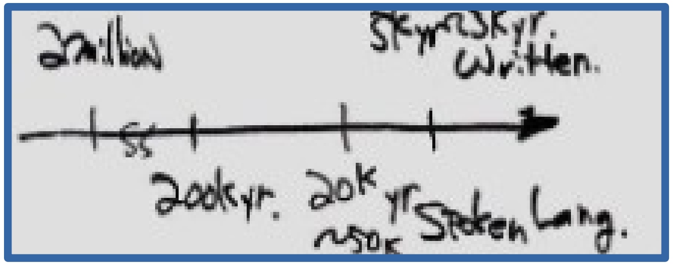
Background and Motivation

Evolution of Human Intelligence



In AI, especially in Vision related applications, our process of developing techniques:
1. Develop primitives;
2. develop production rules and grammar for PDL (primitive descriptive language;
3. testing and verification of the PDL.

Intelligence interpretation:

Step 1. Alphabet (Primitives);

Step 2. Words (Meaningful Composition of Primitives);

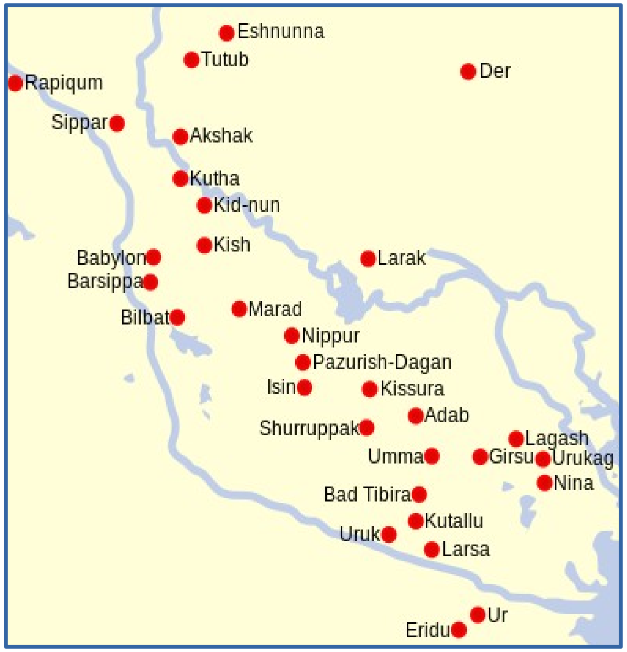
Step 3. Sentences (Follow grammar and logical reasonning);

Step 4. Written language as composition of sentences, e.g., to become reasoning and knowledge (derive conclusion).

Earliest Symbol And Written Language

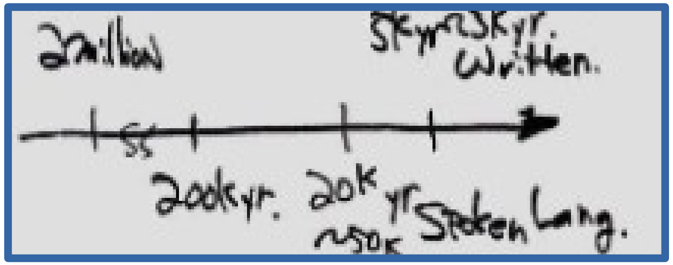
“Writing systems have evolved in different human civilizations, more complete writing systems were preceded by proto-writing, systems of ideographic or early mnemonic symbols. True writing, in which the content of a linguistic utterance is encoded so that another reader can reconstruct …” comes way later.

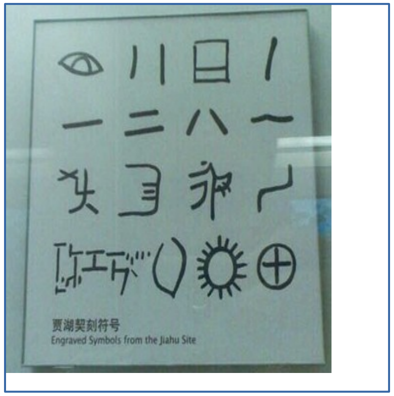
https://en.wikipedia.org/wiki/History_of_writing

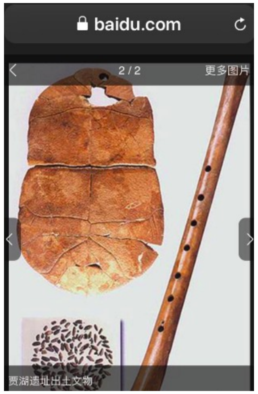


Sumer, an ancient civilization of southern Mesopotamia, is believed to be the place where written language was first invented around 3100 BC

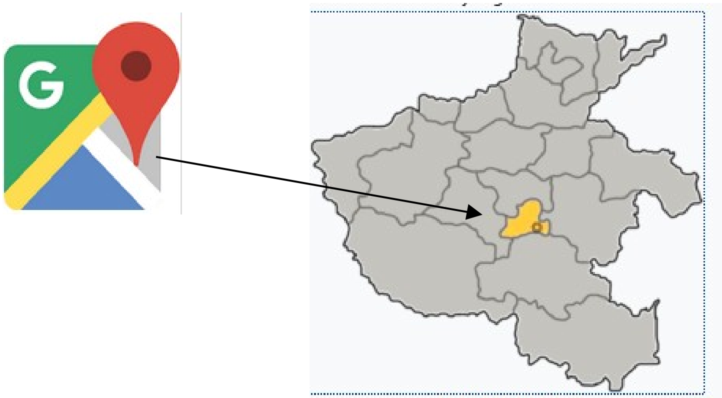
Earliest Symbol And Written Language







Wuyang County is a county in the central part of Henan province, China.



Luohe in Henan

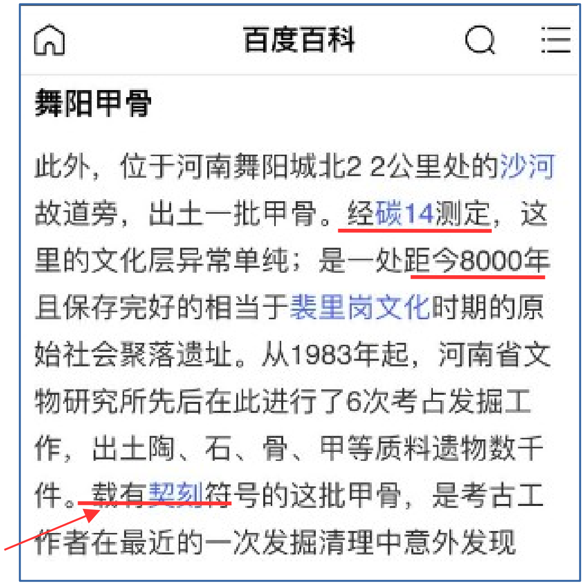
Coordinates: 33°26′17″N 113°36′32″E

Step 1. Alphabet (Primitives);

Step 2. Words (Meaningful Composition of Primitives);

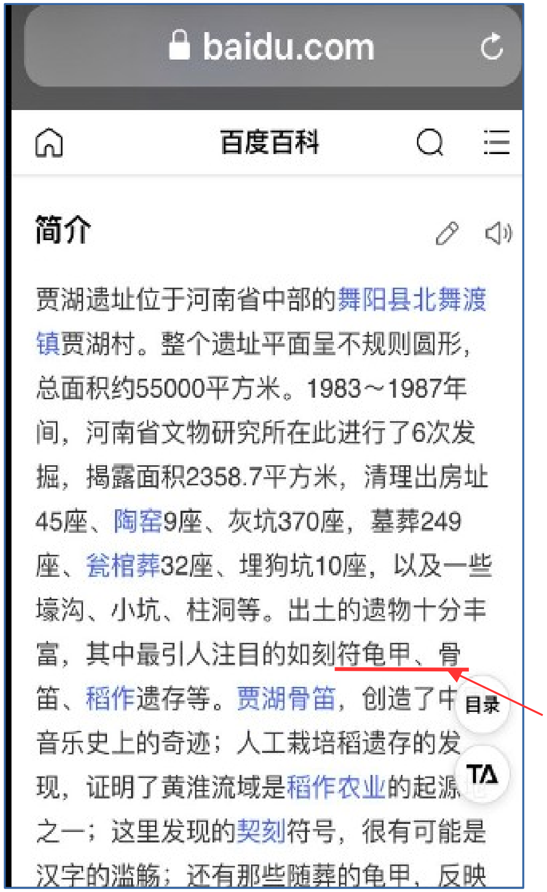
Step 3. Sentences (Follow grammar and logical reasonning);

Step 4. Written language as composition of sentences, e.g., to become reasoning and knowledge (derive conclusion).



舞阳甲骨

此外，位于河南舞阳城北2 2公里处的沙河故道旁，出土一批甲骨。经碳14测定，这里的文化层异常单纯；是一处距今8000年且保存完好的相当于裴里岗文化时期的原始社会聚落遗址。从1983年起，河南省文物研究所先后在此进行了6次考占发掘工作，出土陶、石、骨、甲等质料遗物数千件。载有契刻符号的这批甲骨，是考古工作者在最近的一次发掘清理中意外发现



简介

贾湖遗址位于河南省中部的舞阳县北舞渡镇贾湖村。整个遗址平面呈不规则圆形，总面积约55000平方米。1983～1987年间，河南省文物研究所在此进行了6次发掘，揭露面积2358.7平方米，清理出房址45座、陶窑9座、灰坑370座，墓葬249座、瓮棺葬32座、埋狗坑10座，以及一些壕沟、小坑、柱洞等。出土的遗物十分丰富，其中最引人注目的如刻符龟甲、骨笛、稻作遗存等。贾湖骨笛，创造了中音乐史上的奇迹；人工栽培稻遗存的发现，证明了黄淮流域是稻作农业的起源之一；这里发现的契刻符号，很有可能是汉字的滥觞；还有那些随葬的龟甲，反映

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Written Language Brief Development Stage

A conventional "proto-writing to true writing" system follows a general series of developmental stages:

1. Picture writing system: glyphs (simplified pictures) directly represent objects and concepts. directly represent an object or a concept such as (A) chronological, (B) notices, (C) communications, (D) totems, titles, and names, (E) religious, (F) customs, (G) historical, and (H) biographical.

2. Ideographic: graphemes are abstract symbols that directly represent an idea or concept.

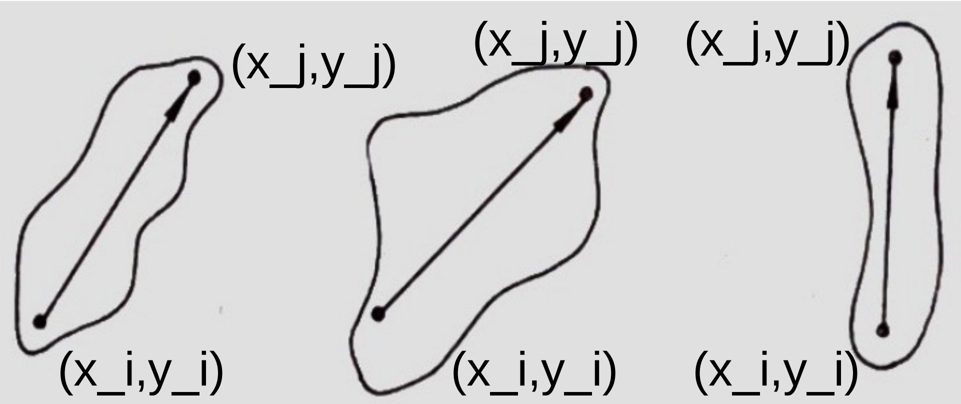
3. Transitional system: graphemes refer not only to the object or idea that it represents but to its name as well.

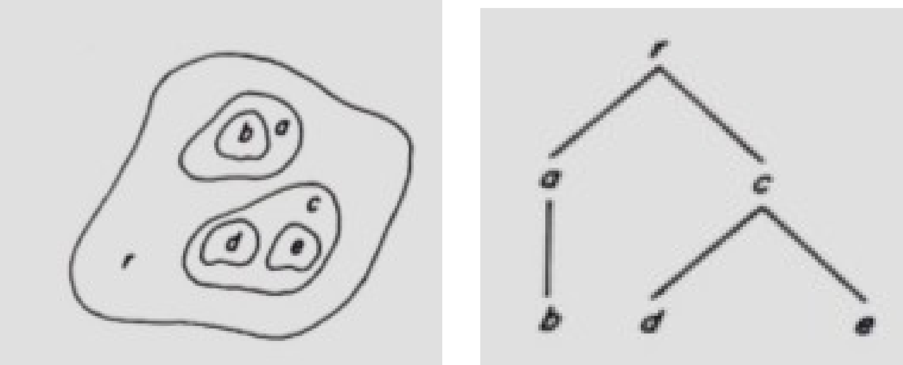
4. Phonetic system: graphemes refer to sounds or spoken symbols, and the form of the grapheme is not related to its meanings. This resolves itself into the following substages:

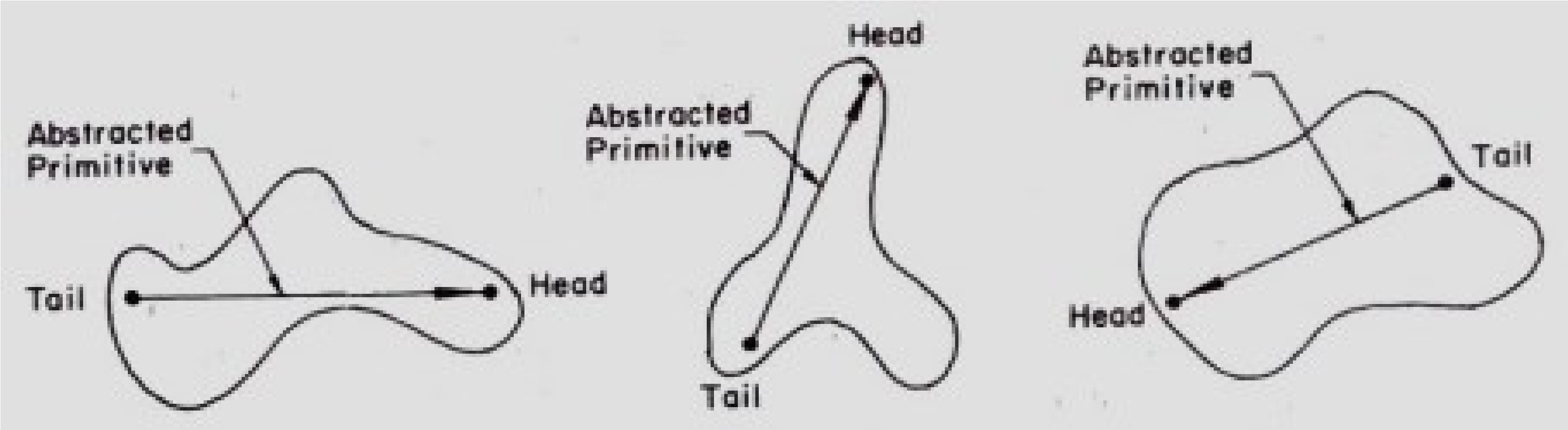
Verbal: grapheme (logogram) represents a whole word.
Syllabic: grapheme represents a syllable.
Alphabetic: grapheme represents an elementary sound.

