

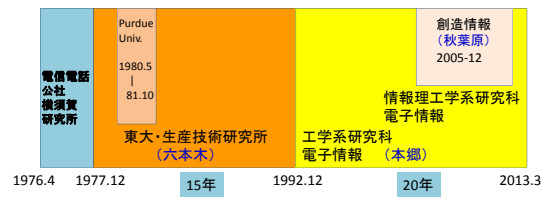
2013.3.11 最終講義

知能情報のコアと工学


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 電子情報学専攻


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所属



1976.4 1977.12 15年 1992.12 20年 2013.3


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研究テーマと変遷

- 画像符号化, 適応的画像処理(1971-76: 大学院・猪瀬研究室)
- デジタル移動通信(1976-77: 日本電信電話公社・横須賀研究所)
- **画像メディア処理, 生命的エージェント, マルチモーダルメディア**
 - 画像処理, パターン認識(1978-80, 1982-85)
 - リアルスティックな顔をもつVSA(Visual Software Agent)(1988-2000)
 - 並列画像処理プロセッサTN-VIT(1888-93)
 - マルチモーダルメディア記述言語MPMLとその発展形(1998--)
 - 生命的エージェントとの(Webを含む)インタラクション(1994--)
 - テキストからの感情センシング(2005-11)
 - モノログテキストからの対話生成(2007--)
- **人工知能, 知能情報学**
 - エキスパートシステム, AIツール(1980-81:パデュ大学, 1981-85)
 - 不確実な知識の扱い(1980-85)
 - 仮説推論, 特にその高速化(1986-2000)
- **Web知能化**
 - Web変化検出, Webテキストマイニング, 要約, キーワード抽出, 構造化(1995--)
 - 人間関係ネットワーク抽出, 属性抽出(2003-10)
 - 関係類似性, 関係検索(2007-12)
 - 意味計算基盤: Semantic Computing(2001--)

Before Web, After Web.

何を考えて研究テーマを選んだか


1. 「面白い, 面白そうか」 AIは夢があった
2. 「価値ある研究, インパクトある研究か」
 - 社会, 産業, 生活の進歩, 改革に寄与
 - ソフトの比重が大きい情報技術は, 使われて広まることにより評価が上がり, 大きなインパクト 工学
 - 一方で, 大学での研究の役割, 企業では出来ないこと.
 - 次世代を拓く基盤, 基礎 コア
 - 学生の教育の観点からも両面必要だった


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コア

- **画像メディア処理, 生命的エージェント, マルチモーダルメディア**
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コア


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電信電話公社 横須賀通研 (1976.4--77.12)



自動車電話のサービス開始 1979.12

□ **移動通信研究室: デジタル移動通信**


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音声を送るデジタル移動通信の最初

デジタル化の可能性/基本方式設計

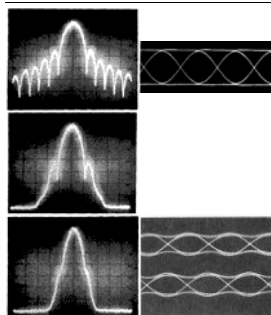
- ※ 変復調, 音声符号化, 誤り訂正, 秘話...
- ※ 主にSCPS(Single-Channel-Per-Carrier)
- ※ 位置測定関連でCDMAも考えてはいたが...

800MHz&Baseband回路試作とフェージング下での実験による性能評価

GMSK(Gaussian Minimum Shift Keying)の最初の実験



GMSK (Gaussian Minimum Shift Keying)



K. Hirade and K. Murota "A study of modulation for digital mobile telephony", 29th IEEE Vehicular. Tech. Conf., 1979
 K. Murota and K. Hirade "GMSK Modulation for Digital Mobile Radio Telephony", IEEE Trans. Commun., vol. COM-29, no.7, pp.1044-1050, July, 1981

石塚満 安田靖彦: GMSKの誤り回復機能をもつ直交2軸位相検波の原理, 電子通信学会通信方式研究会報告, CS79-191 (1979.12)
 M. Ishizuka and K. Hirade "Optimum Gaussian filter and deviated-frequency-locking scheme for coherent detection of MSK", IEEE Trans. Commun., Vol. COM-28, pp.850-857 (1980.6)
 M. Ishizuka and Y. Yasuda: Improved Coherent Detection of GMSK, IEEE Trans. Commun., Vol.COM-32, No.3, pp.308-311 (1984.3)

欧州 ETSIでの GSM 1987 標準がGMSKを採用—2G Mobile

東大生産技術研究所へ



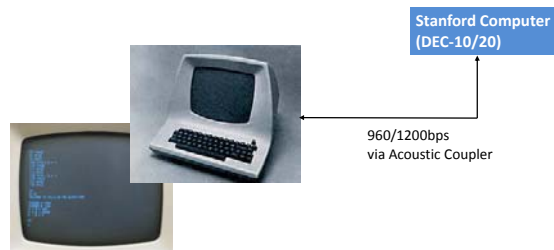
多次元画像情報処理センター

尾上守夫先生, 高木幹雄先生, (安田靖彦先生)

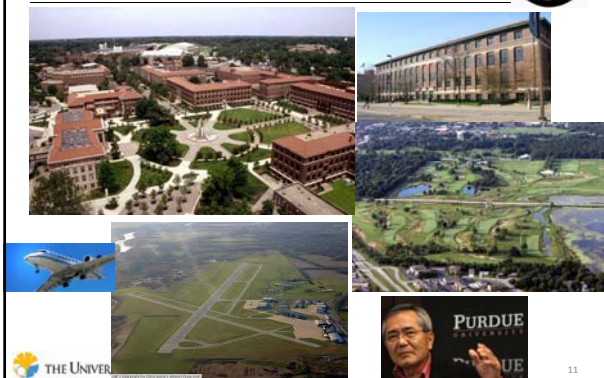
期待されていたので画像の研究を始めた。対象は広がった。幸い上の先生との関係はゆるかった。画像分野は著名な先生がおられるので、違うことを始めたいと思った。

Previous Year going to Purdue

※ I saw MYCIN demonstration by E. Shortliffe at IJCAI-1979 in Tokyo



Purdue Univ. (1980.5 – 1981.10)



Employed by a NSF Project on Damage Assessment

※ K. S. Fu (1930-1985): syntactic pattern recognition

※ James T. P. Yao (1932-2009): damage assessment, and applications of fuzzy set in civil eng.



プロポーザルではパターン認識手法で行うとされていたが、手法は何でもよかった。新しいAIに着手するため、Rule-based Systemでやろう。Yao先生のfuzzyも考慮しなければ。でもそれだけでは... 新しいコアも...

SPERIL: 構造物耐震性査定のエキスパートシステム


• by M. Ishizuka, James T.P. Yao, and K.S. Fu at Purdue Univ. (1980-81)




THE UNIVERSITY OF TOKYO IEEE Spectrum, Aug. 1983 J.T.Yao's Book, 1985

SPERIL's Program appeared in the appendix of Yao's Book

Appendix B SPERIL-I



THE UNIVERSITY OF TOKYO pp. 73 - 118

不確実性(uncertainty)の表現と推論


- MYCINのCF (certainty factor)
 - 人間の主観的不確実性を扱うのにベイズ確率量は必ずしも適当でないとした
- 主観的ベイズ法(Subjective Bayesian Method)
 - SRI: PROSPECTORで使われる
- Dempster-Shafer確率理論
 - 無知量を集合内で移動可能な基本確率量として扱う。
 - (石塚によるFuzzy集合への拡張)
- 確率論理 (Probabilistic Logic, by N. Nilsson)
 - 論理と整合す堅固な基礎をもつのだが...
- ベイジアンネットワーク (Bayesian Network, by J. Pearl)
 - ネットワーク形の表現で知識処理に適合
- 別の系譜: Fuzzy集合論, Fuzzy推論

石塚の研究以後

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Dempster-Shaferの確率理論

※ 肩まで髪のあるズボン姿の人物を後ろから見て「0.4女らしい」



Bayes 確率理論による解釈

0.4	0.6
女	男

Dempster-Shafer理論

0.4	
0.6	
女	男
Max 1.0	0.6
Min 0.4	0

集合内を自由に移動する基本確率(確率質量) (Probability mass freely movable in a set) この場合は無知の量

石塚によるこの集合のfuzzy集合への拡張

A. P. Dempsterによる1968の論文, G. Shaferの1976の良く分かる本

A. P. Dempster (Harvard Univ.) は1977に EM アルゴリズムも定式化している。

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日本に戻ると第5世代コンピュータが始まった

- AI Tools (Rule-based System, Frame System)
 - これらによる画像理解
 - SPERILの日本版(生研の構造物の先生との共同研究)
- Prolog-ELF incorporating Fuzzy Logic
 - 命題, 述語項が0~1.0のfuzzy所属値をとる。(否定の理論的扱いが明らかでない点あり)

Fuzzyはそれ程好きではなかったが Latfi Zadeh先生(1921生れ)は大変良い人だった。




2006 in Beijing

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Workstationを買えた 1984

Ridge 32 (最初のコマーシャルRISC computer) 5 MIPS (CPUはチップでなくボード)



