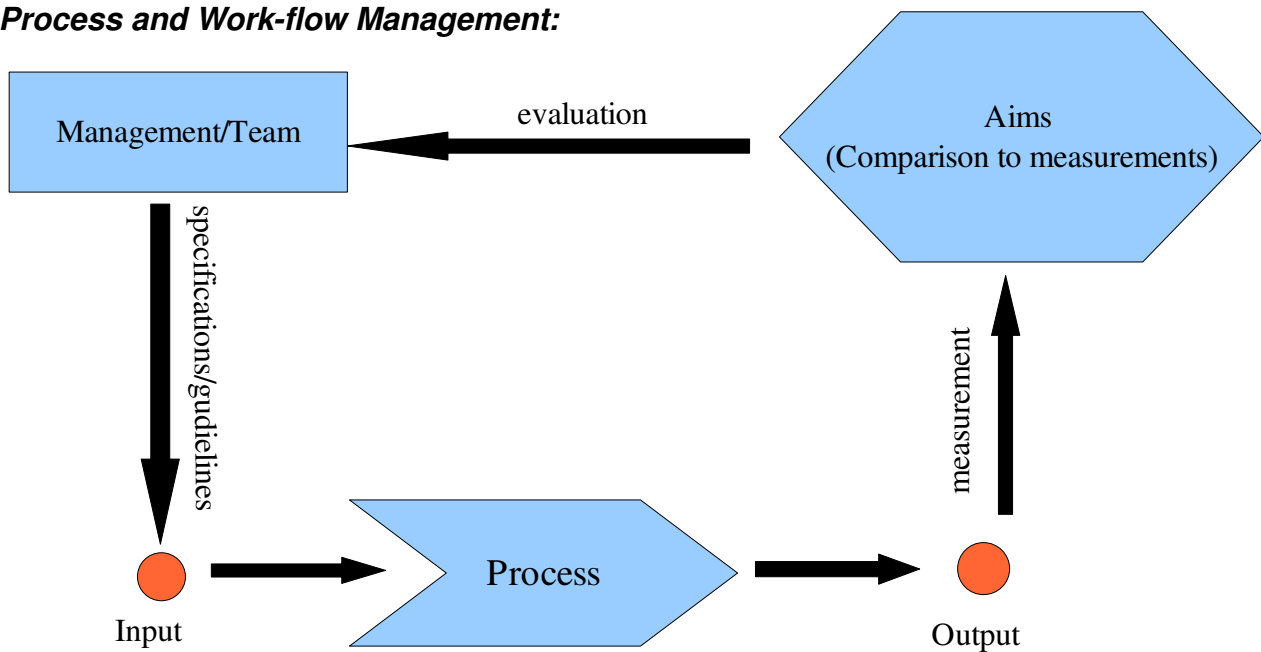
At Design Time	At Execution Time
<ul style="list-style-type: none"> <li>● Plan generation</li> <li>● advanced plan-editing</li> <li>● plan verification</li> <li>● plan validation</li> <li>● plan visualization</li> <li>● plan-scenario testing</li> </ul>	<ul style="list-style-type: none"> <li>● Plan selection</li> <li>● Plan instantiation</li> <li>● Data abstraction</li> <li>● Monitoring</li> <li>● Plan execution</li> <li>● Execution visualisation</li> <li>● Critiquing/Evaluation</li> <li>● Plan Rational/History</li> </ul>

#### Plan representation:

- Huge volume of data (large domain knowledge)
- pre- and post-conditions
- Goal (might be unachievable)
- sequential, parallel or cyclic
- durative
- granularity (multiple time lines)
- suspendable
- interleaving (verschachtelbar)
- Free Text, Flow charts, Time-Orientated skeletal plans → reuse in different context – automated reactive planning)

Planning	VS	Scheduling (e.g. Auto-reminder)
<ul style="list-style-type: none"> <li>● action selection</li> <li>● action ordering</li> </ul>		<ul style="list-style-type: none"> <li>● resource assignment</li> <li>● timing</li> <li>● OR method (operation research: e.g. Charts, etc.)</li> </ul>