Patterns As Directed Lines

Example: Contours and its corresponding tree, pp. 328

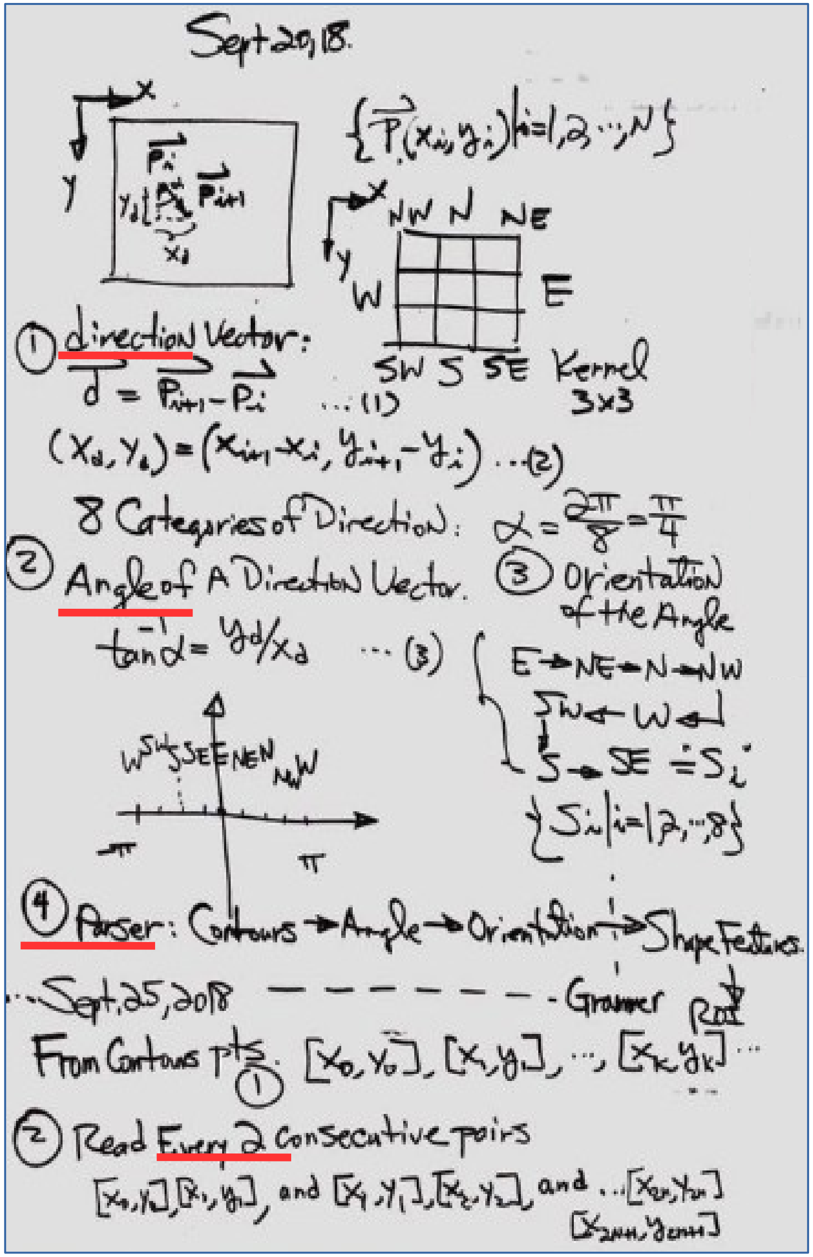






From “Pattern Recognition” book, pp. 326 and 332.

Symbolic Representation



Sept 20, 18.

x
y
$\vec{P}_i$
$\vec{P}_{i+1}$
y_d
x_d

$\{\vec{P}_i(x_i, y_i) | i = 1, 2, \cdots, N\}$

x
y
NW N NE
W
E
SW S SE

Kernel 3x3

① direction Vector:

$\vec{d} = \vec{P}_{i+1} - \vec{P}_i$ ...(1)

$(x_d, y_d) = (x_{i+1} - x_i, y_{i+1} - y_i)$ ...(2)

8 Categories of Direction: $\alpha = \frac{2\pi}{8} = \frac{\pi}{4}$

② Angle of A Direction Vector.

$\tan^{-1}\alpha = y_d/x_d$ ...(3)

③ Orientation of the Angle

E → NE → N → NW

SW ← W ←

S → SE ≐ S_i

$\{S_i | i = 1, 2, \cdots, 8\}$

W SW S SE E NE N NW
−π
π

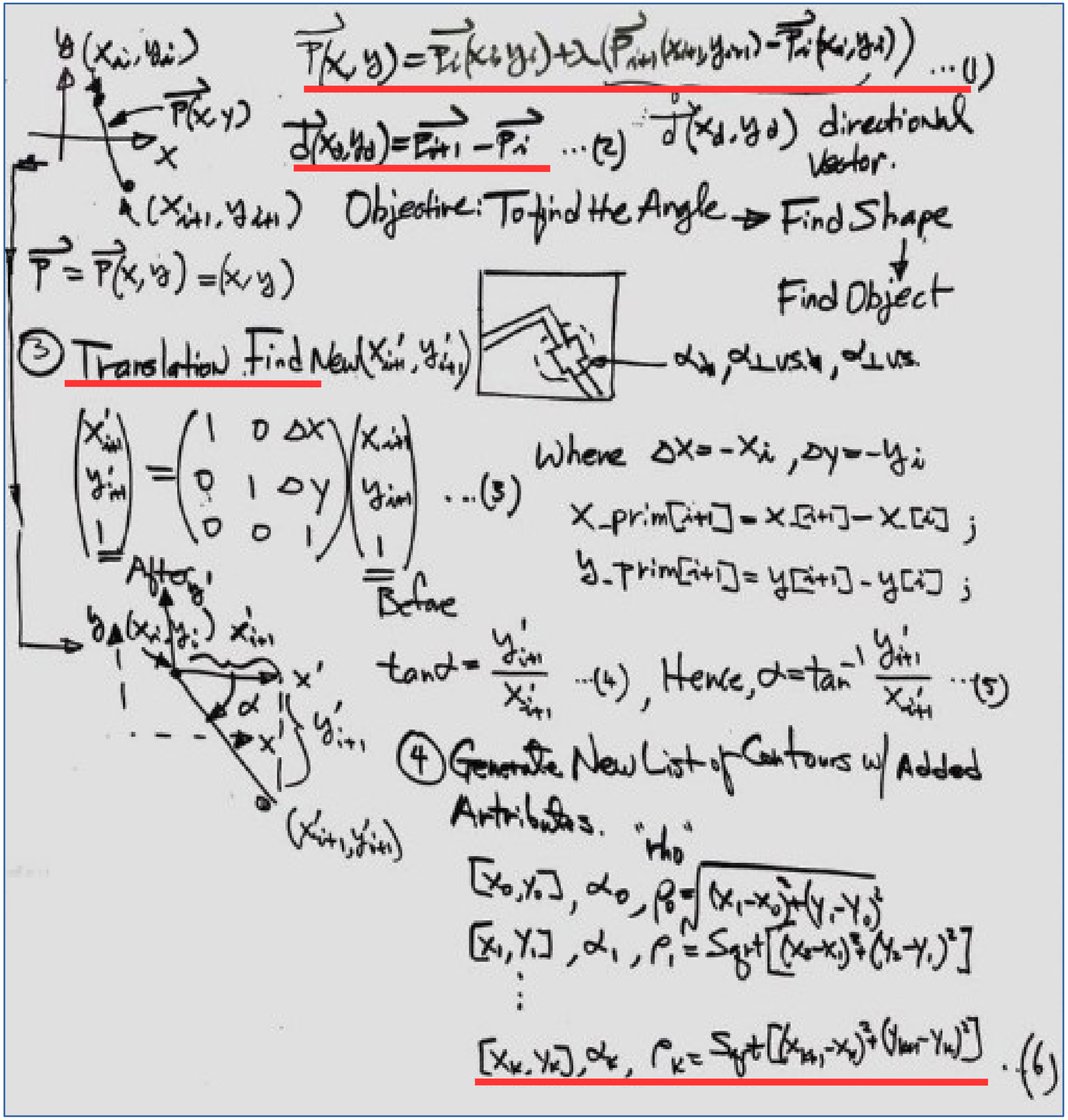
④ Parser: Contours → Angle → Orientation → Shape Features.

...Sept. 25, 2018 - - - - - - - Grammer Rot

From Contours pts. ① $[x_0, y_0], [x_1, y_1], \cdots, [x_k, y_k] \cdots$

② Read Every 2 Consecutive pairs

$[x_0, y_0], [x_1, y_1]$, and $[x_1, y_1], [x_2, y_2]$, and ... $[x_{2n}, y_{2n}]$ $[x_{2n+1}, y_{2n+1}]$



y
(x_i, y_i)
$\vec{P}(x,y)$
x
(x_{i+1}, y_{i+1})

$\vec{P}(x, y) = \vec{P}_i(x_i, y_i) + \lambda(\vec{P}_{i+1}(x_{i+1}, y_{i+1}) - \vec{P}_i(x_i, y_i))$ ...(1)

$\vec{d}(x_d, y_d) = \vec{P}_{i+1} - \vec{P}_i$ ...(2) $\vec{d}(x_d, y_d)$ directional Vector.

Objective: To find the Angle → Find Shape → Find Object

$\vec{P} = \vec{P}(x, y) = (x, y)$

③ Translation Find New (x'_{i+1}, y'_{i+1})

$\alpha_1, \alpha_{\perp vs. k}, \alpha_{\perp vs.}$

$$\underbrace{\begin{pmatrix} x'_{i+1} \\ y'_{i+1} \\ 1 \end{pmatrix}}_{\text{After}} = \begin{pmatrix} 1 & 0 & \Delta x \\ 0 & 1 & \Delta y \\ 0 & 0 & 1 \end{pmatrix} \underbrace{\begin{pmatrix} x_{i+1} \\ y_{i+1} \\ 1 \end{pmatrix}}_{\text{Before}} \quad \ldots(3)$$

Where $\Delta x = -x_i$, $\Delta y = -y_i$

X_prim[i+1] = x[i+1] − x[i];

y_prim[i+1] = y[i+1] − y[i];

$\tan\alpha = \frac{y'_{i+1}}{x'_{i+1}}$ ...(4), Hence, $\alpha = \tan^{-1}\frac{y'_{i+1}}{x'_{i+1}}$ ...(5)

④ Generate New List of Contours w/ Added Attributes. "rho"

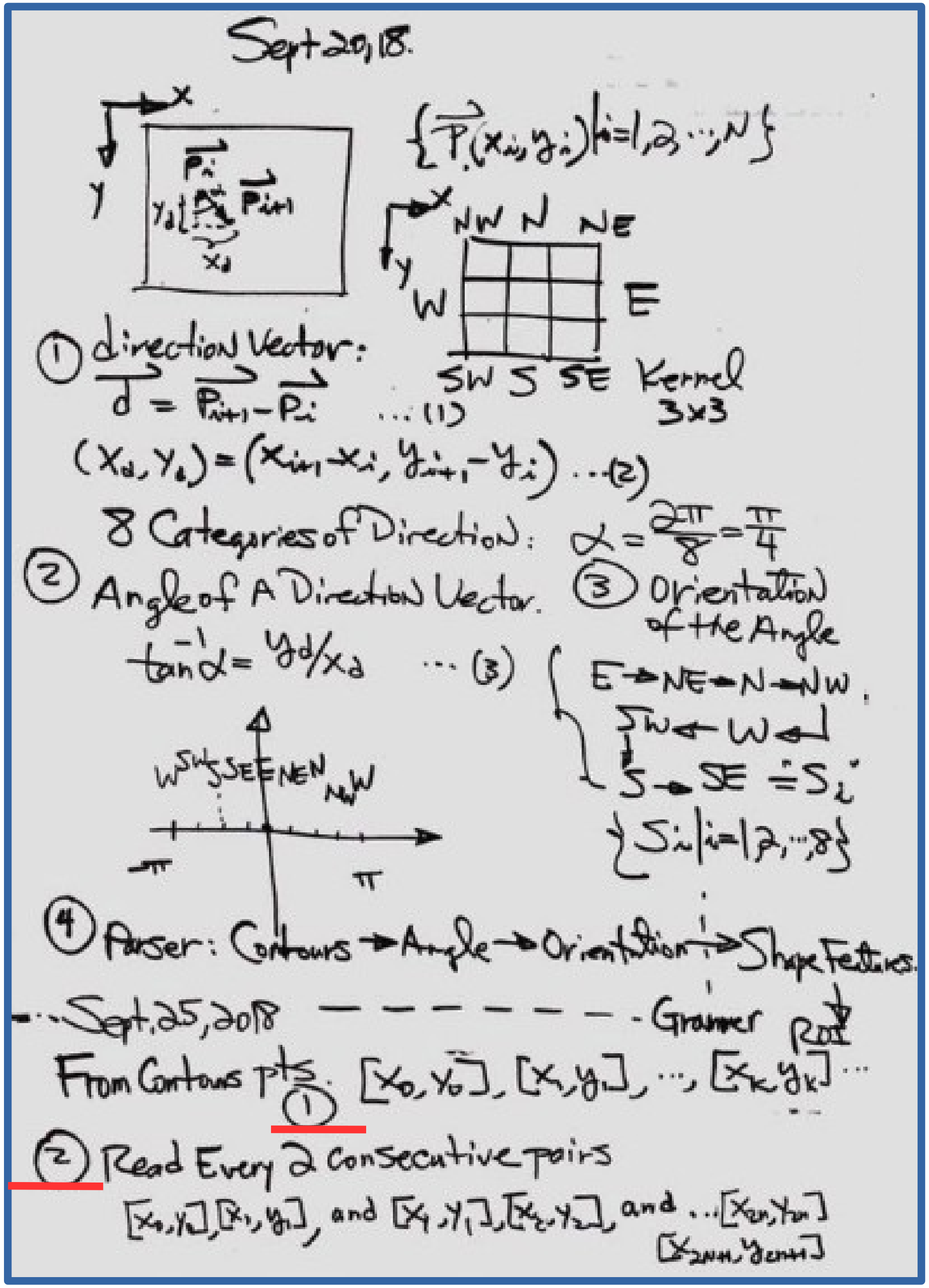
$[x_0, y_0], \alpha_0, \rho_0 = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}$

$[x_1, y_1], \alpha_1, \rho_1 = \mathrm{Sqrt}[(x_2 - x_1)^2 + (y_2 - y_1)^2]$

⋮

$[x_k, y_k], \alpha_k, \rho_k = \mathrm{Sqrt}[(x_{k+1} - x_k)^2 + (y_{k+1} - y_k)^2]$ ...(6)

Contours To Syntax Parsing



x
y
$\vec{P}_i$
$\vec{P}_{i+1}$
y_d
x_d
NW N NE
W E
SW S SE
W SW S SE E NE N NW W
$-\pi$
π

Sept 20, 18.