実は最初買ったのはこのSyteで、Displayは大きかったが動作不良だった。Ridgeはこの代替で納入された。

SUNは1982だったが、日本発売は1984以後だった。

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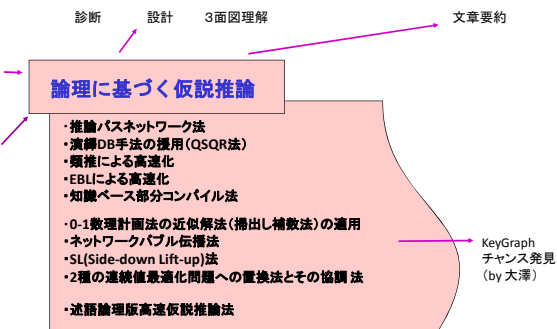
ALTO at Xerox PARC, Sept. 1978



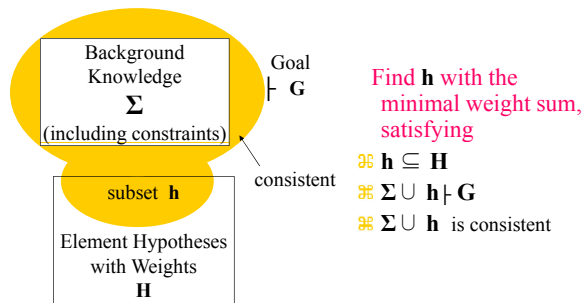
Google's First Server



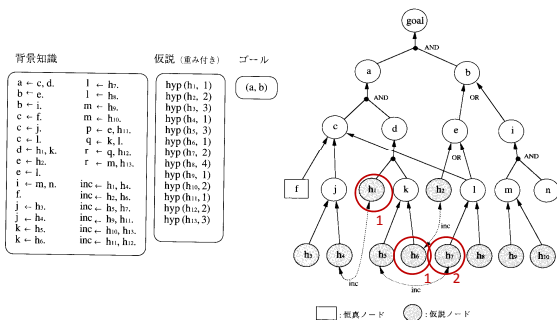
論理に基づく仮説推論と高速推論メカニズム (1986-2000)



Cost-based Hypothetical Reasoning (or Abduction) -- [1]



An Example of Simple Hypothetical Reasoning Problem



Cost-based Hypothetical Reasoning (or Abduction) -- [2]

- ⌘ Sound theoretical (logical) basis (inverse problem of deduction)
 - ⌘ Useful for many practical problems, such as, diagnosis, design, planning, etc.
- But:**
- ⌘ Problem of low inference speed (nonmonotonic reasoning and NP-hard problem in general)

Our Fast Inference Mechanisms for Hypothetical Reasoning [1]

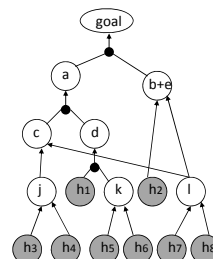
{ATMS}

- **Inference-path Network method**
(推論パスネットワーク法; 1991年人工知能学会5周年記念論文賞)
based on Dowling & Gallier's linear-time algorithm for propositional Horn logic. (ゴール指向バックトラックなしのボトムアップ計算)
- **Efficient method for Predicate-logic Hypothetical Reasoning employing a Deductive Database mechanism.**
(演繹DB手法の採用)
- **Fast Inference using Analogical Reasoning** (類推による高速化)
- **Speedup by Experience-based Learning (EBL)**
- **Partial Knowledge-base Compilation** (知識ベース部分コンパイル)
-- computing prime implicates (主項)

Inference-path Network method (推論パスネットワーク法)

1. 推論パス生成フェーズ

- Dowling-Gallierの線形アルゴリズムにより高速
- ネットワークのコンパイル



2. 仮説合成フェーズ

- 順次仮説を投入するバックトラックなしの前向き合成
- 集合演算による矛盾仮説セット, 冗長仮説セットの排除

Inference Speed attained by the Inference-path Network method

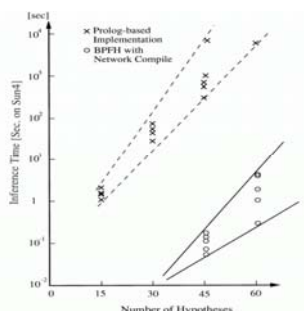


Fig. CPU time v.s. number of hypotheses in fault diagnosis for a full adder circuit.

教訓

- Top-down or Bottom-up ?

My choice:

- Goal-directed Bottom-up

Local Searches and the Use of Mathematical Programming

□ Successful Local Searches for Propositional-level Reasoning

- GSAT (by Selman & Kautz)
- Gu's method using non-linear programming
- ---

These methods find a single solution, and cannot be used to find an optimal solution since random restart strategies are employed to escape from local optima.

□ Use of Mathematical Programming Techniques

- J.N.Hooker(1988) for general logical inference, particularly for Horn-clause logic.
- E.Santos,Jr.(1994, 96) for cost-based abduction (but with no inconsistency)
- **Pivot-and-Complement method** (Balas & Martin, 1980) for 1-0 integer programming ---- simplex method for finding an initial search point and a sophisticated local search (involving lots of heuristics).

Our Fast Inference Mechanisms for Hypothetical Reasoning [2]

Computing a near optimal solution using linear and non-linear programming in polynomial-time for cost-based hypothetical reasoning, [Propositional Case]

□ A method employing an approximate solution method of 1-0 Integer Programming (0-1整数計画法の近似解法の適用)

(Simplex method and Pivot-and-Complement methods, 単体法と掃出し補数法)

□ Networked Bubble Propagation (NBP) method

(ネットワークバブル伝播法) -- fast but complex → KeyGraph(大澤)

□ SL (Side-down Lift-up) method

-- employing both linear and non-linear programming

□ Cooperation of Two Basic Transformations

Transformation into Linear Programming (a set of linear inequalities)

Associate true/false states of logical variables with 1/0 of the corresponding numerical variables.

Ex1) $q \leftarrow p1 \wedge p2.$

$q \leq p1, q \leq p2, p1 + p2 - 1 \leq q$

Ex2) $q \leftarrow p1 \vee p2.$ (combination of $q \leftarrow p1.$ and $q \leftarrow p2.$)

$p1 \leq q, p2 \leq q, q \leq p1 + p2$

Define the cost of the solution as

$cost = w_1h_1 + w_2h_2 + \dots \rightarrow \min.$

Transformation into Unconstraint Non-linear Programming (Gu's method)

Associate truth/false of logical variable with 1/-1 of the corresponding numerical variable.

Replace logical atom x and $\neg x$ by $(x-1)^2$ and $(x+1)^2$, respectively.

Replace \wedge and \vee by $+$ and \times , respectively, assuming that all the clauses are connected with conjunction.

Ex) $1 \leftarrow g., g \leftarrow a, b, c.$

Completion ($g \Leftrightarrow a, b, c.$); Construction of a non-linear function

$f = (1-g)^2 + (g-1)^2(a+1)^2(b+1)^2(c+1)^2 + (g+1)^2(a-1)^2 + (g+1)^2(b-1)^2 + (g+1)^2(c-1)^2 \rightarrow 0$

Problem: the magnitude of each product term varies to a large extend. This causes an undesirable effect.

SL Method: New Transformation into Non-linear Functions

Gu's transformation

$f = (1-g)^2 + (g-1)^2(a+1)^2(b+1)^2(c+1)^2 + (g+1)^2(a-1)^2 + (g+1)^2(b-1)^2 + (g+1)^2(c-1)^2$

New transformation (true / false $\Leftrightarrow 0.5 / -0.5$)

$f = (0.5-g)^2 + (g-0.5)^2(a+0.5)^2(b+0.5)^2(c+0.5)^2 + (g+0.5)^2(a-0.5)^2 + (g+0.5)^2(b-0.5)^2 + (g+1)^2(c-0.5)^2$

All product terms stay almost less than or equal to 1.0.

Solution

If $f = 0$, then the system finds a solution hypothesis set which can prove a given goal.

This is not necessarily an optimal one in general.

However, as the local search starts from the optimal solution in continuous-value space, it reaches a (near) optimal solution.

Variable Fixing for escaping from local optima

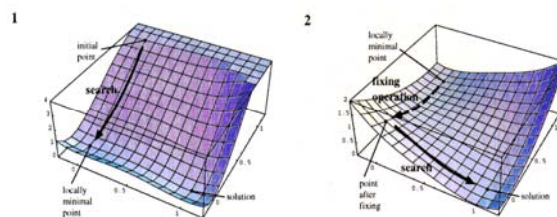
Goal-directed correction of the inconsistent combinations of variable (node) states by fixing targeted variables to 0.5 (true) or -0.5 (false).

Ex.) A parent node whose all AND-related child nodes are true state is fixed to 0.5 (true).

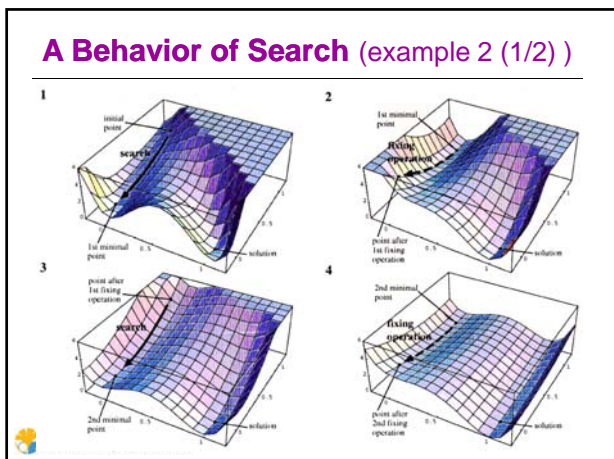
Consider the fixed nodes to be constants so as to avoid going into the same local optima again.

Unlike probabilistic schemes used in simulated annealing (SA), this gives a systematic escaping scheme.