### ***Process and Work-flow Management:***



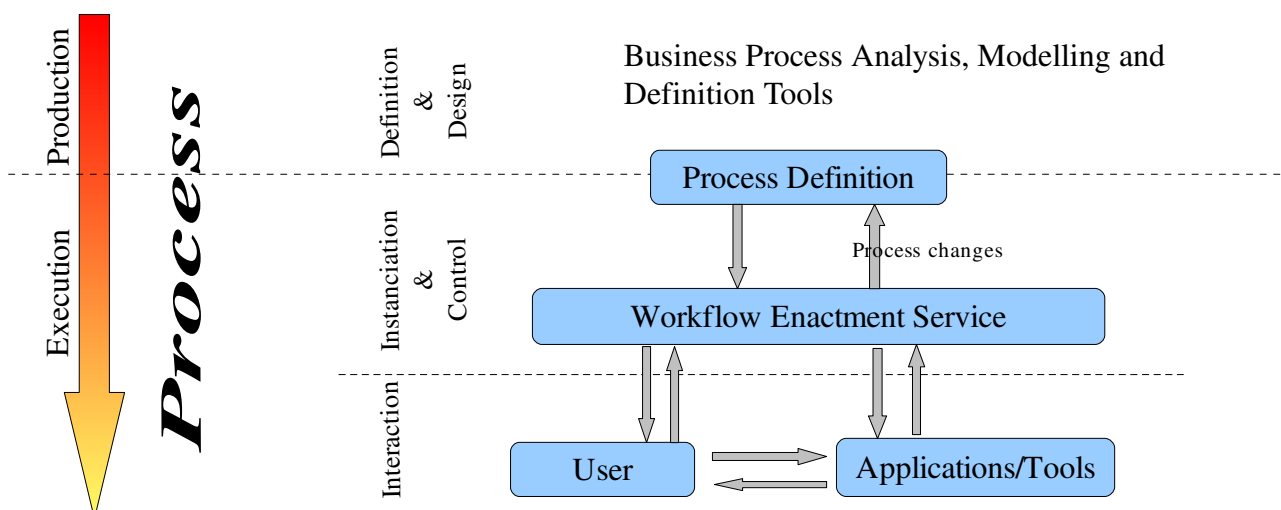
→ Prozessbeschreibung zu ablauffähige (work-flow) Beschreibung machen

Workflow (Spezifizierung und Ausführung von koordinierten Aktivitäten):

- Process
- ausführende Personen
- zu bearbeitende Daten
- benutzte Anwendungen im Process

Workflow-(Management)-System (CSCW-Groupware-System zur Unterstützung bei einem Geschäftsprozess):

- Einrichtung/Steuerung/Kontrolle(Verfolgung)
- einheitliche Benutzeroberfläche
- vollständige Integration in bestehendes System



# Medical Diagnosis Systems (suggests likely Diagnosis after user input)

## ***Diagnostic Process (Risk estimation; Which Tests/Actions/Questions/Complementary Questions?) :***

- initial judgement (is patient ill?)
- development of intuitive (implicit) belief of the likelihood of disease → refinement: (explicit) estimation of prior (or pretest) probability
- gathering more information (e.g. many tests → quality depends on test's ability to reduce uncertainty)
- conclude posterior (or post-test) probability (should increase!)
- leads to Diagnosis(dia=“durch“; gnosi=“erkennen“ - vgl. Gnosiker)

## ***Clinical Decision Support System (DSS):***

- synthesizes/integrates patient information
- performs complex evaluations
- presents results in timely fashion

*and is*

- Administrative (Supports coding/documentation/authorization/referrals)
- Managing clinical complexity and details (trials, tracking order, referrals follow-up, preventive care)
- Cost Controlling (Avoid unnecessary tests, etc.)
- Decision Supporting (in plan processes, in best-practice guidelines and in population-based management)

*and has*

- passive VS active role: user has to request VS by-product of monitoring/data-management
- consultation model VS Critiquing model: DSS advises & asks questions VS expressing (dis)agreement & suggests alternatives
- decision making process is bayesian, analysis, ANNs or knowledge-based
- human interaction in a way, that it is integrated in the existing system and that the user can predict the outcomes/consequences of the when taking their actions (undo...!?)

## **Examples of CDSS:**

- MYCIN: Modifiable Rule-Based Expert System for infectious disease with knowledge presented as production rules (Relates conditional statements to observations → inference → explanation)
- ISABEL: Electronic-Medical-Record (EMR) interfaced, web-based diagnosis reminder and knowledge mobilising system that has a underlying knowledge base, an inference engine and a search methodology (NLP, Proprietary DB, Extraction from EMR, ...)

# Workflow (in Context of Guidelines/Protocols)

## ***Evidence-Based Medicine (EMB):***

- Formulate accurate clinical questions (**P**erson-**I**ntervention-**C**omparison-**O**utcome)
- research on best evidence in literature
- Critically evaluate found evidence → Quality of study type: Meta Analysis & Systematic reviews of (among others) Clinical Practice Guidelines with
  - Level of Evidence: Evidence Grading Schemas!
  - Strength of Recommendations: Strongly recommended/Recommended/Weakly recommended/Not recommended
  - Benefits/Harms: ClearBenefit/Benefit/Unclear Balance/No clear Benefit)
- Is valid evidence adaptable to current clinical situation?