$\{\vec{P}_i(x_i, y_i) | i=1,2,\cdots,N\}$

Kernel 3x3

① direction Vector:

$\vec{d} = \vec{P}_{i+1} - \vec{P}_i$ …(1)

$(X_d, Y_d) = (x_{i+1} - x_i, y_{i+1} - y_i)$ …(2)

8 Categories of Direction: $\alpha = \frac{2\pi}{8} = \frac{\pi}{4}$

② Angle of A Direction Vector.

$\tan^{-1}\alpha = y_d / x_d$ …(3)

③ Orientation of the Angle

E → NE → N → NW,
SW ← W ←
S → SE ≐ S_i

$\{S_i | i=1,2,\cdots,8\}$

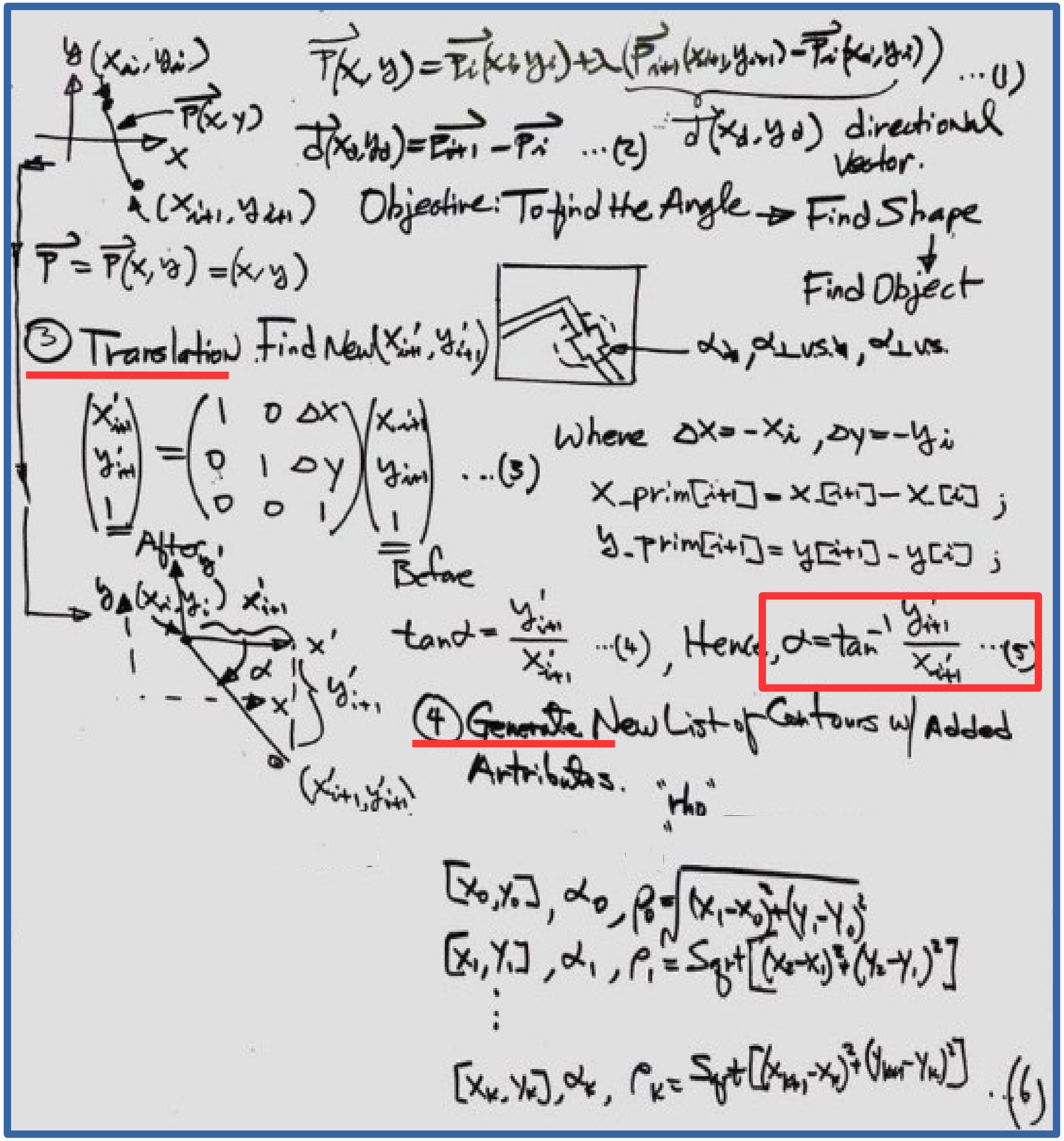
④ Parser: Contours → Angle → Orientation → Shape Features.

Sept. 25, 2018 - - - - - - - - Grammer Rot

From Contours pts. ① $[x_0, y_0], [x_1, y_1], \cdots, [x_k, y_k]$ …

② Read Every 2 Consecutive pairs

$[x_0, y_0], [x_1, y_1]$, and $[x_1, y_1], [x_2, y_2]$, and … $[x_{2n}, y_{2n}]$ $[x_{2n+1}, y_{2n+1}]$



y
(x_i, y_i)
$\vec{P}(x, y)$
x
(x_{i+1}, y_{i+1})
y
(x_i, y_i)
x'_{i+1}
x'
α
y'_{i+1}
x'
(x_{i+1}, y_{i+1})

$\vec{P}(x, y) = \vec{P}_i(x_i, y_i) + \lambda(\underbrace{\vec{P}_{i+1}(x_{i+1}, y_{i+1}) - \vec{P}_i(x_i, y_i)}_{\vec{d}(x_d, y_d)})$ …(1)

$\vec{d}(x_d, y_d) = \vec{P}_{i+1} - \vec{P}_i$ …(2)

$\vec{d}(x_d, y_d)$ directional Vector.

Objective: To find the Angle → Find Shape → Find Object

$\vec{P} = \vec{P}(x, y) = (x, y)$

③ Translation Find New (x'_{i+1}, y'_{i+1})

$\alpha_{\searrow}$, $\alpha_{\perp \text{vs.} \searrow}$, $\alpha_{\perp \text{vs.}}$

$$\underset{\text{After}}{\begin{pmatrix} x'_{i+1} \\ y'_{i+1} \\ 1 \end{pmatrix}} = \begin{pmatrix} 1 & 0 & \Delta x \\ 0 & 1 & \Delta y \\ 0 & 0 & 1 \end{pmatrix} \underset{\text{Before}}{\begin{pmatrix} x_{i+1} \\ y_{i+1} \\ 1 \end{pmatrix}} \quad \ldots(3)$$

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$\tan\alpha = \frac{y'_{i+1}}{x'_{i+1}}$ …(4), Hence, $\boxed{\alpha = \tan^{-1} \frac{y'_{i+1}}{x'_{i+1}} \ldots(5)}$

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$[x_1, y_1], \alpha_1, \rho_1 = \text{Sqrt}[(x_2 - x_1)^2 + (y_2 - y_1)^2]$

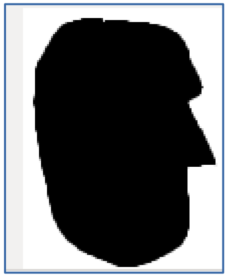
$\vdots$

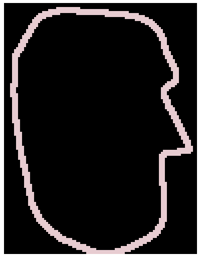
$[x_k, y_k], \alpha_k, \rho_k = \text{Sqrt}[(x_{k+1} - x_k)^2 + (y_{k+1} - y_k)^2]$ …(6)

Examples From Our Experiment

Example:

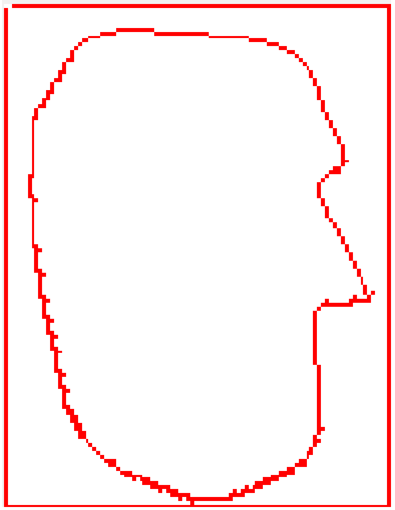
drawContourOrientation.cpp



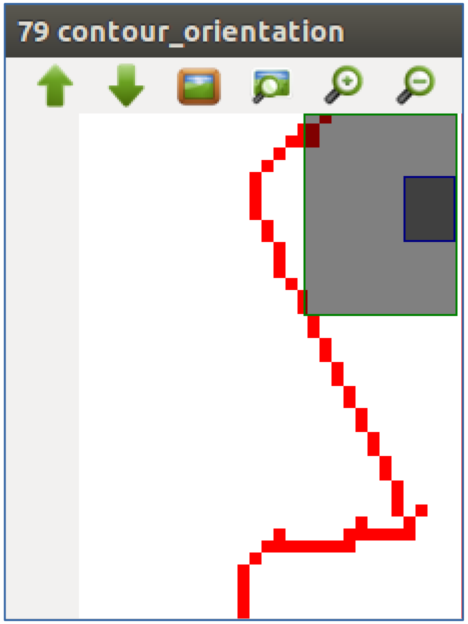


Original image

3test.png



```
Pre, Cur, Nex Points has angle= 45: [91, 68] [91, 69] [92, 70]
Pre, Cur, Nex Points has angle= 45: [92, 70] [92, 71] [93, 72]
Pre, Cur, Nex Points has angle= 45: [93, 73] [93, 74] [94, 75]
Pre, Cur, Nex Points has angle= 45: [80, 91] [80, 92] [81, 93]
Pre, Cur, Nex Points has angle= 45: [48, 127] [47, 127] [48, 128]
Pre, Cur, Nex Points has angle= 45: [45, 126] [44, 126] [45, 127]
Pre, Cur, Nex Points has angle= 45: [43, 125] [42, 125] [43, 126]
Pre, Cur, Nex Points has angle= 45: [40, 124] [39, 124] [40, 125]
Pre, Cur, Nex Points has angle= 45: [38, 123] [37, 123] [38, 124]
Pre, Cur, Nex Points has angle= 45: [36, 122] [35, 122] [36, 123]
```



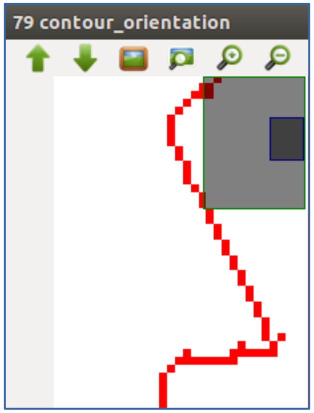
```
:~/Documents/CTI0/3 项目 /3-0-AGV/3-0-0-lec/lec3-Vision-Software-Architecture/lec3-4-Path/lec3-4-7-Path-debug-2017-12-3/lec3-4-7-11-ContourOrientation/contour_orientation$
```

Examples From Our Experiment

Example: :~/Documents/CTI0/3 项目 /3-0-AGV/3-0-0-lec/lec3-Vision-Software-Architecture/lec3-4-Path/lec3-4-7-Path-debug-2017-12-3/lec3-4-7-11-ContourOrientation/contour_orientation$

drawContourOrientation.cpp

```
set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -std=c++11")
cmake_minimum_required(VERSION 2.8)
project(     main )
find_package( OpenCV REQUIRED )
include_directories( ${OpenCV_INCLUDE_DIRS} )
add_executable( main drawContourOrientation.cpp )
target_link_libraries( main ${OpenCV_LIBS} )
```

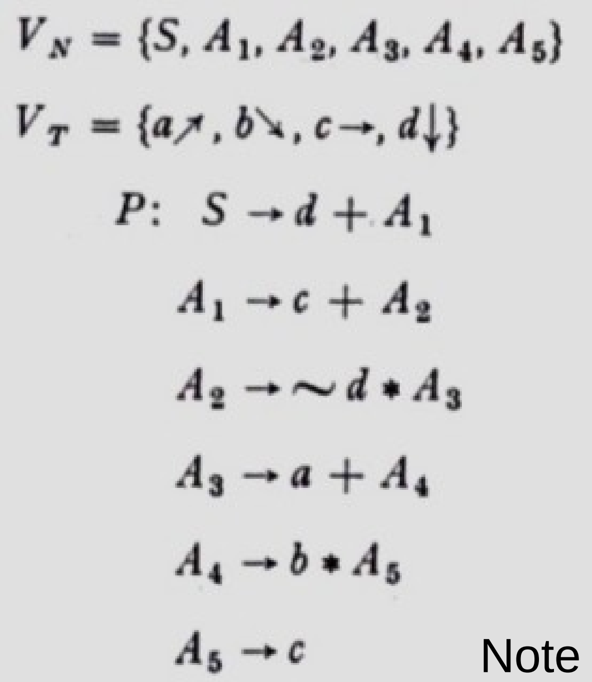


PDL Grammar

G = { V_n, V_t, P, S}   … (1)