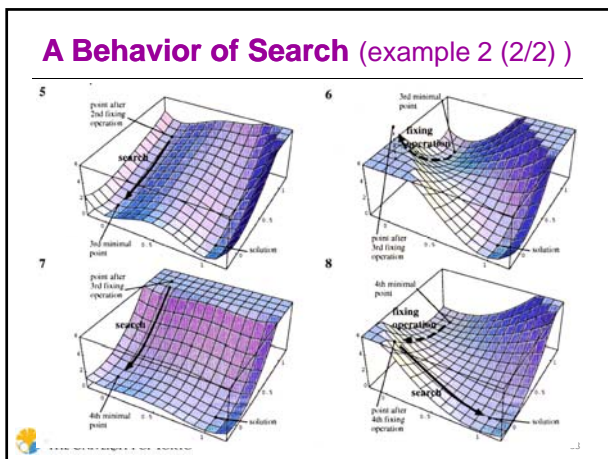
SL Method: A Behavior of Search (example 1)



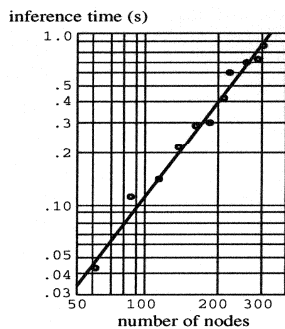
A Behavior of Search (example 2 (1/2))



A Behavior of Search (example 2 (2/2))

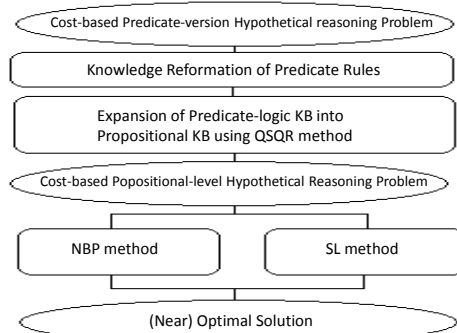


Inference Time of SL Method

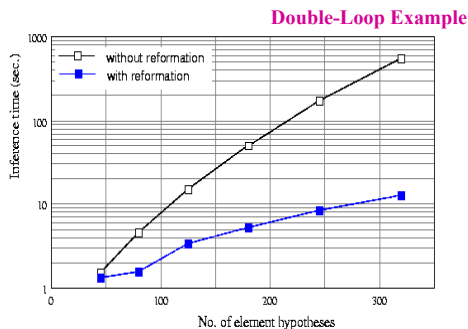


- Time $\propto N^{1.85}$, where N is the number of nodes.
- Solution cost obtained is almost the same as that of NBP.
- The failure of the search is one case out of 110 test problems generated randomly.

Our Fast Inference Mechanisms for Hypothetical Reasoning [3: Predicate-Logic Case]



Efficiency Improvement of Total Inference Time with Knowledge reformation in Predicate-Logic Case



何故Binary空間探索より連続値空間探索の方が有効か

- 探索点周囲の僅かな傾斜情報でも探索のガイドに使える。
- シンプレックス法のような優れた大局を考慮する推論法を利用できる (直感による目星)
- 有効な近似解法は問題枠組み毎に異なる。
- 問題を類型化し有効近似解法を系統的に整理できないものだろうか。 ← 今後の課題

幾分の反省点

仮説推論に関し国際レベルの高速化は達成したが、国的認知度は必ずしも十分でない。

その理由

- 当初からの「**仮説推論 (Hypothetical Reasoning)**」の呼称と枠組みにこだわった。(Abductionでもあるが、区別して用いた。)
- かなりの部分は**CSP, SAT**にも共通であるのに、**CSPやSAT**の枠組みで示さなかった。(枠組みによる差異もあり)
- 公開プログラムの整備が十分でなかったこともある。

2分決定グラフ(BDD and ZBDD)を使う応用も早期に手掛けた(回路設計以外で初?)

Vol. 37 No. 11 情報処理学会論文誌 Nov. 1996

二分決定グラフの適用による三面図の効率的理解

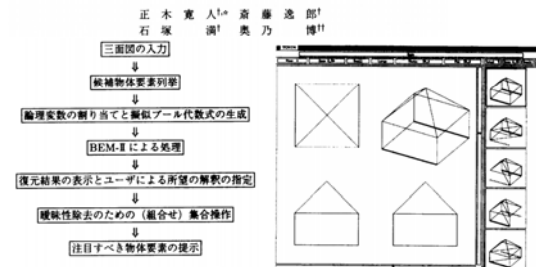


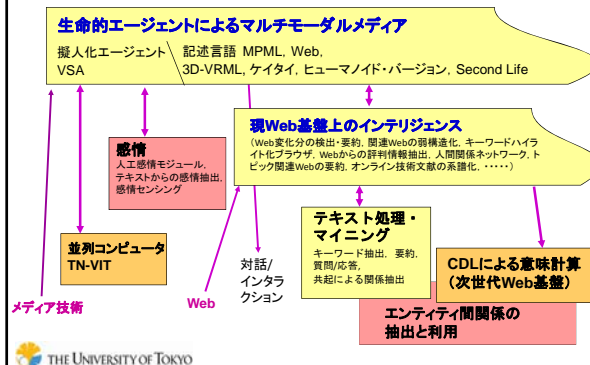
図5 三面図理解システム TOVIN の処理の流れ
Fig. 5 Processing flow of the understanding system for three orthographic views: TOVIN.

図6 試作システム TOVIN の表示画面
Fig. 6 A display of the prototype system: TOVIN.

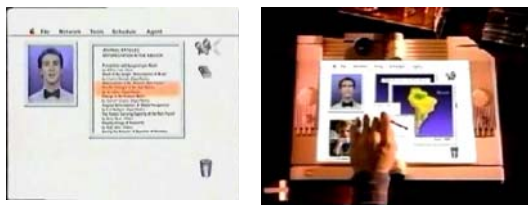
画像/マルチモーダル再開の背景 1988~

- 生研に来た時に言われたテーマで、AIを始めたため棚上げしていた。
- 画像認識だけでなく、新しいヒューマンインタフェース/インタラクションが視野に入ってきた。AIも関係する。
郵政省・ヒューマンインタフェースサポートシステム調査委員会・座長(1988-1990)で勉強した。
- 原島先生の顔モデラーは擬人化インタフェースとして使うのが面白そうだった。
- 学生もふえてきた。
- 尾上先生には画像処理ハードをやるように期待されていて、幾分か行ったが十分でなかった。Transputer (INMOS Inc.) が並列画像処理に面白そうだった。

生命的エージェントによるマルチモーダルメディア(1989-) Webインテリジェンス(1995-)

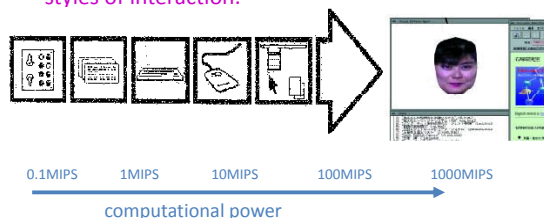


Apple's Knowledge Navigator (in 1987)



Progress in Human Interfaces

Towards more natural and more intuitive styles of interaction.



Multimodalities (Non-verbal factors) in Human Communication

(by Albert Mehrabian)

☞ Information transferred in daily human communication

- ☞ via Language (flat sentence) 7%
- ☞ via Speech with tone and intonation 38%
- ☞ via Facial expression and Gesture 55%



豊富な情報の伝達

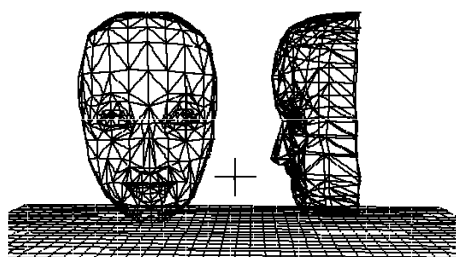
- ➡ 豊かな印象
- ➡ 理解度の向上と、印象に残る記憶

VSA (Visual Software Agent) -- Early Stage

from 1989



Realistic Texture-mapped Moving Face



Our "Software Agent" papers in 1991

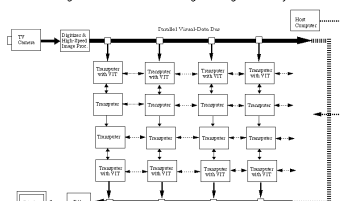
- ☞ W. Wongwarawipat, C.W. Lee, O. Hasegawa, H. Dohi, and M. Ishizuka: **Visual Software Agent Built on Transputer Network with Visual Interface**, Transputing'91 (Proc. Int'l Conf. on Transputing), Sunnyvale, California, pp.813-827 (1991.4)
- ☞ M. Ishizuka, O. Hasegawa, W. Wongwarawipat, C.W. Lee, and H. Dohi: **Visual Software Agent (VSA) built on Transputer Network with Visual Interface (TN-VIT)**, Proc. Computer World'91, Osaka, pp.36-46 (1991.9)