## ***Guideline Development (no longer consensus-based but evidence-based and multidisciplinary!):***

- Select guideline topics:
  - Sources of morbidity/mortality
  - Burden of disease
  - Health care costs
  - Gap between research and practice
  - New developments
  - Dilemmas in treatment or diagnosis
- Install multidisciplinary guideline development group:
  - chairman (authority, mediator, team leader)
  - group (all disciplines, patients, open-minded)
- Design phase:
  - Problem Analysis (key questions, major issues of daily practice → experts)
  - Literature search/selection (inclusion/exclusion criteria, search all repositories)
  - Quality assessment of literature (study design, evidence grading Schemas, adaptability to health care system)
  - summary statements of evidence (formatted, clear, standardized) and considerations (explicit? → organisational issues, costs, etc.) and recommendations (best-evidence!)
  - Discussion → draft version of guideline
- Comment phase:
  - feedback of medical scientific associations and national open meetings
  - Authorization phase (scientific societies approve guideline)
- Dissemination phase:

- Distribution of final guideline (publication)
- Implementation tools
- Living guideline (Maintenance on continuous/periodic basis) – e.g. Aids, ...

### ***Quality Appraisal Instruments:***

- Agree (Appraisal of Guideline Research&Evaluation): 6 Dimensions, Overall Assessment, User Guide
- Glia (Guideline Implementability Appraisal): imperative/conditional recommendations?, 1 Dimension of whole guideline document plus 9 Dimensions, Responses: Y/N/?/NA

### ***Clinical Indicators (internal and external):***

- Structure Indicators (organisational)
- Process Indicators (actions, howtos, etc.)
- Outcome Indicators

## **Medical Terminology Systems (standardized computerized global “language for health” → collection, retrieval & reuse)**

### ***Medical Record Abstraction:***

- Abstraction = make an abstract of medical information (Coding), according to granularity
- International Statistical Classification (ICD) (of Disease and Related Health Problems)
  - ICD-9:
    - ~7000 3-digit codes
    - 4<sup>th</sup> digit for additional level of detail
    - ICD-9-CM (Clinical Modifications)
      - more morbidity information
      - procedure code section
      - 5<sup>th</sup> digit
      - strict hierarchy (every concept only once)
  - ICD-10 (since 1992):
    - ~12500 codes
    - Alphanumeric categorisation
    - Country extensions (e.g. ICD-10-CA for Canada)
- Current Procedural Terminology (CPT)
  - Nomenclature used to report medical procedures of physicians
  - used for billing in US

- 3 categories
- Medical Subject Headings (MeSH)
  - indexing/cataloging/searching of biomedical information
  - MeSH2008
    - ~25000 subject headings
    - >170000 supplementary concept records
    - ~100000 entry terms
  - poly-hierarchical tree structure
  - cross-references (e.g. synonyms, etc.)

***Multi-Purpose Coding System (basis of EP(atient)R~=EMS):***

- Systematic Nomenclature of Medicine (SNOMED)
  - SNOMED - CT (Clinical Terms)
    - Patient history (Illnesses, Treatments, Outcomes)
  - SNOMED – RT (Reference Terminology) → Newer!
    - >340000 relationships
    - completely machine readable
    - now a semantic network
  - has >50 attributes to model concepts
  - uses Description logic (DL) for knowledge representation
- Logical Observation Identifiers, Names and Codes (LOINC)
  - identifies laboratory test results and other clinical observations
  - compatible with HL7
- General Architecture for Languages, Encyclopedias and Nomenclatures in Medicine (GALEN)
  - Reference Model for representation of medical concepts
  - using GRAIL modelling language to represent and integrate GALENs
  - high level ontology
  - Extensible
  - Composite Concepts
- Unified Medical Language System (UMLS)
  - Mapping structure between national and international vocabulary/classifications (>100 vocabularies – statistical classifications, thesauri, clinical coding systems [e.g. SNOMED], etc...)
  - is a Metathesaurus
  - is a Semantic Network
  - is SPECIALIST lexicon:



- (NLP Mapping)
- text tools
- meta-mapping: mapping from concepts to natural language
- 5-to-1 relation between concept names and concept itself

## **Guideline Implementation/Adaption**

- Practice Guideline Evaluation and Adaption Cycle (PEAC)
- Guideline Adaption proposed by ADAPTE group

### ***Guideline Modelling***

- Making decisions
- Sequencing actions
- Setting goals
- Interpreting data
- Refining actions

### ***Computer-Interpretable Guideline Formalisms***

- Rule-Based (e.g. Help, Arden)
- Augmented Decision Analysis (Decision tables & logic inference)
- Multi-step guidelines (e.g. Asbru, Guideline Interchange Format[GLIF], Dilemma, ...)

### ***Medical Logic Modules (MLMs) → e.g. Arden***

- Linked to other knowledge sources (URLs, articles, etc.)
- logical rules (if-then rules → conditions & actions)
- Examples
  - Arden:
    - NO uncertain knowledge representation (FUZZY)
    - NO Object Orientation
    - NO Parallel Processing
  - Asbru
    - hierarchical decomposition of plans
    - temporal annotations
    - uncertainty
    - Different Knowledge Roles (Intentions, Conditions, Effects, Plan Layouts, ...)
    - Plan State Transitions (activated, suspended, aborted, completed)
    - sequential and parallel plans (Synchronization)
    - Subplans and repetitive plans

- XML-Based language
- Task = Procedural Plan Hierarchy
- LASSIE (ModeLing TreAtment ProceSSes using Information Extraction)