G   : grammar
V_n : variables non-terminal
V_t : variables terminal
P   : production
S   : starting

Define 4 operators “ +, -, *, x ” to build product rules, as in figure 1



$V_N = \{S, A_1, A_2, A_3, A_4, A_5\}$

$V_T = \{a\nearrow, b\searrow, c\rightarrow, d\downarrow\}$

$P\colon\ S \rightarrow d + A_1$

$A_1 \rightarrow c + A_2$

$A_2 \rightarrow \sim d * A_3$

$A_3 \rightarrow a + A_4$

$A_4 \rightarrow b * A_5$

$A_5 \rightarrow c$

Note ~d is the negation of d

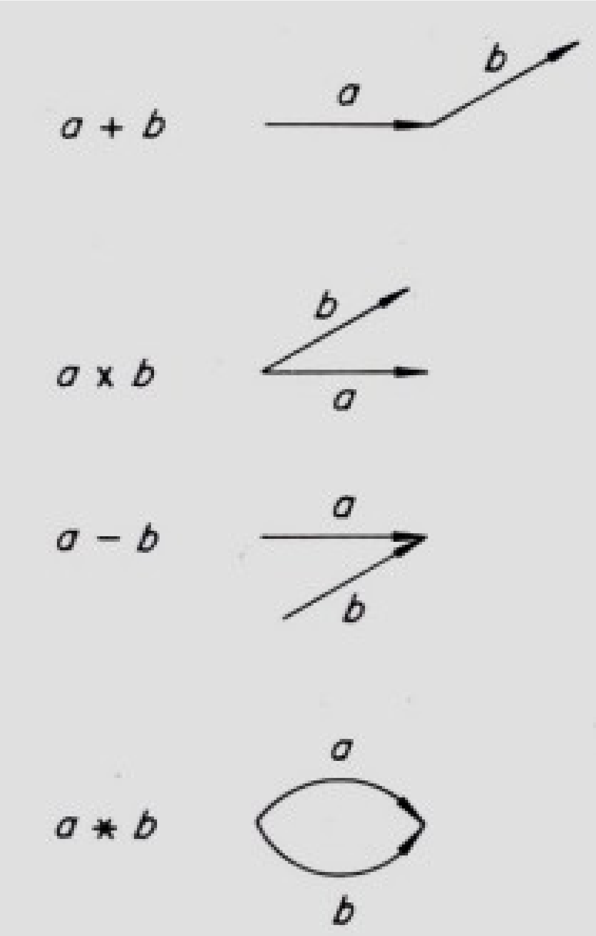
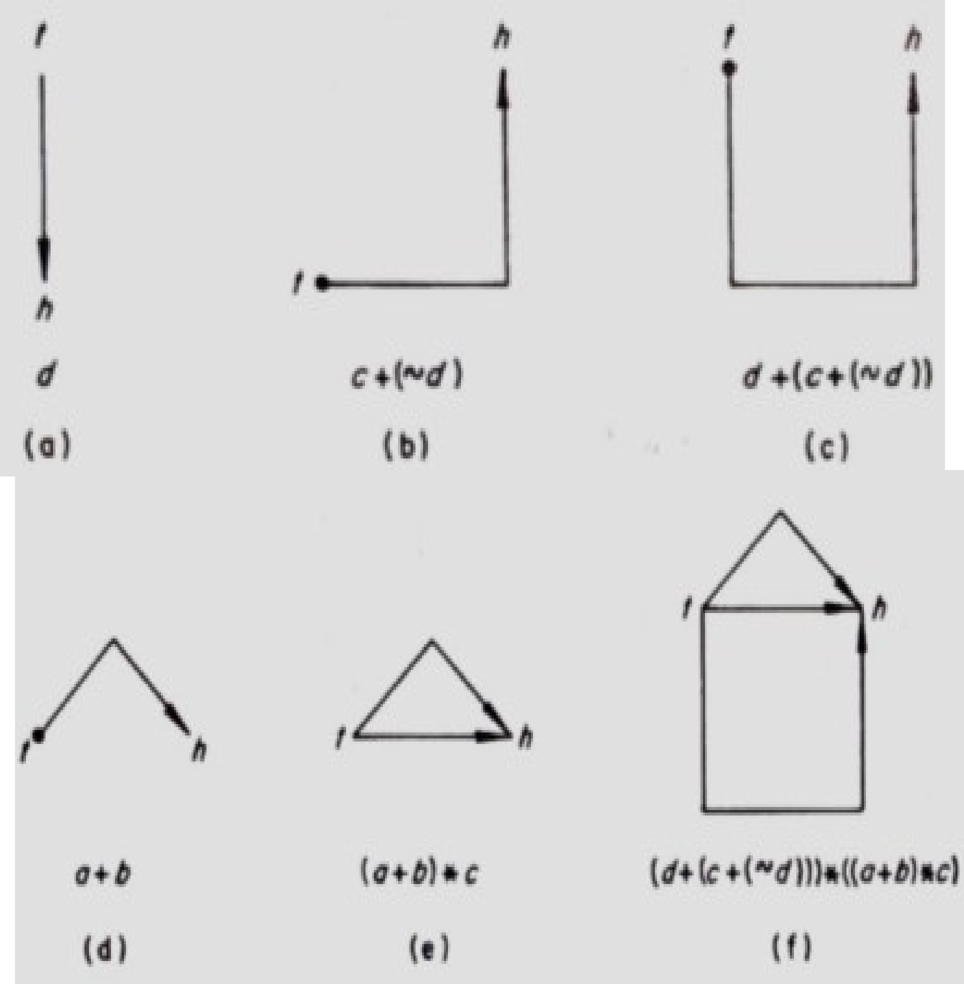


Figure 1. 4 operators in PDL, pp. 333

Example of PDL Production

Example: Apply the Production Rules to produce the following language, pp. 334



AI Software Engineer
Expert Systems, Reasoning

Primitive Features of Chromosome and PDL

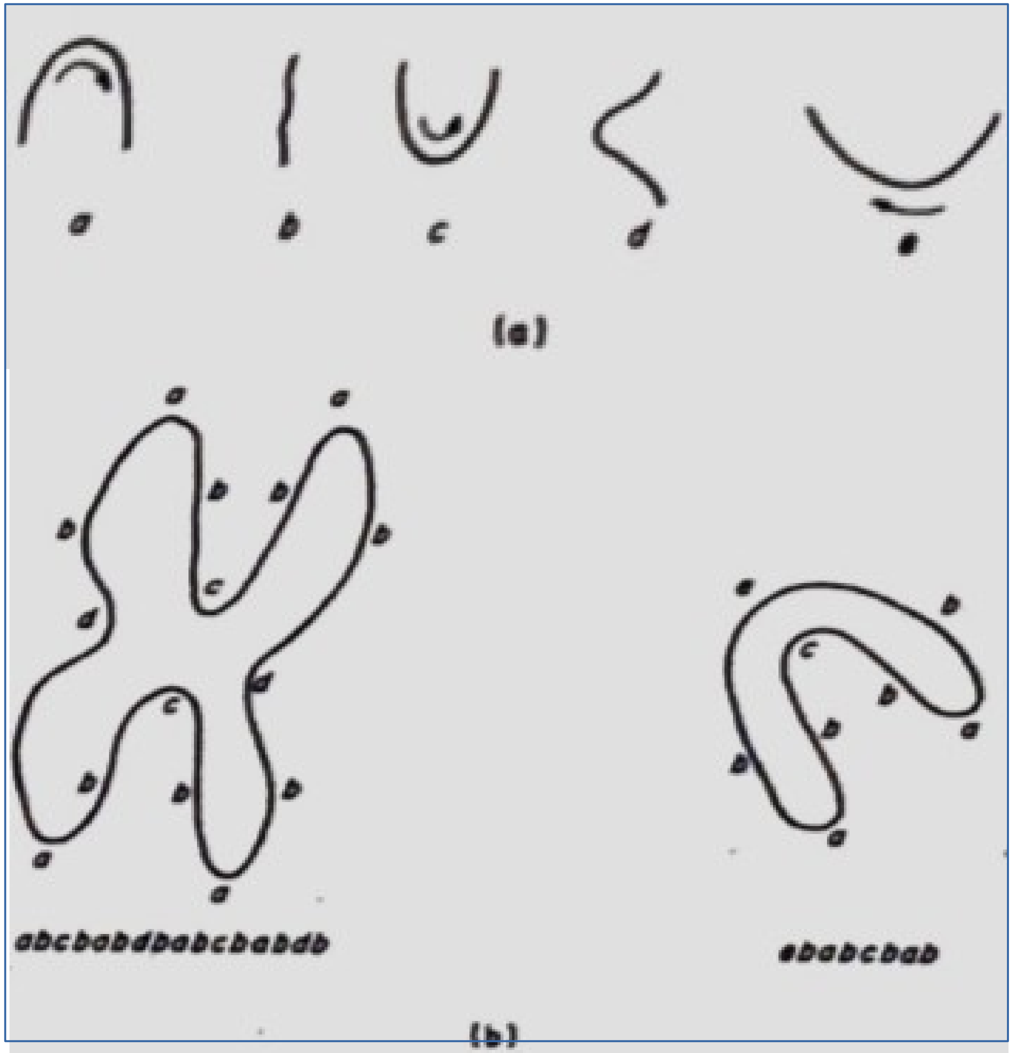
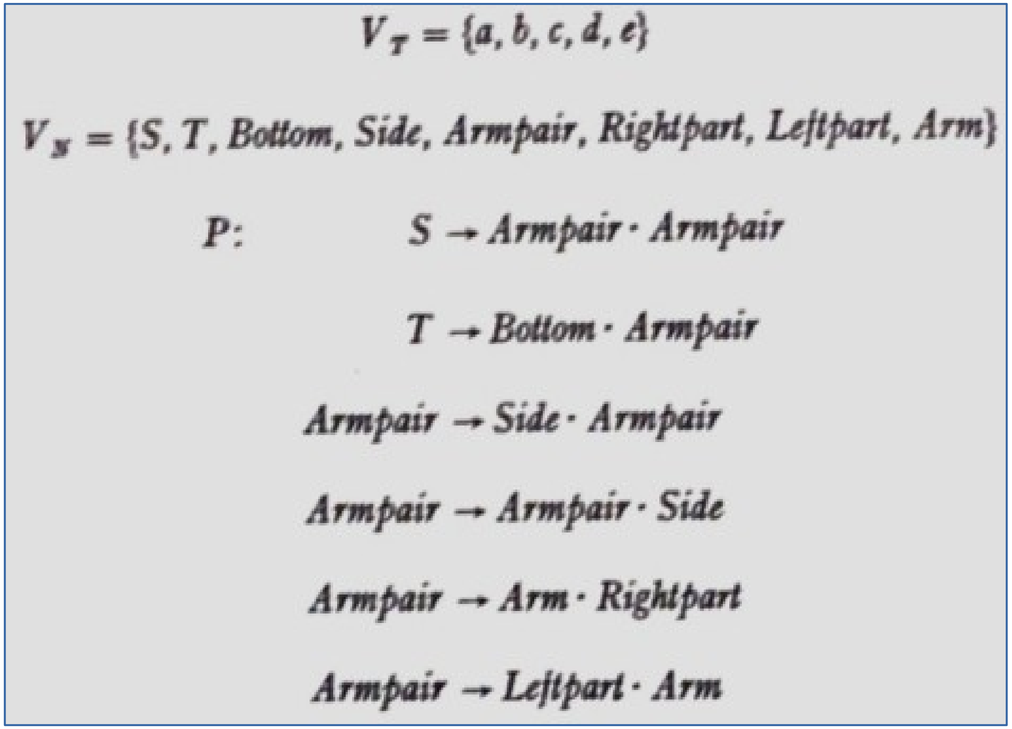


Figure 8.8. (a) Primitives of a chromosome grammar. (b) Submedian and telocentric chromosomes and corresponding terminal sentences. From R. S. Ledley, "High-Speed Automatic Analysis of Biomedical Pictures," *Science*, vol. 146, No. 3641, 1964