TN-VIT for Real-time Image Recognition and Synthesis

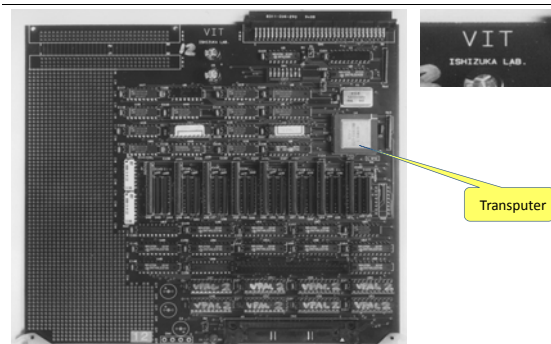
☐ トランスポータT-805 48台並列

独自の32ビット並列画像データベースにより、実時間動画生成、実時間動画認識の両者に適用可能

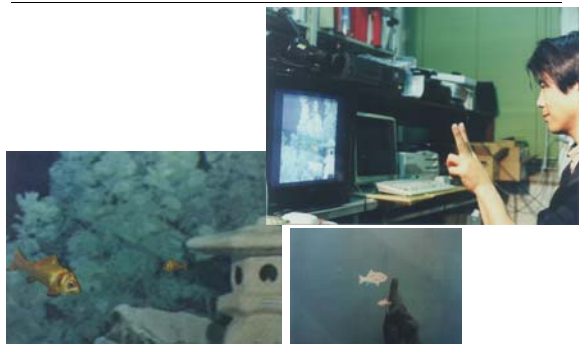
VIT Configuration for Real-time Image Recognition & Synthesis



VIT Board



Finger Gesture Recognition and Interaction



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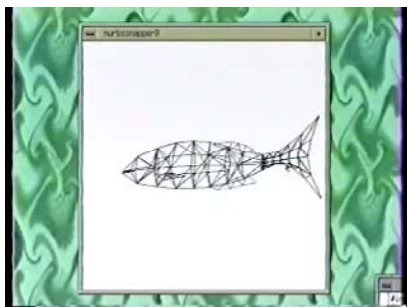
Real-time Moving Texture Mapped Images



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56

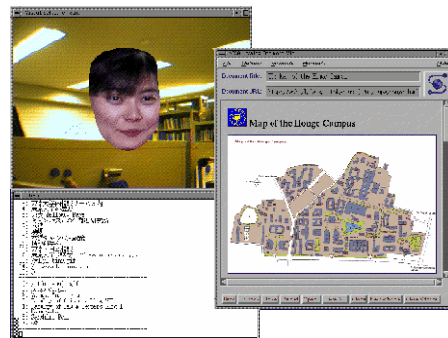
Demo



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VSA connected with Mosaic (1995)



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VSA connected with Netscape

Visual Software Agent
with rocking realistic face
and speech dialog function.

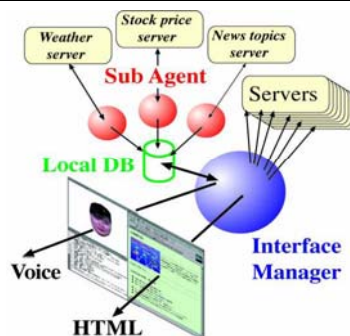


Netscape Navigator
window

Anchor list
automatically extracted whenever new page is opened
<index_number, anchor_string, URL>

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Sub Agents



Autonomously
gathers
relevant special
topics, and
updates the
local database.

The VSA replies
user's requests
promptly in
voice.

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Before Web, After Web

- 1989: World Wide Web by Tim Berners-Lee
- 1992: Mosaic by Marc Andreessen
- 1993: Mosaic Commun. (=>Netscape) with Jim Clark
- 1994: We started Web-related Researches.
- 1995: Yahoo! by Jerry Yang and David Filo
- 1998: Google by Larry Page and Sergey Brin
- 2004: YouTube by Chad Herly and Steven Chen
- 2004: Facebook by Mark Zuckerberg
- 2005: Web 2.0 (Tim O'Reilly)

Progress in Lifelike Embodied Agents

- Research Activities from approx. 1990 at
 - DFKI, USC/ISI, CMU, NCSU, Stanford, MIT, Univ. of Rome, Curtin Univ. of Tech., Microsoft, etc.,
 - and Univ. of Tokyo
- have been showing the feasibility and positive effect as new multimodal media and new educational media.



- Necessary media components are becoming available.



Some Cognitive Backgrounds

□ Non-verbal Communication

by Albert Mehrabian

via Language (flat sentence)	7%
via Speech with tone and intonation	38%
via Facial expression and Gesture	55%

□ The Media Equation

by B. Reeves, C. Nass

Media = Real Life



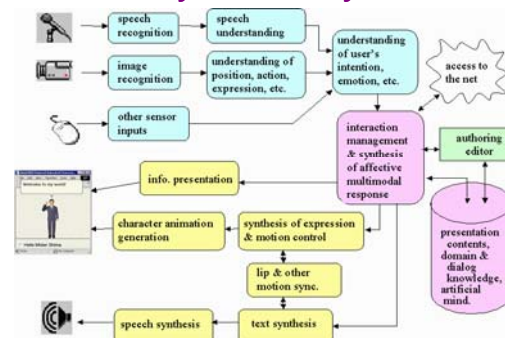
□ The Persona Effect

The presence of a lifelike character even one that is not expressive - can have a strong positive effect on student's perception of their learning experience.

Dimensions:

motivation, entertainment, helpfulness, ...

Many Component Technologies are necessary to build a system



2000-2004 未来開拓学術研究プロジェクト

大型研究費で実施するので、いろいろ研究開するだけでは弱いので、何かコアになる技術を確立したいと思った。

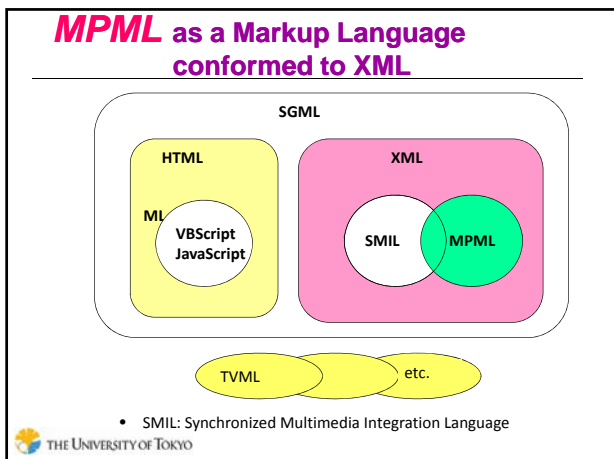
- マルチモーダルコンテンツの記述言語
- 感性的ヒューマンインタフェースが大きなテーマだったので、「感情機能」も特徴とする。

MPML concept

(Multimodal Presentation Markup Language)

- Multimodal Presentation Anytime, Anyplace through the network (even to mobile).
- Allows Anyone (ordinary people) to write effective/attractive Multimodal Presentation Contents easily.
- Serves as an extensible center integrating many advanced functional modules.

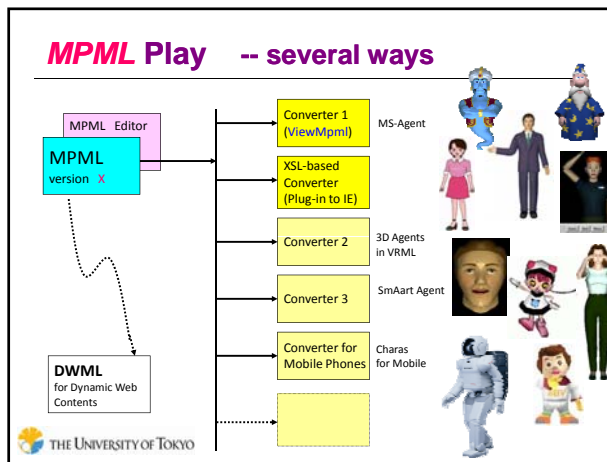
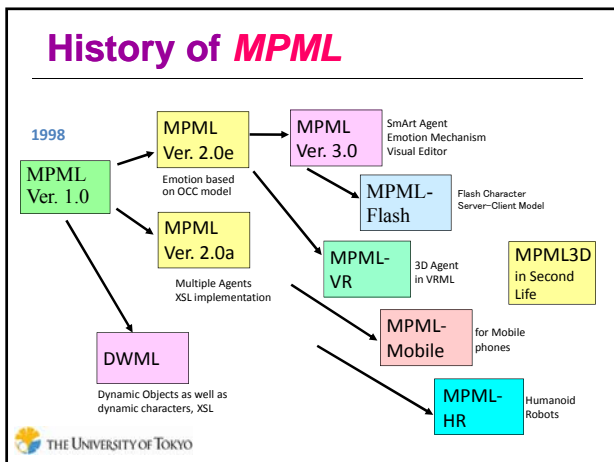




A simple example of MPML script

```

<mpm>
<head>
<spot id="spot1" location="200,260" />
<agent id="simasan" system="MSAgent" character="simasan"
voice="LH" agreeableness="50" activity="50" spot="spot1" />
</head>
<body>
<seq>
<scene agents="simasan">
<page ref="page0.html">
<play agent="simasan" act="greet" />
<speak agent="simasan">
<emotion assign="simasan:happy+" />
Hello! My name is Sima. Welcome to our Web.
</speak>
</page> </scene> </seq>
</body>
</mpml>
    
```



