

A patient record at a medical office or clinic is a list of a patient's demographic characteristics, medical history, including symptoms, diagnoses, treatments, drugs administered and health outcomes. In practice such records can be quite complicated, but for purposes of explaining the INDSTAR algorithm, we present a highly simplified model.

**Table 1: Symptoms, Diagnoses, Treatments and Outcomes of Silly Diseases**

HEADACHE TIRED DISORIENTED FORGETFUL DIZZINES BRAIN TUMOR MALE THIRTIES SURGERY DEATH	STOMACH ACHE FOOD POISONING TUMS FULL RECOVERY	STOMACH ACHE FEVER COUGH FLU ASPIRIN FRUIT JUICE FULL RECOVERY
HEADACHE IBUPROFIN FULL RECOVERY	PAINFUL JOINTS ARTHRITIS ASPIRIN PAIN RELIEF	PAINFUL JOINTS ASPIRIN REPETITIVE STRESS INJURY SURGERY REST PARTIAL RECOVERY
COUGH FEVER COLD ASPIRIN FRUIT JUICE COMPLETE RECOVERY	COUGH BLOOD IN SPUTUM TUBERCULOSIS PENICILIN BED REST CONFINEMENT EVENTUAL RECOVERY	NERVOUS DISORIENTED DEPRESSED SUICIDAL SCHIZOPHRENIA DRUGS PARTIAL CONTROL
NERVOUS DISORIENTED DEPRESSED SUICIDAL SCHIZOPHRENIA PSYCHOTHERAPY NO IMPROVEMENT	SEVERE CHEST PAINS UNCONSCIOUSNESS NO TREATMENT DEATH	SEVERE CHEST PAINS UNCONSCIOUSNESS ASPIRIN NITROGLYCERINE RECOVERY

Table 1 lists 12 encounters with patients, listing their symptoms, diagnosis, treatment and outcome. INDSTAR reads these lists, and learns the pattern of

relationships among these elements. After the data have been read once, INDSTAR can be queried.

#### A Simplified Example:

Here a patient presents the symptoms *nervous*, *depressed*, *suicidal* to the doctor, who suggests psychotherapy...

Enter as many items as you want, Doctor. -1 when done)  
nervous  
depressed  
suicidal  
psychotherapy

Indstar, which has learned the relationships among all symptoms, diagnoses, demographics, treatment options and outcomes, suggests further symptoms to look for along with alternative treatments and most likely outcomes:

And the winners are...

Activation

DISORIENTED	0.0175
NERVOUS	1.0000
DEPRESSED	1.0000
SUICIDAL	1.0000
SCHIZOPHRENIA	0.0175
DRUGS	0.0076
PARTIAL CONTROL	0.0076
PSYCHOTHERAPY	1.0000
NO IMPROVEMENT	0.0100

INDSTAR suggests another symptom the might occur (disoriented), along with another suggested treatment (drugs), and, finally, a guess about the outcome: both *no improvement* and *partial control* are suggested as possible outcomes, but the activation for *no improvement* is higher (.01) than the possibility of *partial control* (.0076). While these numbers do not represent actual probabilities, they do indicate that *no improvement* is the more likely outcome.

#### Another Example:

In this example, the doctor once more enters the patient's symptoms, but adopts INDSTAR's suggestion of drugs as a treatment:

Enter as many items as you want, Doctor. -1 when done)  
nervous

depressed  
suicidal  
drugs

And the winners are...

Activation

DISORIENTED	0.0175
NERVOUS	1.0000
DEPRESSED	1.0000
SUICIDAL	1.0000
SCHIZOPHRENIA	0.0175
DRUGS	1.0000
PARTIAL CONTROL	0.0101
PSYCHOTHERAPY	0.0075
NO IMPROVEMENT	0.0075

Now INDSTAR indicates that *partial control* (.0101) is more likely than *no improvement* (.0075).

A Real Example:

In this example, a very overweight patient with a history of asbestos exposure, excessive use of aspirin and Von Hippel-Lindau disease complains of excessive tiredness. Indstar suggests a possible diagnosis of Renal Cell Carcinoma, and suggests several other symptoms and precursors to expect (treatment suggestions and prognoses are left out for simplicity.)

Enter as many items as you want, Doctor. -1 when done)

FEELING TIRED  
VERY OVERWEIGHT  
ASBESTOS  
EXCESSIVE ASPIRIN  
VON HIPPEL-LINDAU DISEASE

And the winners are...

Activation

FEVER	0.0125
LUMP ON SIDE	0.0125
LUMP ON BELLY	0.0125
LUMP ON LOWER BACK	0.0125
BLOOD IN URINE	0.0125
LOW BACK PAIN ON ONE SIDE	0.0125
LOSING WEIGHT FOR NO CLEAR REA	0.0125

NOT FEELING HUNGRY	0.0125
FEELING TIRED	1.0000
ANEMIA	0.0125
NIGHT SWEATS	0.0125
HIGH LEVELS OF CALCIUM	0.0125
HIGH BLOOD PRESSURE	0.0125
RENAL CELL CARCINOMA	0.0125
SMOKING	0.0125
VERY OVERWEIGHT	1.0000
LOT OF PAIN MEDICINE	0.0125
EXCESSIVE ASPIRIN	1.0000
EXCESSIVE IBUPROFEN	0.0125
EXCESSIVE ACETAMINOPHEN	0.0125
DYES	0.0125
ASBESTOS	1.0000
CADMIUM	0.0125
HERBICIDES	0.0125
SOLVENTS	0.0125
VON HIPPEL-LINDAU DISEASE	1.0000

In a practical system, data from each medical encounter would be recorded on a laptop or iPad at the time of the encounter and directed to a central computer which would learn the relationships among the elements of that (and all other) encounters in real time. Each encounter would increase Indstar's understanding of the relationships among the elements and improve its capabilities without human intervention. The science is stable and well understood; the engineering implementation is tedious but straightforward.