$V_T = \{a, b, c, d, e\}$

$V_N = \{S, T, Bottom, Side, Armpair, Rightpart, Leftpart, Arm\}$

$P:$ $S \rightarrow Armpair \cdot Armpair$

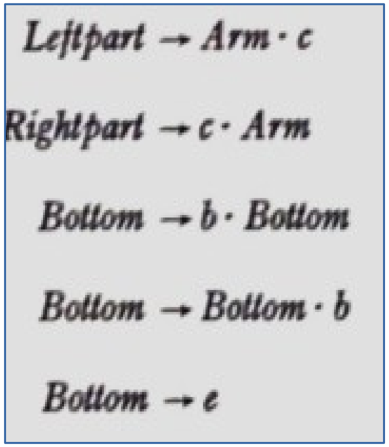
$T \rightarrow Bottom \cdot Armpair$

$Armpair \rightarrow Side \cdot Armpair$

$Armpair \rightarrow Armpair \cdot Side$

$Armpair \rightarrow Arm \cdot Rightpart$

$Armpair \rightarrow Leftpart \cdot Arm$



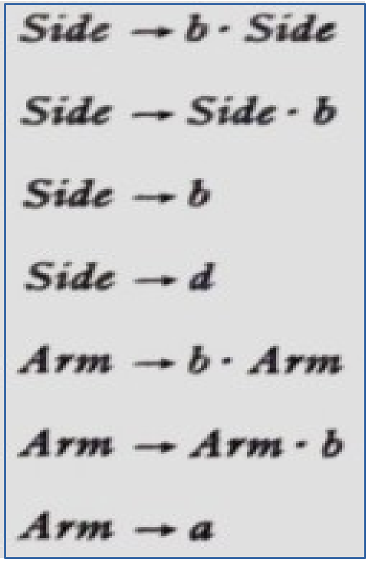
$Leftpart \rightarrow Arm \cdot c$

$Rightpart \rightarrow c \cdot Arm$

$Bottom \rightarrow b \cdot Bottom$

$Bottom \rightarrow Bottom \cdot b$

$Bottom \rightarrow e$



$Side \rightarrow b \cdot Side$

$Side \rightarrow Side \cdot b$

$Side \rightarrow b$

$Side \rightarrow d$

$Arm \rightarrow b \cdot Arm$

$Arm \rightarrow Arm \cdot b$

$Arm \rightarrow a$

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Parse Chromosome Tree

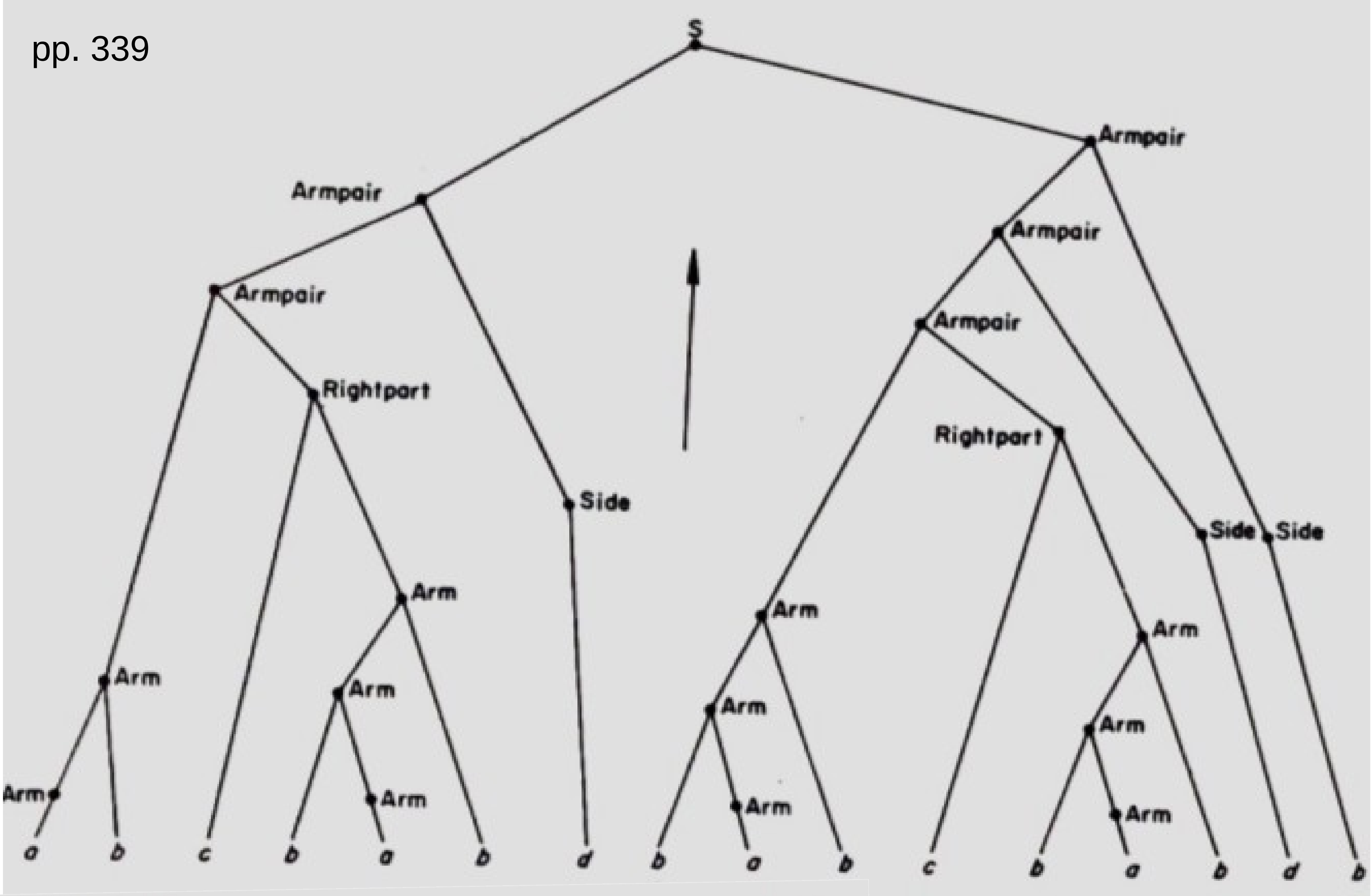
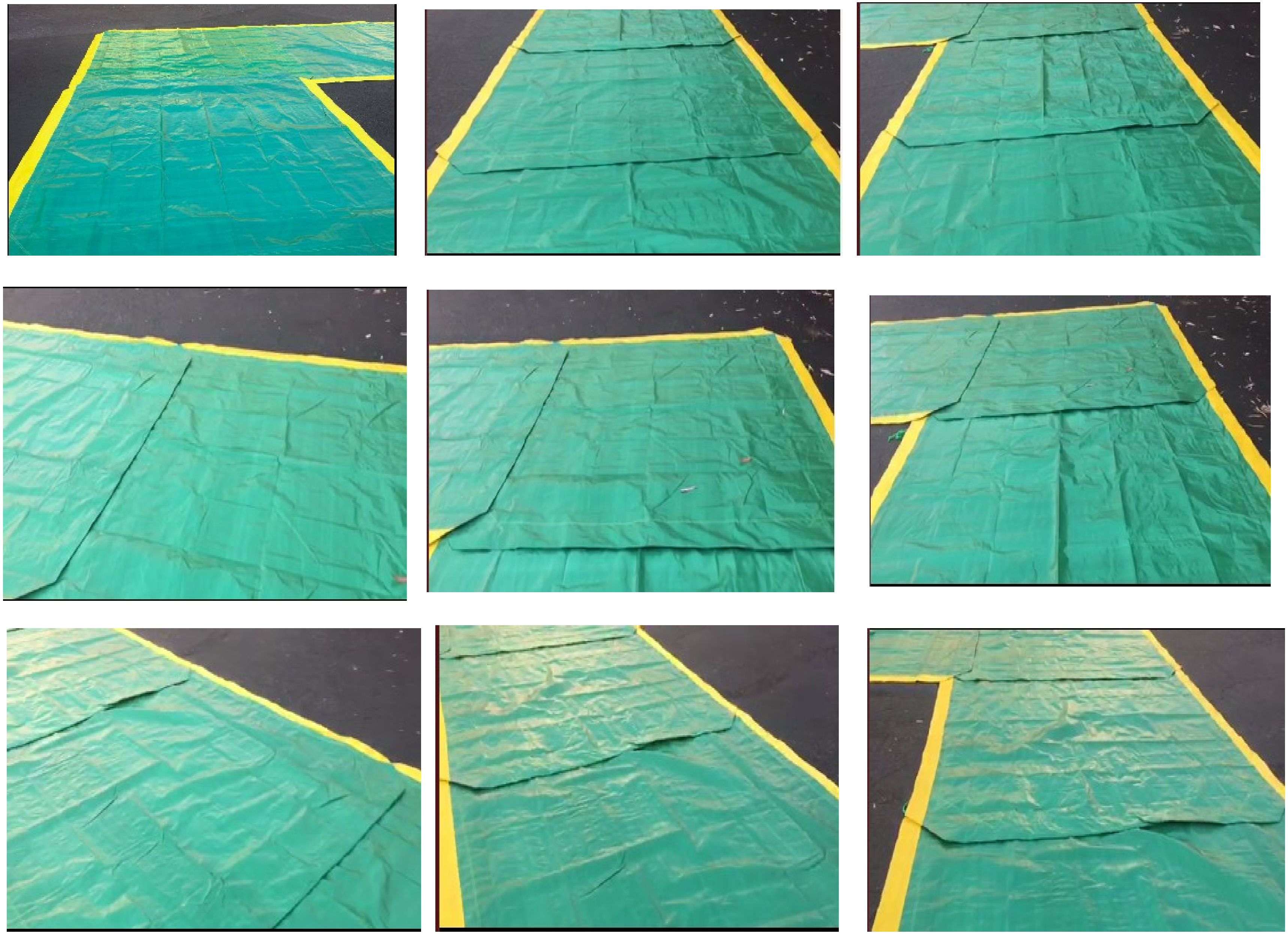

pp. 339

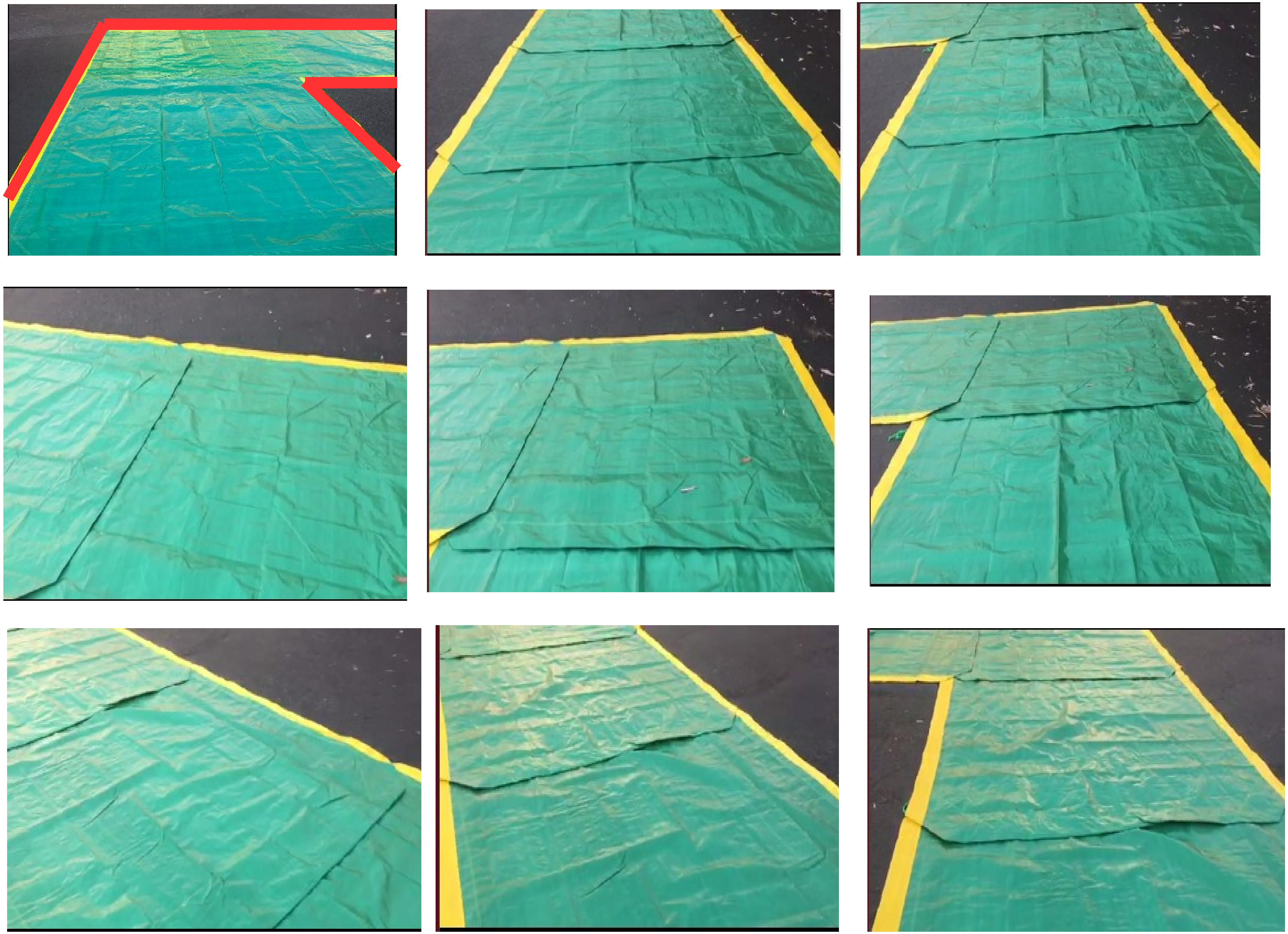
Figure 8.9. Bottom-up parsing of the chromosome sentence *abcbabdbabcbabdb*

Parse Tree with Production to Expert System

CAT-II Path

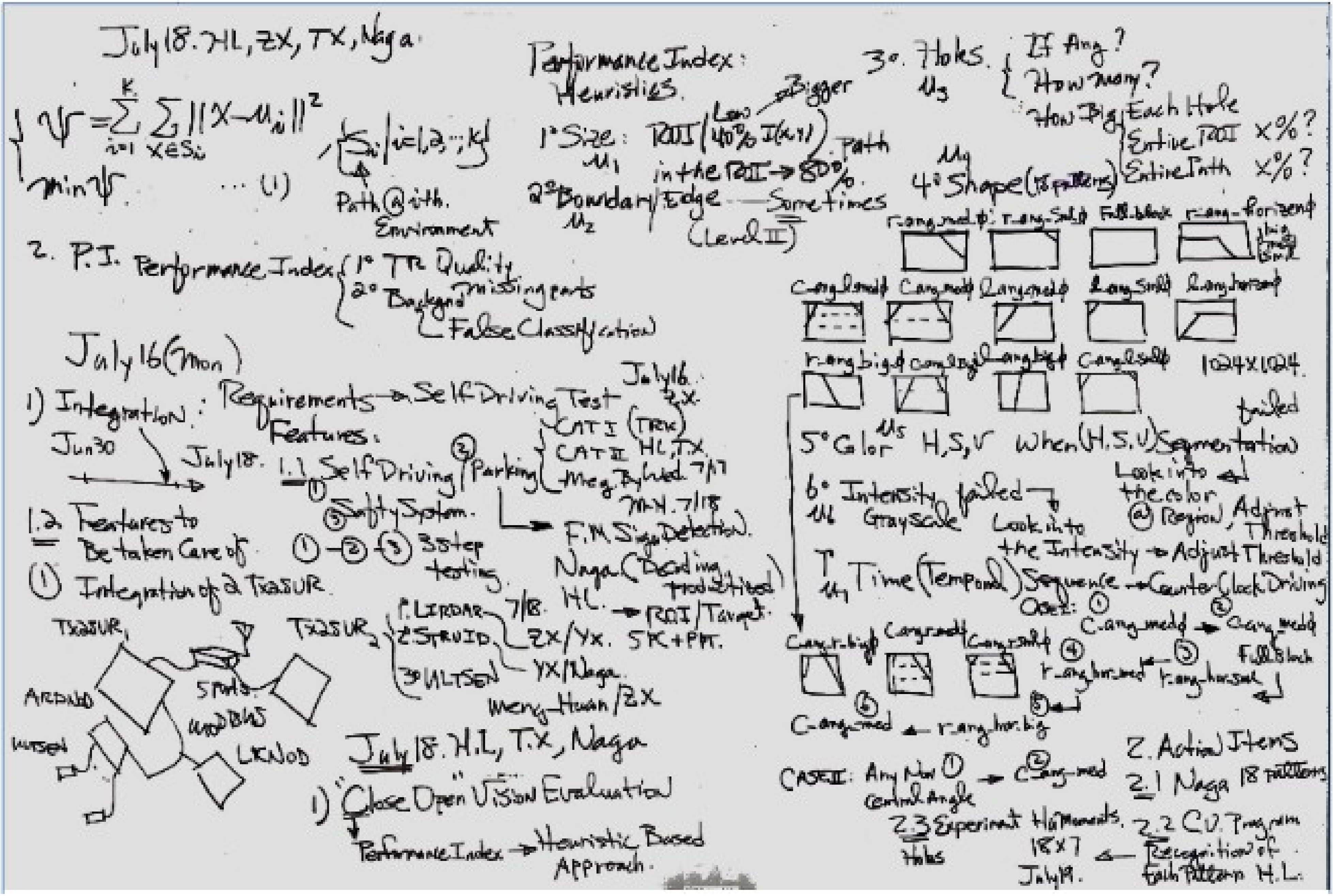


CAT-II Path Primitives



Confidential

7-18-18 CAT II-Path Performance Index



July 18. HL, ZX, TX, Naga.

$$\left\{\begin{array}{l}\psi = \sum_{i=1}^{K} \sum_{x \in S_i} \|x - u_i\|^2 \\ \min \psi \qquad \cdots (1)\end{array}\right. , \{S_i \mid i = 1, 2, \cdots, K\}$$

Path @ ith. Environment

2. P.I. Performance Index
- 1° TR Quality
- 2° Backgnd missing parts
  - False Classification

July 16 (Mon)

1) Integration: Requirements → Self Driving Test
Features.