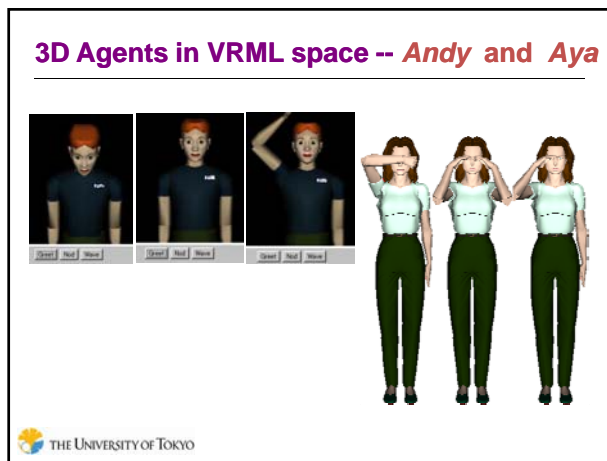
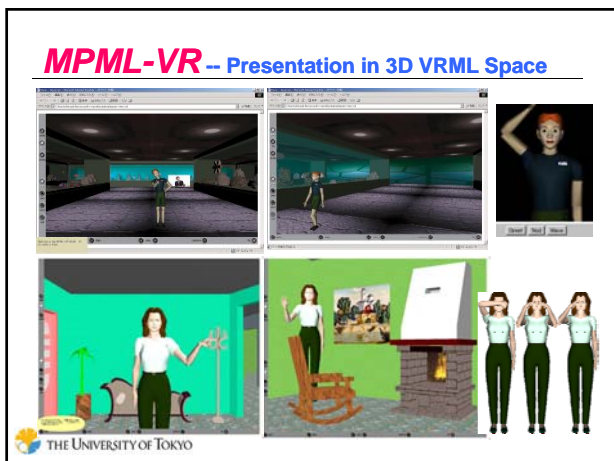
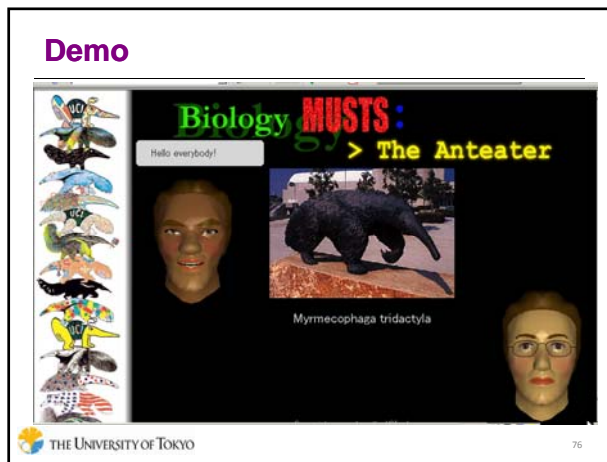
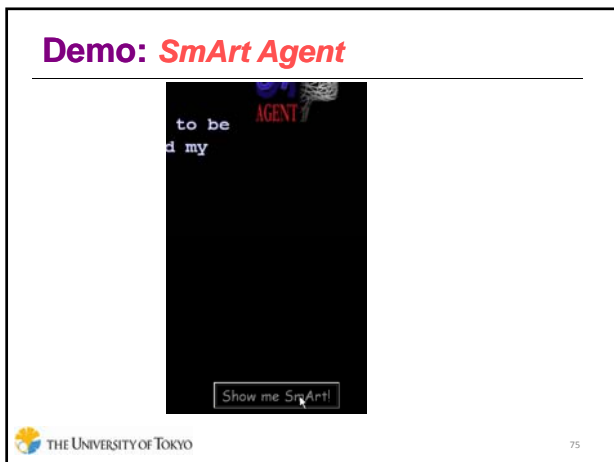
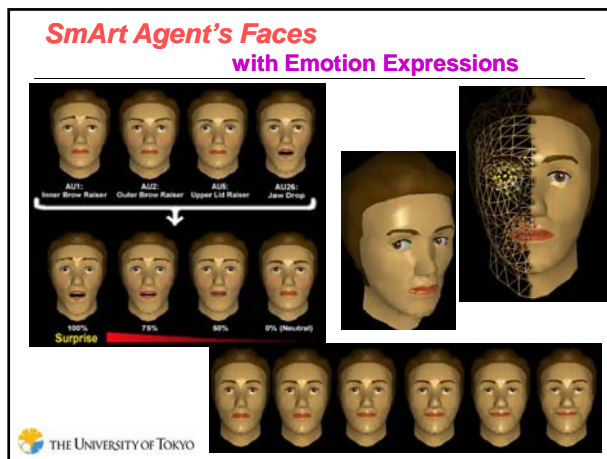
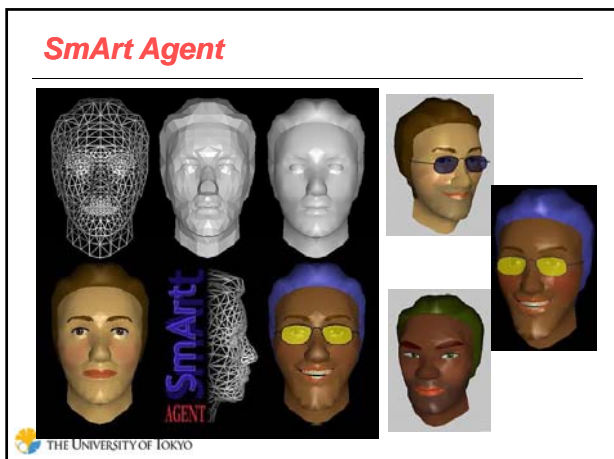
MPML 2.0 featuring Full Presentation with Emotional Expressions

The image shows several screenshots of MPML 2.0 web pages. One page highlights the 'Emotion express function' with examples like action, volume, pitch, and emphasis. Another page shows a 'What's MPML stand for?' slide with the acronym:

- M Multimodal
- P Presentation
- M Markup
- L Language

MPML3.0

This section shows the MPML3.0 graphical editor interface, which allows for visual editing of MPML content. Below the editor are screenshots of SmArt Agents, including a character named 'The Anteater' and other 3D models.



Demo: Award Winner of GALA 2006



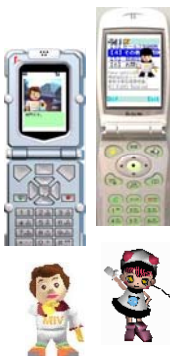
DWML: Dynamic Web Markup Language

Animation control not only for character agents, but also for all objects.



MPML-Mobile version

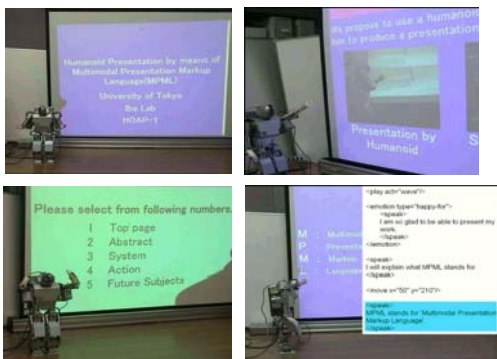
```
<?xml version="1.0" encoding="shift_jis"?>
<?xml:stylesheet type="text/xsl" href="mpml.xsl"?>
<mpml>
<head>
<title> Hello World! </title>
<agent char="rockey" id="rockey" x="400" y="100"/>
</head>
<body>
<par>
<play id="rockey" act="Nod"/>
<speak id="rockey"> Hello World!
You're ready to proceed </speak>
</par>
</body>
</mpml>
```



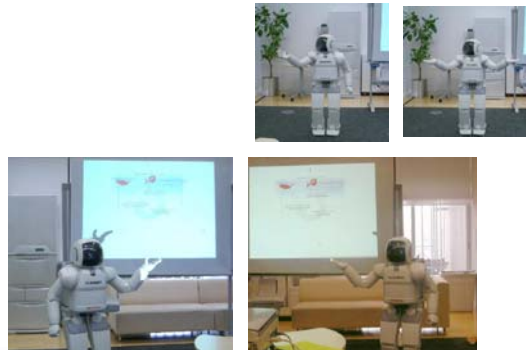
MPML-Mobile for KDDI-au's EZ-web



MPML-HR (humanoid robot) version



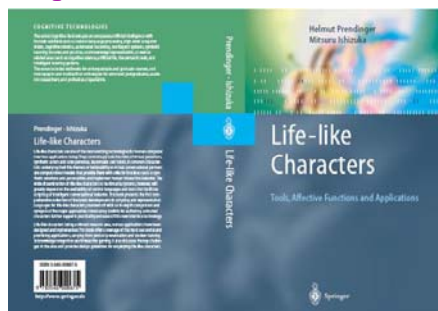
MPML-HR for Honda's ASIMO



Demo: *MPML-HR*



Our edited Book published from Springer in 2004



記述言語標準化の幾分の努力はしたが...

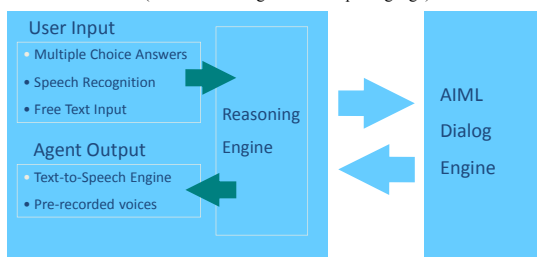
- HTMLのようにまず広く使って貰うのが重要で標準化が必要なのだが。(高機能化はその後順次行う)
- 二つの立場
 - 一般ユーザが記述しやすい v.s.
 - プロのクリエイターにも使える機能レベル (使用するキャラクタも反映)
- 2005年から欧州中心にBML(Behavior Markup Language) 標準の動きがあるが、必ずしも順調にっていない。

Toward Less Scripting Load

- Gesture Generation from Speech Text (発話テキストからのジェスチャー生成)
- Connection to a Chatbot (おしゃべりロボットとの結合)
- Content Creation from Web (Webからのコンテンツ生成)
- Dialogue Generation from Text (T2D) (モノローグテキストからの対話生成)
- Affect Sensing from Text (テキストからの感情センシング)

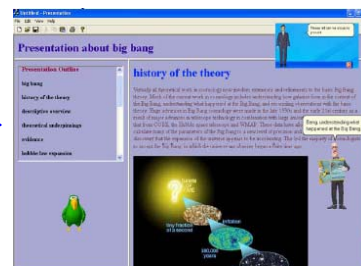
Enhancement of Conversational Flexibility through Chatbot technology

- ALICE Chatbot (by Richard Wallace, Winner of the 2000&2001 Loebner prizes)
- AIML (Artificial Intelligence Markup Language)



Auto Presentation : An Automatic Content Creation with Web Intelligence Functions

- ☞ Understand the presentation topic from input query.
- ☞ Search the topic in Wikipedia, or Search by Google, Yahoo and AltaVista.
- ☞ Text segment summarization (extraction), and associate with relevant outline.
- ☞ Generation of a scene-based MPML script with affective support.