Jun 30 → July 18.

1.1 Self Driving / Parking
① Self Driving ② Parking ③ Safty System.

July 16. ZX.
- CAT I (TRK)
- CAT II HL, TX.
- Meng Byhud 7/17
- M.H. 7/18

→ F.M. Sign Detection.

① — ② — ③ 3 step testing.

Naga (Deciding prohibited)
HL. → ROI / Target.

1.2 Features to Be taken Care of
① Integration of 2 TX2SUR

TX2SUR,

ARDNOD

5 Ports. UNOBUS

LKNOD

MTSEN

TX2SUR₂
- 1. LIRDAR — 7/18. ZX/YX. 5K + PM.
- 2. STRVID. — YX/Naga.
- 3. ULTSEN

Meng-Huan / ZX

July 18. H.L, T.X, Naga

1) "Close Open" Vision Evaluation
↓
Performance Index → Heuristic Based Approach.

Performance Index: Heuristics.

1° Size: ROI (Low 40% I(x,y) → Bigger) Path
u_1 in the ROI → 80%.

2° Boundary / Edge — Sometimes (Level II)
u_2

3° Holes. u_3
- If Any?
- How many?
- How Big Each Hole
  - Entire ROI x%?
  - Entire Path x%?

u_4 4° Shape (18 patterns)

r_ang_med; r_ang_Sml; Full_block; r_ang_horizont big (long) Bnk

C_ang_l_med; C_ang_med; l_ang_med; l_ang_Sml; l_ang_horizont

r_ang_big; C_ang_big; l_ang_big; C_ang_l_sml; 1024 x 1024.

5° Color u_5 H, S, V When (H.S.V) Segmentation failed → Look into the color @ Region, Adjust Threshold

6° Intensity u_6 Grayscale failed → Look into the Intensity → Adjust Threshold

7° u_7 Time (Temporal) Sequence → Counter Clock Driving

Case I: ① C_ang_med → ② C_ang_med Full Block → ③ r_ang_hor_sml → ④ r_ang_hor_med → ⑤ → ⑥ C_ang_med ← r_ang_hor_big

C_ang_r_big; C_ang_r_med; C_ang_r_sml

CASE II: Any New ① Central Angle → ② C_ang_med

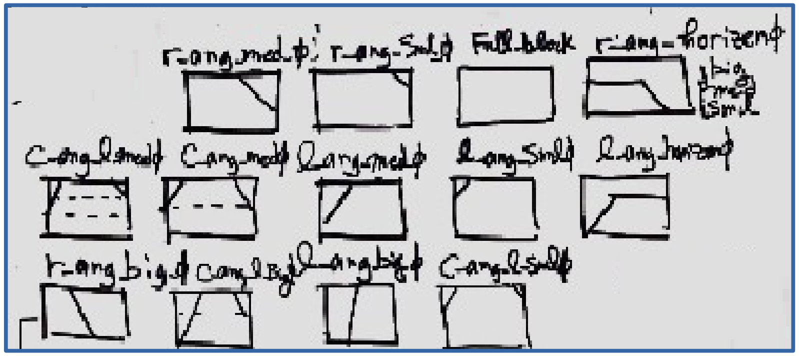
2. Action Items

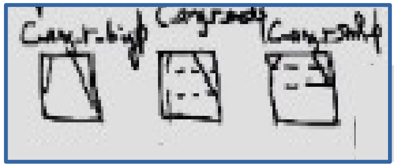
2.1 Naga 18 patterns

2.2 C.V. Program Recognition of Each Pattern H.L. → 18 x 7 July 19.

2.3 Experiment Hu Moments. Holes

9-25-2018 Primitive Features for CAT-II Path Classification





1. r_ang_big	right angle big
2. r_ang_med	right angle medium
3. r_ang_sml	right angle small
4. r_ang_hor	right angle horizon
5. l_ang_big	left angle big
6. l_ang_med	left angle medium
7. l_ang_sml	left angle small
8. l_ang_hor	left angle horizon
9. cr_ang_big	centeral-right big
10. cr_ang_med	central angle medium
11. cr_ang_sml	central angle small
12. cl_ang_big	centeral-right angle
13. cl_ang_med	central angle medium
14. cl_ang_sml	central angle small
15. c_ang_big	centeral-angle big
16. c_ang_med	central-ang medium
17. c_ang_sml	central-ang small
18. full	full block

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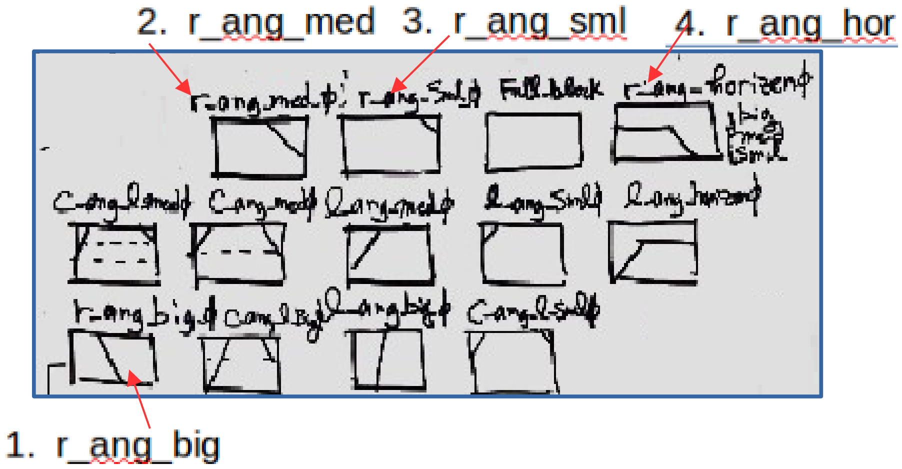
9-25-2018 Contour As Primitive Features



1. r_ang_big	right angle big
2. r_ang_med	right angle medium
3. r_ang_sml	right angle small
4. r_ang_hor	right angle horizon

1. r_ang_big	right angle big	left region color 1 + path marker + right reg color 2
2. r_ang_med	right angle medium	lft region color 1 + path marker + right reg color 2
3. r_ang_sml	right angle small	lft rgn color 1 + path marker + right reg color 2
4. r_ang_hor	right angle horizon	lft rgn clr 1 + path marker + r rgn clr 2 + top rgn clr2

1. lft rgn clr 1 + path marker + r rgn clr 2:contour 1+no curvature+start/end pts+hough ang
2. lft rgn clr 1 + path marker + r rgn clr 2:contour 1+no curvature+start/end pts+hough ang
3. lft rgn clr 1 + path marker + r rgn clr 2:contour 1+no curvature+start/end pts+hough ang
4. lft rgn clr 1 + path marker + r rgn clr 2 + top rgn clr2:
   contour 1+curvature-angle-E/SE/S+start/end pts+2hough angs

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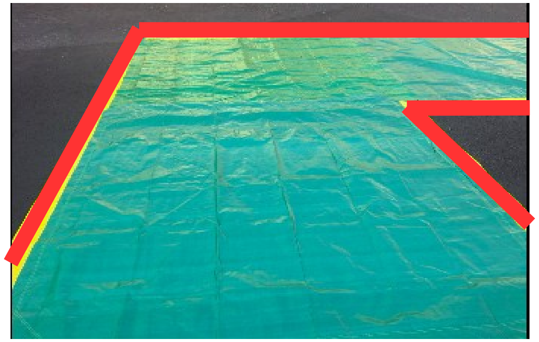
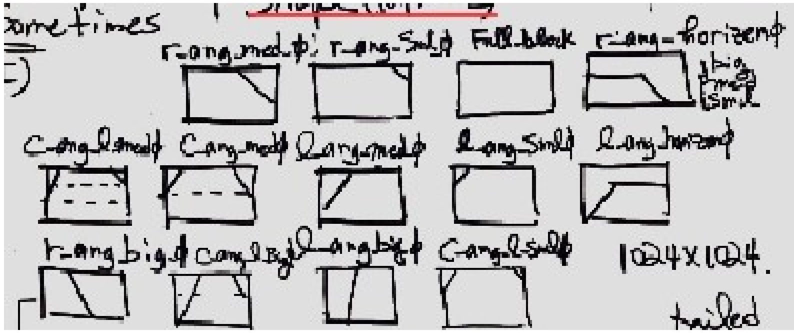
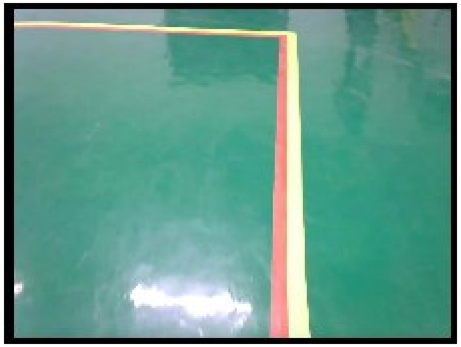
PDL Language for CAT-II Path Classification



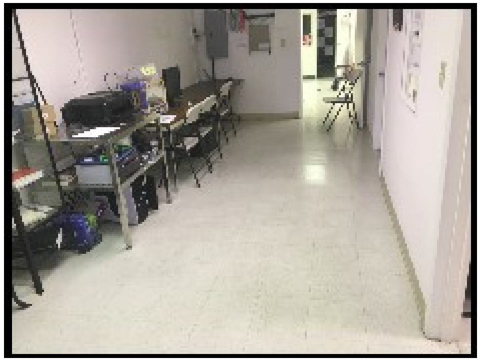


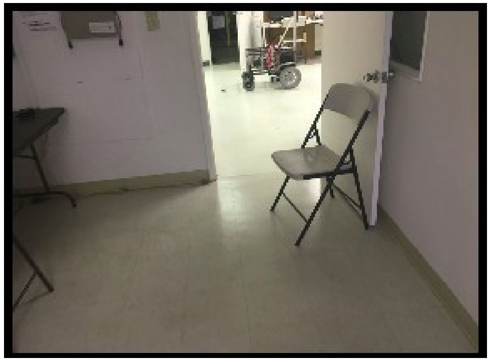
CAT-I Path Adaptive Thresholding

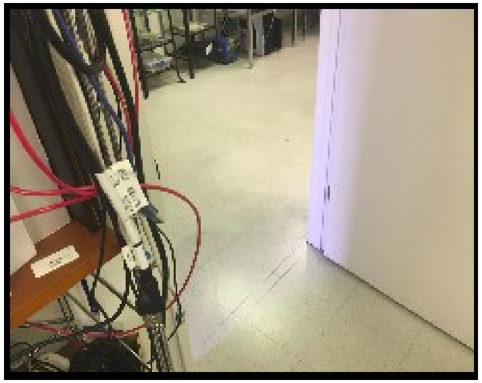


CAT-III Path

VideoPath-Indoor-2018-9-27







1. How many categories? How many is too many? How many is too few? What is the selection criterion? Can we use design principal from computer architecture (uniformity, regularity, orthogonality?)

Three sub-categories to consider for navigation need?