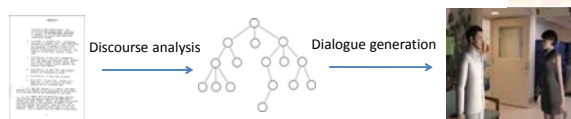


The topic is "Big Bang" here.

Gesture Generation from Speech Text



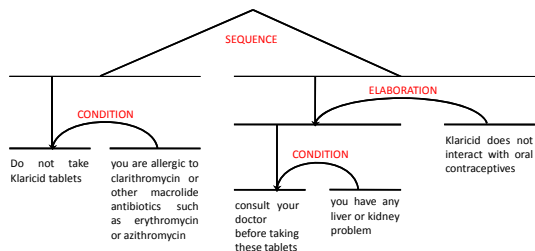
T2D: Monologue Text to Dialogue



- ⌘ We developed an original Discourse Analyzer in the framework of RST (Rhetorical Structure Theory: Mann & Thompson, 1988)
- ⌘ RST classifies discourse units into Nucleus and Satellite connected with predefined discourse relations.

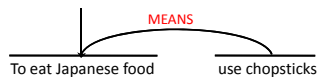
An Example of RST Discourse Analysis

"Do not take Klaricid tablets if you are allergic to clarithromycin or other macrolide antibiotics such as erythromycin or azithromycin.
If you have any liver or kidney problems consult your doctor before taking these tablets.
Klaricid does not interact with oral contraceptives."



How to Generate Dialogue

⌘ An example



Layman (Customer) > How should I eat Japanese food?
Expert (Chef) > You could use chopsticks.

Demo:



Textual Affect Sensing

We define here:

⌘ Textual Sentiment Analysis

- Positive / Negative (or Neutral)
- Popular in opinion mining

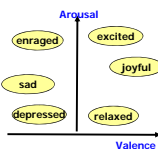
⌘ Textual Affect Sensing

- more detailed affective or emotional states appearing in text, such as happy, sad, anger, fear, disgust, surprise and much more.



Several Emotion (or Affect) Models

- **Six Basic Emotions** (by Ekman)
 - happy, sad, surprise, anger, fear, disgust
- **Two-dimensional Emotion Model** (Lang's model or Russell's model)
 - **Valence** (positive or negative dimension of feeling)
 - **Arousal** (intensity of emotional response)
- **OCC (Ortony, Clore & Collins) Emotion Model** (Cognitive Appraisal Structure Model)
 - 22 emotions : most comprehensive



Our Two Approaches

1. A Textual Affect Analysis Model based on Linguistic Compositionality Principle

COLING 2010 Best Paper Award Finalist

- With an Extended Affective Lexicon: SentiFul

2. Textual OCC Emotion Analysis through Cognitive Variables

- The First and Only One Challenge to OCC Emotion Sensing in Text

Methods of Textual Affect Sensing and our contribution

Method	Strengths	Weaknesses
Keyword spotting technique	Simple and fast	Restricted to lexicon of sentiment-bearing words Disregards syntactic and semantic information Inaccurate
Commonsense approach	Considers contextual information Relies on real-world knowledge	Relies on manually created network of concepts Strong dependency on well grammatically structured sentences
Machine learning method	(Efficient to classify Neg/Pos, Subjective/Objective opinion) Fast and suitable for large scale data Better for domain specific classification	Requires large annotated corpora Difficult to formulate the diverse set of features Mostly disregards modifiers, negation and condition constructions, syntactic relations and semantic dependencies in sentences Semantically weak Less accurate for sentence-level analysis
Rule-based approach	Works well on sentence and document levels Considers contextual information Easy to improve the rules and extend the lexicon	Relies on manually annotated lexicon Always rules have exceptions Slow performance with large documents Strong dependency on well grammatically structured sentences
plus compositionality principle and the semantics of terms	plus Fine-grained classification of attitude Determines strength of attitude Relies on the extensive set of modifiers, valence shifters, and rules elaborated for semantically distinct verb classes Robust in handling complex cases	Main contributions

Other methods have been weak in linguistic analysis so far, and most probably misclassify

I spent the whole day eating junk food without feeling guilty.
[negative => neutral]

Polarity Shift

My whole **enthusiasm** and **excitement** disappear like a bubble touching a hot needle. [positive => negative]

She **never** lost her **animosity** for my brother. [positive => negative]

They discontinued **helping** children. [positive => negative]

It should have been the **greatest** trip of my entire life, but it was a total **nightmare**. [positive/negative? => negative]

Audible chewing is rather **disgusting**, especially if you are also trying to **enjoy** food. . [negative/positive? => negative]

Affects and Enriched Affective Lexicon

9 Fine-grained Affects (Izard 1971):

'anger' 'disgust' 'fear' 'guilt' 'interest' 'joy'
'sadness' 'shame' 'surprise'

NEG aff

POS aff

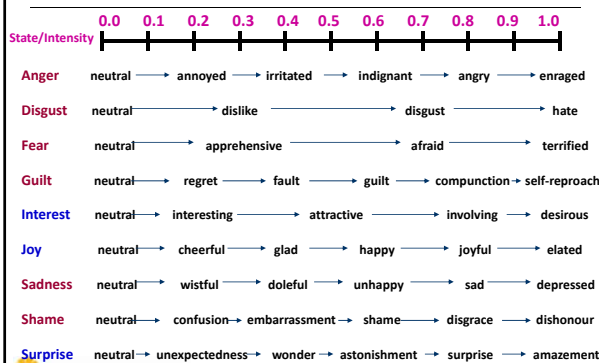
WordNet-Affect contains in total
2438 direct and indirect emotion-related entries:

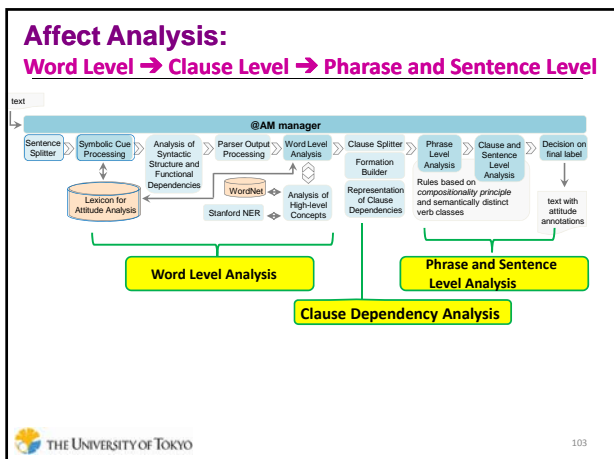
- 918 adjectives (e.g., 'euphoric', 'hostile')
- 243 adverbs (e.g., 'luckily', 'miserably')
- 900 nouns (e.g., 'fright', 'mercy')
- 377 verbs (e.g., 'reward', 'blame')

SentiFul	
Core of SentiFul (WordNet-Affect)	2438
Synonymy	4190
Antonymy	288
Hyponymy	1085
Derivation (Affixes)	4029
Compounding	853
SentiFul TOTAL	12883

extension

Examples of Intensity Levels





Compositionality Principle

‘The full story of how lexical items reflect attitudes is more complex than simply counting the valences of terms’ (Polanyi and Zaenen 2004)

Compositionality principle: the attitudinal meaning of a sentence is determined by composing a pieces that correspond to lexical units or other linguistic constituent types governed by the rules of

- ✓ polarity reversal
- ✓ aggregation (fusion)
- ✓ propagation
- ✓ domination
- ✓ neutralization , and
- ✓ intensification at various grammatical levels.

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Interface

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AffectIM: Affect-sensitive Instant Messaging

Avatar displays:

- emotions
- communicative behaviour
- idle states

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EmoHeart: application in Second Life

✓ about 180 users in SL (July 2010)
 ✓ 4 research projects (University of Sydney, Loyola Marymount University, NII, University of Tokyo)

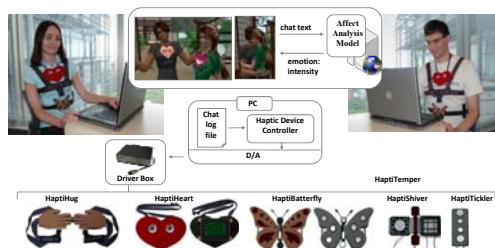
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Demo: EmoHeart

EmoHeart: Automatic expression of emotions in Second Life

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iFeel_IM!: communication system with rich emotional and haptic channels



✓ demo at 4 Int. Conferences (about 500 participants experienced iFeel_IM!)
 ✓ featured at Daily Planet Show on Discovery Channel (April 07, 2010)

Our Two Approaches

1. A Textual Affect Analysis Model based on Linguistic Compositionality Principle

– With an Extended Affective Lexicon: SentiFul

2. Textual OCC Emotion Analysis through Cognitive Variables

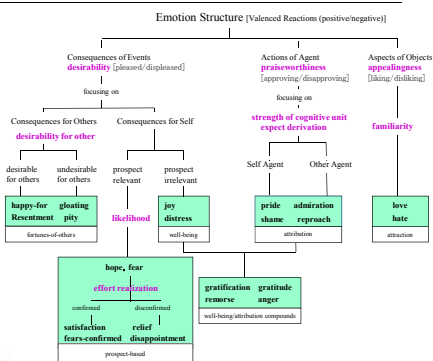
– The First and Only One Challenge to OCC Emotion Sensing in Text

Cognitive Structure of the OCC Emotions

Six groups and 22 emotion categories based on valenced reactions to situations

Purple texts indicate cognitive variables

Challenges are:
 How to use this model in NLP
 How to compute the variables



OCC Emotions (日本語)

嬉しい (happy-for)	他者の望ましい結果を喜ぶ
同僚 (pity)	他者の望ましくない結果に同僚
嫉妬 (resentment)	他者の望ましくない結果に不機嫌
嘲笑 (gloating)	他者の望ましくない結果を喜ぶ
喜び (joy)	自分の望ましい結果に満足
苦痛 (distress)	自分の望ましくない結果を悲しむ
期待 (hope)	望ましい結果を予測し喜ぶ
心配 (fear)	望ましくない結果を予測し心配する
達成感 (satisfaction)	予測した望ましい結果が実現し喜ぶ
不安の中 (fears-confirmed)	予測した望ましくない結果が実現し不機嫌
安堵 (relief)	予測した望ましくない結果が実現せず喜ぶ
落胆 (disappointed)	予測した望ましい結果が実現せず不機嫌
誇り (pride)	自分の褒めるべき行動を認める
恥 (self-reproach)	自分の非難されるべき行動に不満
賞賛 (appreciation)	他者の褒めるべき行動を認める
非難 (reproach)	他者の非難すべき行動に不満
感謝 (gratitude)	他者の褒めるべき行動を認め、それから導かれた望ましい結果に喜ぶ
怒り (anger)	他者の非難すべき行動を認め、それから導かれた望ましくない結果に喜ぶ
自己満足 (gratification)	自分の褒めるべき行動を認め、それから導かれた望ましい結果に喜ぶ
後悔 (remorse)	自分の非難すべき行動を認め、それから導かれた望ましくない結果に不機嫌
好む (liking)	魅力的な対象を好む
嫌悪 (disliking)	魅力ない対象を嫌う

Compound Emotions

16 Cognitive Variables		
Type	Variable Name	Possible Enumerated Values
agent based	agent_fondness (af)	liked, unliked
	direction_of_emotion (de)	self, other
object based	object_fondness (of)	liked, unliked
	object_appealing (oa)	attractive, unattractive
event based	self_reaction (sr)	pleased, displeased
	self_presumption (sp)	desirable, undesirable
	other_presumption (op)	desirable, undesirable
	prospect (pros)	positive, negative
	status (stat)	unconfirmed, confirmed, disconfirmed
	unexpectedness (unexp)	true, false
	self appraisal (sa)	praiseworthy, blameworthy
	valenced_reaction (vr)	true, false
intensity	event_deservingness (ed)	high, low
	effort_of_action (eoa)	obvious, not obvious
	expected_deviation (edev)	high, low
	event_familiarity (ef)	common, uncommon

emotion-inducing variables

An Example of Analysis (1)

An example sentence: "I didn't see John for the last few hours; I thought he might miss the flight but I suddenly found him on the plane."

Output of a dependency parser

- Triplet 1: [{"Subject Name": "I", "Subject Type": "Person", "Subject Attrib": []}, {"Action Name": "see", "Action Status": "Past", "Action Attrib": [{"negation": "the last few hours", "dependency": "and"}]}, {"Object Name": "John", "Object Type": "Person", "Object Attrib": []}]
- Triplet 2: [{"Subject Name": "I", "Subject Type": "Self", "Subject Attrib": []}, {"Action Name": "think", "Action Status": "Past", "Action Attrib": [{"dependency": "to"}]}, {"Object Name": "I", "Object Type": "Person", "Object Attrib": [{"Object Attrib": []}]}
- Triplet 3: [{"Subject Name": "John", "Subject Type": "Person", "Subject Attrib": []}, {"Action Name": "miss", "Action Status": "Modal Infinitive", "Action Attrib": [{"dependency": "but"}]}, {"Object Name": "flight", "Object Type": "Entity", "Object Attrib": [{"Determiner": "the"}]}]
- Triplet 4: [{"Subject Name": "I", "Subject Type": "Person", "Subject Attrib": []}, {"Action Name": "find", "Action Status": "Past", "Action Attrib": [{"ADV": "suddenly", "place": "on the plane"}]}, {"Object Name": "John", "Object Type": "Person", "Object Attrib": []}]

An Example of Analysis (2)

There are **three events** as indicated below:

e1: "not see john the last few hours" [agent: I, tense: 'Past', 'dependency: and']

e2: "think <no obj>, might miss flight" [agent: John, object: flight, tense: 'Modal', dependency: but]

e3: "find john on the plane" [agent: I, tense: 'Past']

Analysis of the recognition of OCC emotions for the given example sentence			
Events	e1	e2	e3
Event Dependency	dependency: and	dependency: but	
SenseNet Value (returned for each event)	event valence:-9.33 prospect value:-9.11 praiseworthy val:-9.22 agent valence:+5.0 object valence:+4.2	event valence:-8.69 prospect value:-7.48 praiseworthy val:-8.09 agent valence:+4.2 object valence:+2.72	event valence:+9.63 prospect value:+8.95 praiseworthy val:+9.29 agent valence:+5.0 object valence:+4.2
ConceptNet Value	familiarity valence: 'john' 0.059% 'see' 0.335% action-actor deviation: "I-see": null	familiarity valence: 'flight' 0.113% 'miss' 0.14% action-actor deviation: "john-miss": null	familiarity valence: 'john' 0.059% 'find' 0.419% action-actor deviation: "I-find": null



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115

"I didn't see John for the last few hours; I thought he might miss the flight but I suddenly found him on the plane."

Events	e1	e2	e3
Values of Cognitive Variables	of: liked de: other oa: attractive sr: displeasable sp: undesirable pros: negative star: confirmed unexp: false sa: blameworthy vr: true ed: low eoa: not obvious ede: low ef: common	of: liked af: liked de: self oa: neutral sr: displeasable sp: undesirable op: undesirable pros: negative star: unconfirmed unexp: false sa: blameworthy vr: true ed: low eoa: not obvious ede: low ef: uncommon	of: liked de: other oa: attractive sr: pleasurable sp: positive star: confirmed unexp: true sa: praiseworthy vr: true ed: high eoa: obvious ede: low ef: common
Apply Rules Phase 1	distress, sorry-for, fears-confirmed, reproach	distress, fear, shame	joy, happy-for, satisfaction, admiration
Apply Rules Phase 2	sorry-for, fears-confirmed, anger	fear, remorse	happy-for, satisfaction, gratitude
Apply 'and'-logic	sorry-for, fears-confirmed, anger		happy-for, satisfaction, gratitude
Apply 'but'-logic	happy-for, relief, gratitude		

Comparison of Two Approaches

	1. @AM	2. OCC Emotion Sensing
Sensing Target	9 emotions with each intensity	22 emotions (first challenge)
Main Methodology	Linguistic Compositionality Principle	Cognitive Appraisal Structure of Emotions using Cognitive Variables
	Certain parts of linguistic composition rules are common	
Prior Information of Elementary Lexicon	9-dimensional vector with intensities	Valence and some other sub-variable values
Accuracy (in different conditions)	62%	80.5%

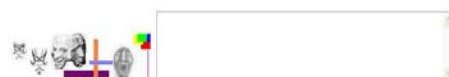
Both systems have achieved deep linguistic analyses toward affect sensing more than ever.



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117

Web Online System



please input sentence(s). [e.g., Computer can sense emotion.]

Output

Input Sentence: An earthquake measuring 8.6 on the Richter scale shook the northern part of Indonesia's Sulawesi island on Tuesday, but there were no immediate reports of damage or casualties, the meteorology agency said.

Output of System 1	Output of System 2
angry: 0.39 fear: 0.42 surprise: 0.17 sad: 0.20 happy: 0.00 disgusted: 0.00	distress: (0.042) disappointment: (0.020)

The Sentence Primarily Expresses **angry** Emotion.