(1) in hall way, facing elongated path

(2) in room facing a door

(3) (hall way | room) facing (wall | surroundings)

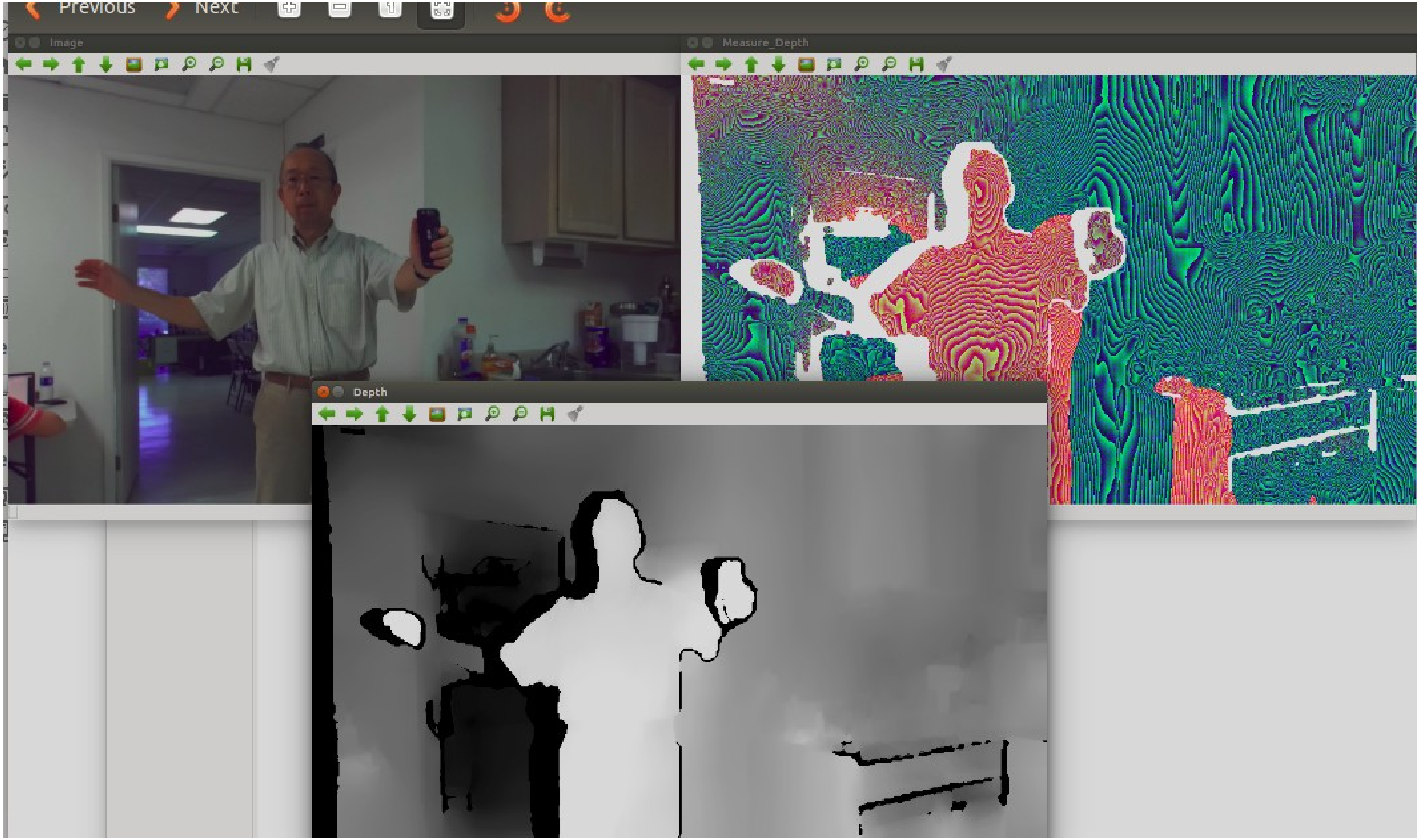
2. What visual clue to use to move the the right direction?

(1) (flat surface) & (longest flat surface) & (somewhat structured surrounding it)

(2) primitive features of (flat surface) | (somewhat structured surroundings) | (longest flat surface)

Depth Map From Stereo Vision

CAT-III Path



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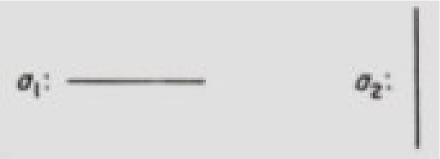
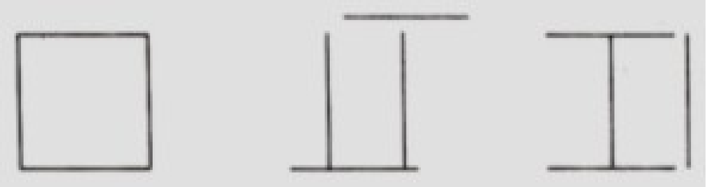
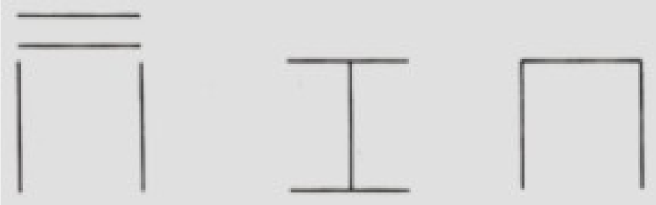
Syntax Parsing



(1) a1 and a2 pattern primitives



(2) patterns parse correctly



Certain rules clearly describe why the failure occurs

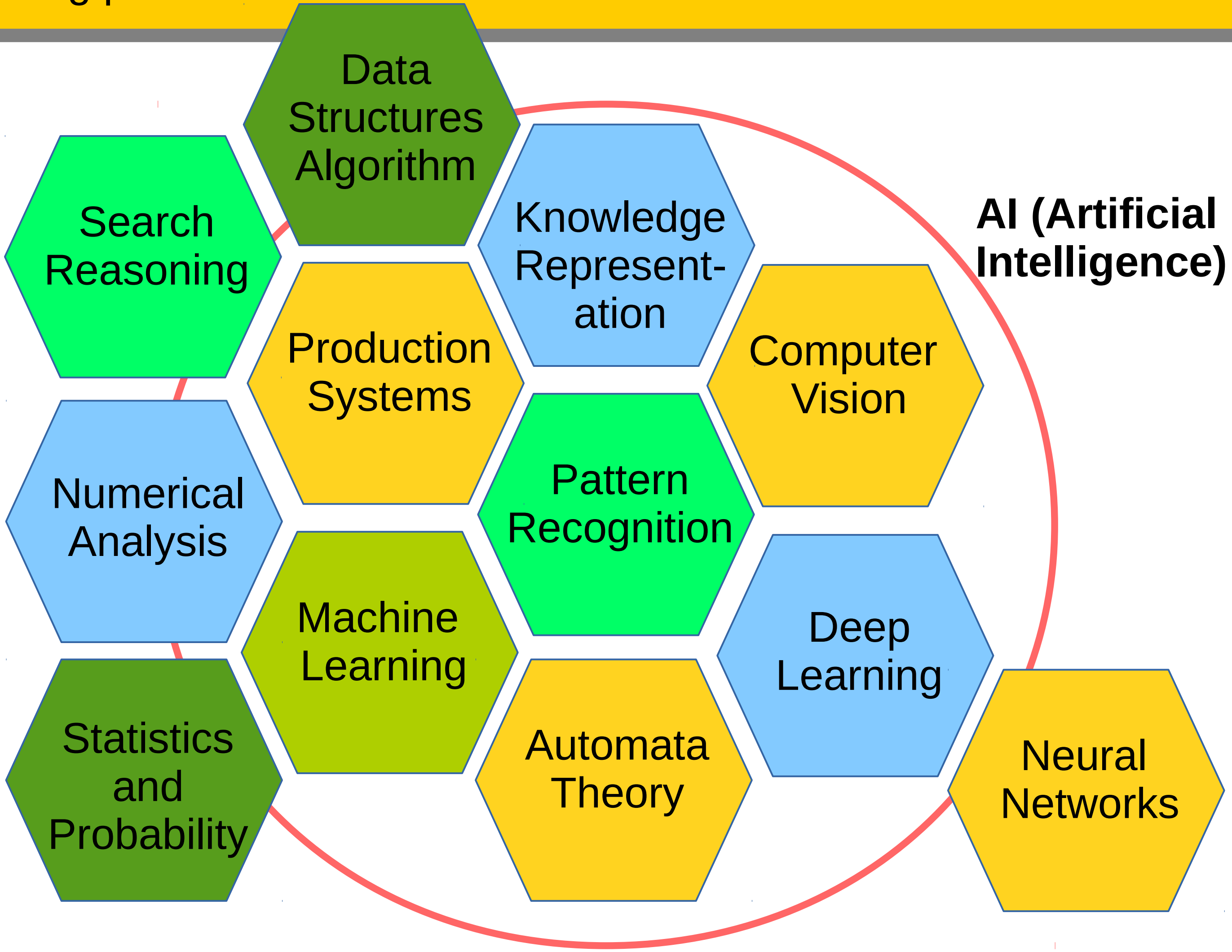
(3) patterns failed parse

From “pattern recognition”, pp. 330

Contours To Syntax Parsing

The Scope of AI

What is AI (Artificial Intelligence)? Technology which employs computer to build intelligence capability to mimic human decision making, to assist and release human from decision making process.



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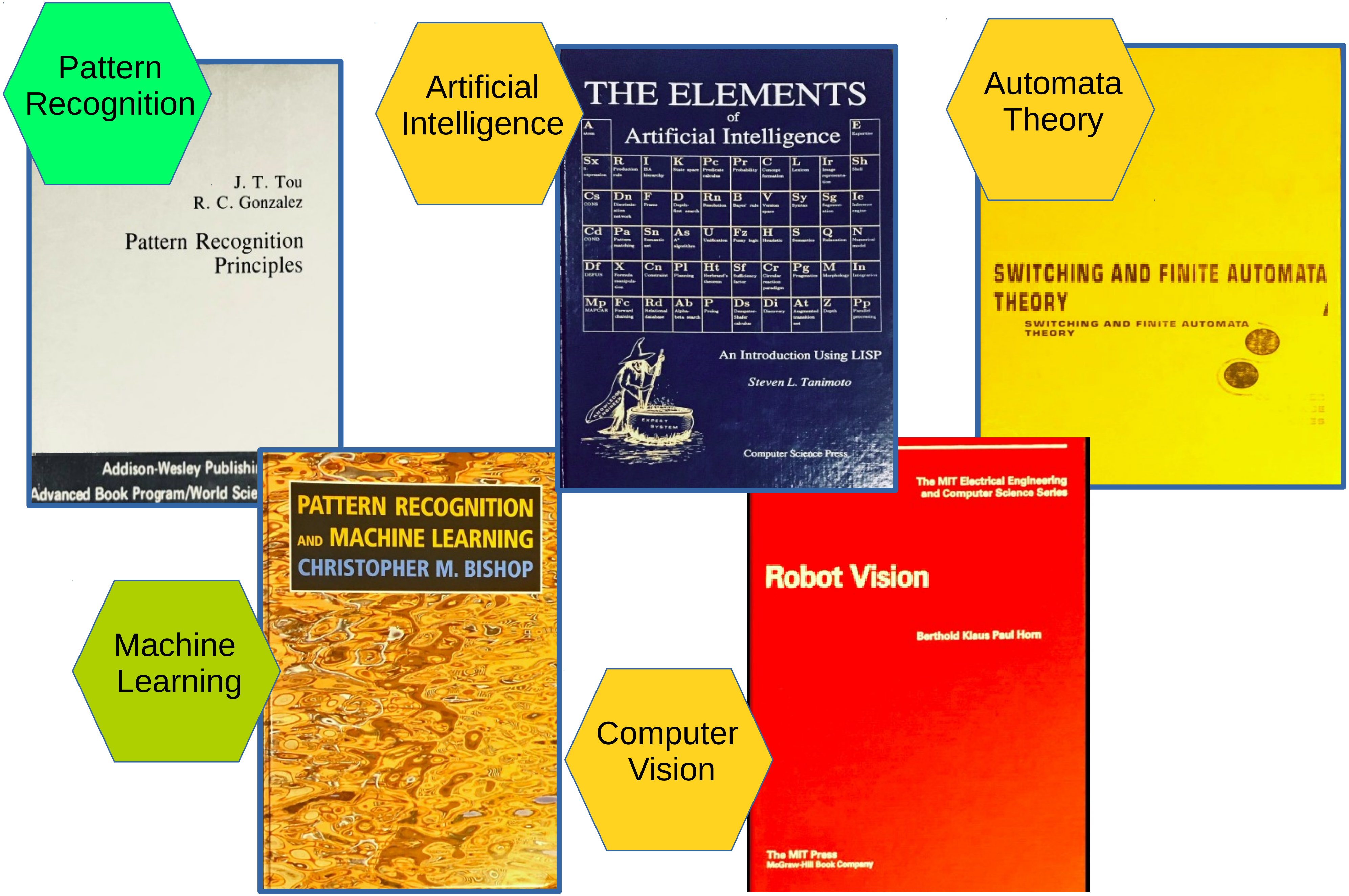
Reference on AI and PR



Pattern Recognition

J. T. Tou
R. C. Gonzalez

Pattern Recognition
Principles

Addison-Wesley Publishi
Advanced Book Program/World Scie

Artificial Intelligence

THE ELEMENTS
of
Artificial Intelligence

A atom									E Expertise
Sx S-expression	R Production rule	I ISA hierarchy	K State space	Pc Predicate calculus	Pr Probability	C Concept formation	L Lexicon	Ir Image representation	Sh Shell
Cs CONS	Dn Discrimination network	F Frame	D Depth-first search	Rn Resolution	B Bayes' rule	V Version space	Sy Syntax	Sg Segmentation	Ie Inference engine
Cd COND	Pa Pattern matching	Sn Semantic net	As A* algorithm	U Unification	Fz Fuzzy logic	H Heuristic	S Semantics	Q Relaxation	N Numerical model
Df DEFUN	X Formula manipulation	Cn Constraint	Pl Planning	Ht Herbrand's theorem	Sf Sufficiency factor	Cr Circular reaction paradigm	Pg Pragmatics	M Morphology	In Integrative
Mp MAPCAR	Fc Forward chaining	Rd Relational database	Ab Alpha-beta search	P Prolog	Ds Dempster-Shafer calculus	Di Discovery	At Augmented transition net	Z Depth	Pp Parallel processing

An Introduction Using LISP

Steven L. Tanimoto

Computer Science Press

Automata Theory

SWITCHING AND FINITE AUTOMATA THEORY

SWITCHING AND FINITE AUTOMATA THEORY

Machine Learning

PATTERN RECOGNITION AND MACHINE LEARNING
CHRISTOPHER M. BISHOP

Computer Vision

The MIT Electrical Engineering and Computer Science Series

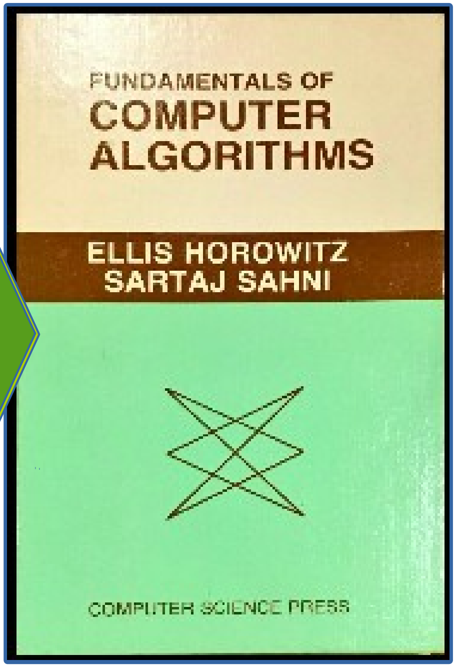
Robot Vision

Berthold Klaus Paul Horn

The MIT Press
McGraw-Hill Book Company

Secondary But Useful Reference

Data Structures Algorithm

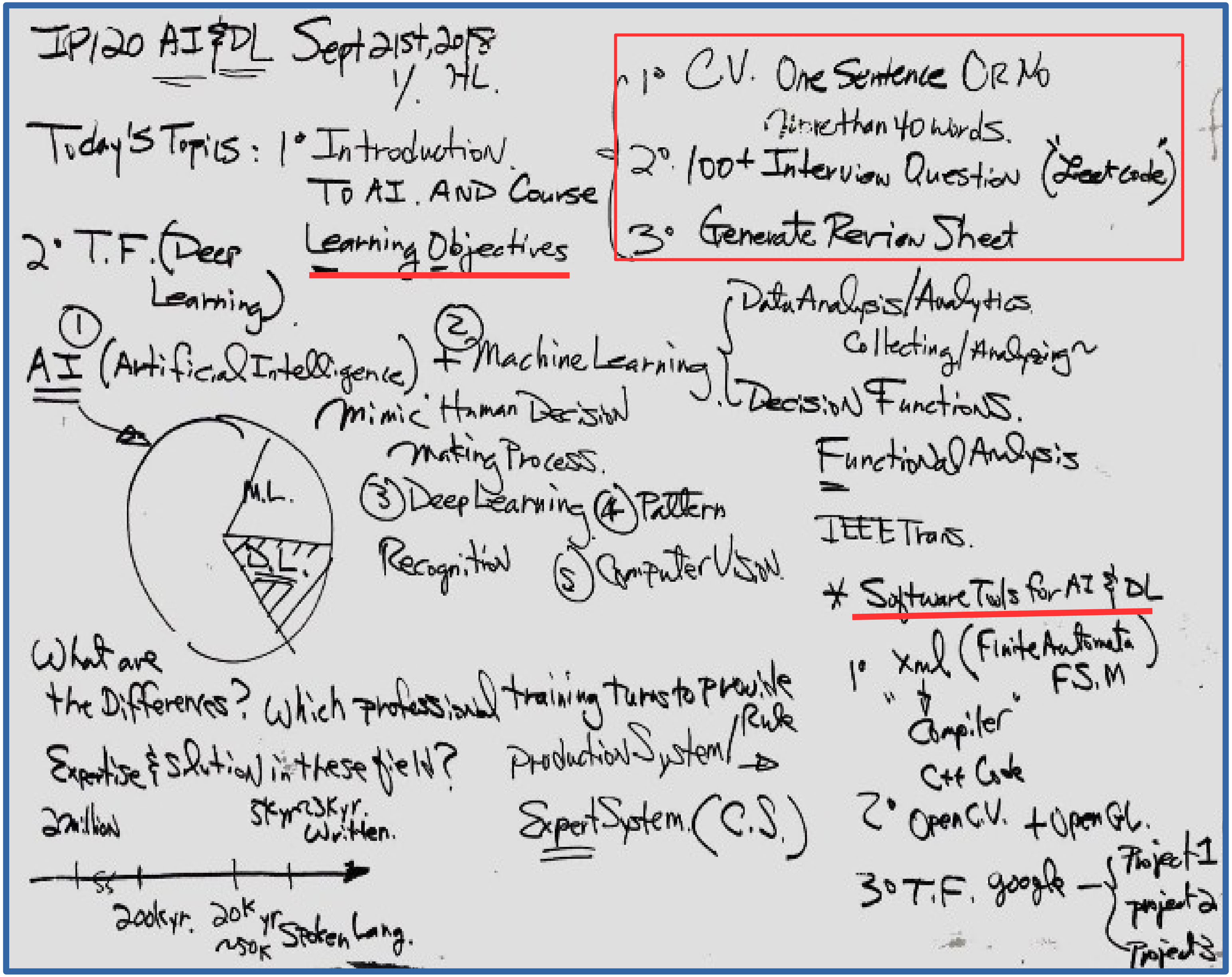


FUNDAMENTALS OF
COMPUTER
ALGORITHMS

ELLIS HOROWITZ
SARTAJ SAHNI

COMPUTER SCIENCE PRESS

9-21-2018 The Scope of AI



IP120 AI & DL Sept 21st, 2018

Y. HL.

Today's Topics: 1° Introduction
To AI. AND Course
Learning Objectives

- 1° C.V. One Sentence OR No more than 40 words.
- 2° 100+ Interview Question ("Leet code")
- 3° Generate Review Sheet

2° T.F. (Deep Learning).

① AI (Artificial Intelligence) ② Machine Learning
- Data Analysis/Analytics Collecting/Analyzing
- Decision Functions.

(Mimic Human Decision Making Process.

③ Deep Learning ④ Pattern Recognition ⑤ Computer Vision

Functional Analysis

IEEE Trans.

* Software Tools for AI & DL

1° Xml (Finite Automata FS.M)
"Compiler"
C++ Code

2° OpenC.V. + OpenGL.

3° T.F. google — Project 1, project 2, Project 3

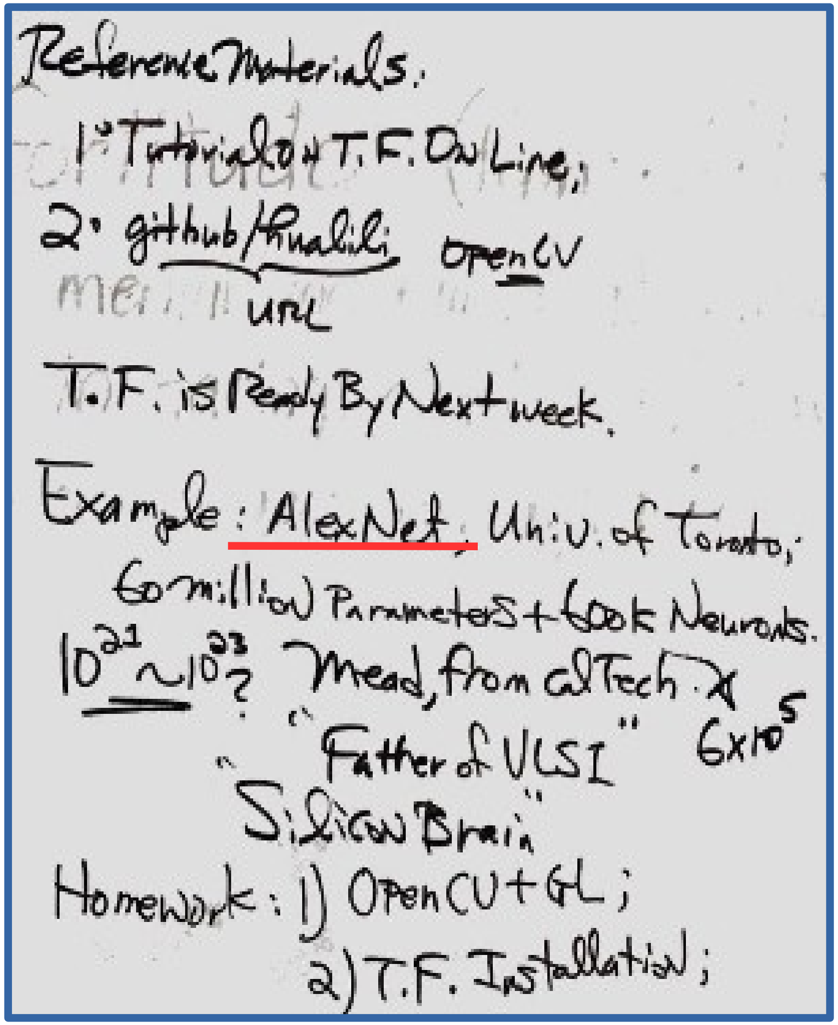
What are the Differences? Which professional training turns to provide Expertise & Solution in these field?

Production System / Rule → Expert System (E.S.)

2 million 5kyr ~3kyr. Written.

55 200kyr. 20k yr ~50K Spoken Lang.

9-21-2018 Three Projects And Reference



Reference Materials:

1° Tutorial On T.F. On Line;

2° github/hualili OpenCV

url

T.F. is Ready By Next week.

Example: AlexNet, Univ. of Toronto;

60 million Parameters + 600k Neurons.

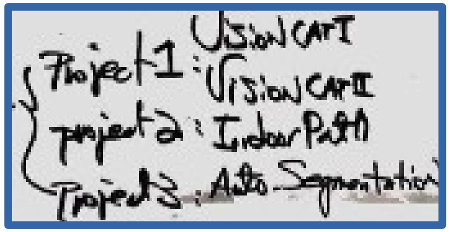
$10^{21} \sim 10^{23}$? "Mead, from CalTech. X 6×10^5

"Father of VLSI"

"Silicon Brain"

Homework: 1) OpenCV+GL;

2) T.F. Installation;



Project 1: Vision CAR I

Vision CAR II

project 2: Indoor Path

Project 3: Auto Segmentation

9-21-2018 CLIPS For Expert Systems

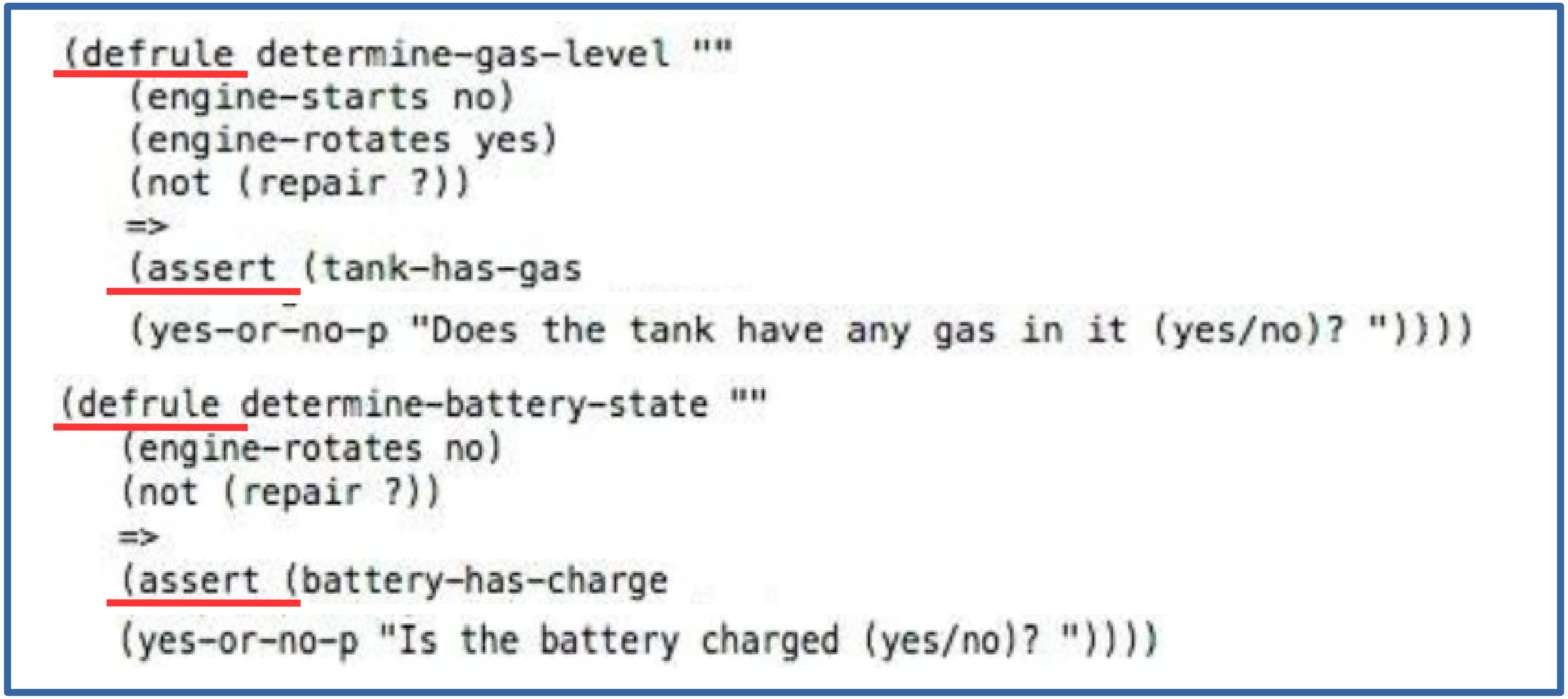
CLIPS

http://clipsrules.sourceforge.net/Version63Beta.html

A Tool for Building Expert Systems

“CLIPS is a forward-chaining rule-based programming language in C with procedural and object-oriented programming facilities”

Sample:



```
(defrule determine-gas-level ""
   (engine-starts no)
   (engine-rotates yes)
   (not (repair ?))
   =>
   (assert (tank-has-gas
   (yes-or-no-p "Does the tank have any gas in it (yes/no)? "))))

(defrule determine-battery-state ""
   (engine-rotates no)
   (not (repair ?))
   =>
   (assert (battery-has-charge
   (yes-or-no-p "Is the battery charged (yes/no)? "))))
```

Mac Version and Windows Version can be down loaded.

https://sourceforge.net/projects/clipsrules/files/CLIPS/6.30/clips_documentation_630.zip/download?use_mirror=superb-sea2&r=https%3A%2F%2Fsourceforge.net%2Fprojects%2Fclipsrules%2Ffiles%2FCLIPS%2F6.30%2F&use_mirror=superb-sea2

9-21-2018 Embed CLIPS To Other C++ Program

CLIPS was designed to be embedded within other programs, the user must provide a main program. Calls to CLIPS are made like any other subroutine. To embed CLIPS, add include statements to the user’s main program file:

#include "clips.h"

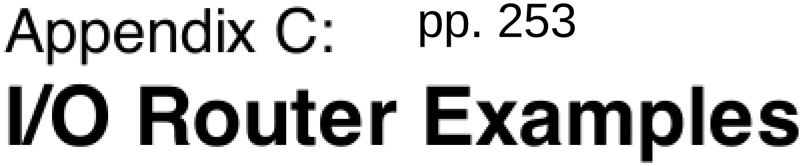
Section 4:

Embedding CLIPS

pp. 67

Section 7:

I/O Router System



Appendix C:

I/O Router Examples

pp. 253

Example: pp. 257

C.3 Batch System

More examples from conference proceedings third_clips_conference_proceedings.pdf

2018F Harry Li, Ph.D.