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118

ASNA: An Agent for Retrieving and Classifying News on the basis of Emotion-Affinity

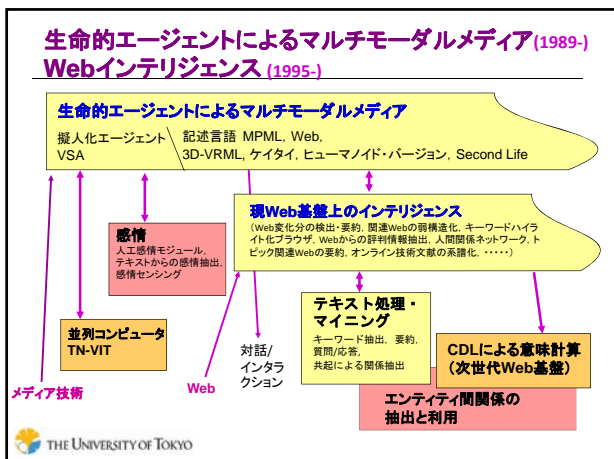
119

Demo: ASNA



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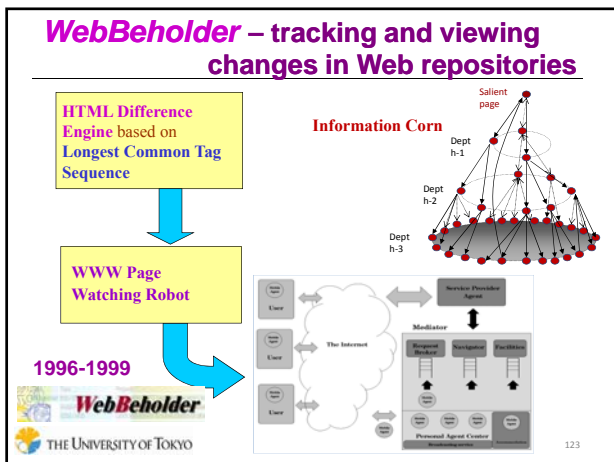
120



After Web -> Web Intelligence

- Web変化分の検出, 要約
 - WebBeholder, ETTS, ChangeSummarizer (Web上の自動ジャーナリズム)
- トピック関連Webの弱構造化 (領域総覧, AreaView)
 - Webからの評判情報抽出
 - 用語定義説明文の抽出
 - Webからの関連語抽出
 - 2 Channel の関係構造分析
- 人間関係ネットワーク (Polyphonet by 松尾)
 - 企業間関係ネットワーク
 - エンティティ間の関係抽出
- キーワード抽出
 - 類出語との共起の類り
 - 語の認知的活性伝搬度
 - 語の共起のソーシャルワールド
- 履歴に基づくキーワードハイライト化ブラウザ(KH Browser)
 - Webページ間距離尺度(Average Click)
 - 複数文書要約 (抽出重要文の順序付け)
 - 構文解析グラフ構造による質問/応答
 - Namesake(同姓同名)の分離
 - エンティティ対間の類似度計算
 - 潜在関係検索エンジン

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WebBeholder – Notification of Changes via Email, and a Multimodal Display

Subject: Page Update Information
 Date: Wed Jan 27 03:30:43 GMT+09:00 1999
 From: webbeholder@u-tokyo.ac.jp
 To: jacob@u-tokyo.ac.jp

Report for http://www.mis.u-tokyo.ac.jp/~sant/

3 changes for page link:
 http://www.cs.columbia.edu/home/mcbryer/WWW.html was added
 http://www.cs.columbia.edu/~mcbryer/WWW.html was added
 http://www.mis.u-tokyo.ac.jp/home/sternet/search.html was added
 The summary can be found at http://www.mis.u-tokyo.ac.jp/WWW/webbeholder/ /jacob@u-tokyo.ac.jp

Total changed weight: 811

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ETTS (Emergent Topic Tracking System) for the Web & Query-based Discovery of Popular Changes in the Web

A Weekly Report with respect to "nuclear weapon" from ETTS

- As world leaders gather for the 2000 Non-Proliferation Treaty Review Conference at the United Nations, the United States is on the verge of deploying a National Missile Defense system. (weight = 3.151)
- If Russia objects to the United States defending itself against the offensive efforts of other states that were not even conceivable threats when the ABM Treaty was signed nearly 30 years ago, then the United States must make it clear that it is no longer bound by the ABM Treaty. (weight = 2.630)
- Leaders of both the nuclear weapon states and potential enemy states know these facts and know that the United States, in response to a missile attack, could wipe out their regimes, if not their countries. (weight = 2.588)

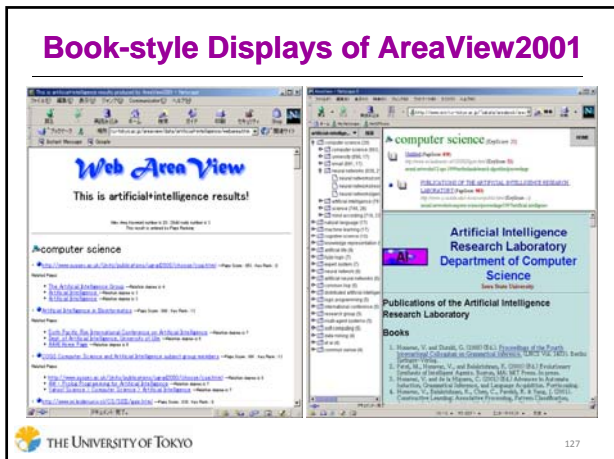
Two weeks later

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AreaView2001 – presenting weakly structured knowledge in a certain area

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Book-style Displays of AreaView2001

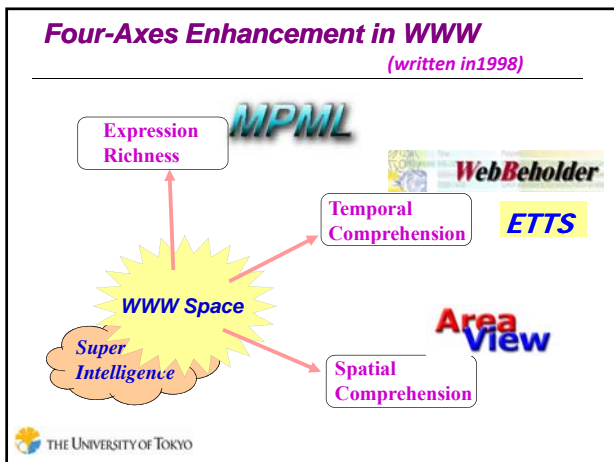


Major Sub-areas extracted for "Artificial Intelligence"

- ⌘ computer science
- ⌘ natural language
- ⌘ machine learning
- ⌘ cognitive science
- ⌘ knowledge representation
- ⌘ artificial life
- ⌘ fuzzy logic
- ⌘ expert system
- ⌘ neural network
- ⌘ artificial neural networks
- ⌘ common lisp
- ⌘ distributed artificial intelligence
- ⌘ logic programming
- ⌘ international conference
- ⌘ research group
- ⌘ multi-agent systems
- ⌘ soft computing et. al.
- ⌘ common sense

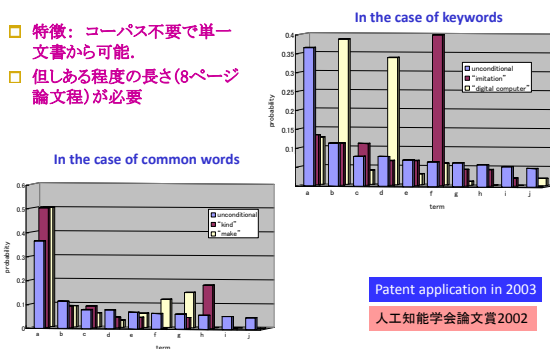
Four-Axes Enhancement in WWW

(written in1998)



Keyword Extraction using Word Co-occurrence with Frequency Terms

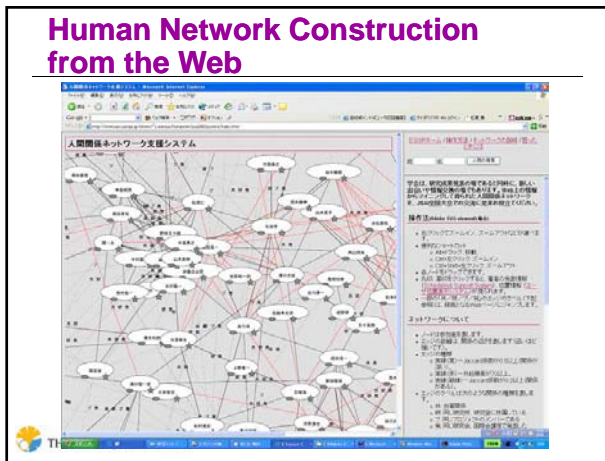
- 特徴: コーパス不要で単一文書から可能.
- 但しある程度の長さ(8ページ論文程)が必要



KH (Keyword Highlighting) Browser based on a User's Browsing History



Human Network Construction from the Web



POLYPHONET (by Y. Matsuo, et al.)

2007

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Relation Extraction among Companies from the Web

Legend:

- Alliance:
 - Capital Alliance (black line)
 - Business Alliance (grey line)
 - Lawsuit (red line)
 - Claim (orange line)
 - Accommodation (yellow line)

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Became Interested in Relations (関係性) between Entities

□ 情報の構造化, 組織化の基本として

↓

□ 情報の意味への接近

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Attributional vs. Relational Similarity

- Attributional Similarity:**
 - Correspondence between attributes of two words/entities
 - e.g., automobile vs. car $sim(X, Y)$
- Relational Similarity:**
 - Correspondence between relations between word/entity pairs
 - e.g., (Ostrich, Bird) vs. (Lion, Cat) $sim(A, B, X, Y)$
 - X is a large Y
 - Y is composed using X

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Computing Relational Similarity between Two Entity Pairs on the Web

- Turney's Work using LSA (Latent Semantic Analysis) (Turney, ACL 2006)

– (traffic, road) vs. (water, river)

X flows in Y

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Distribution of Patterns in Snippets with respect to word-pairs

Pattern	Pattern	Similarity
X buys Y	X acquires Y	0.853133
X buys Y	Y ceo X	0.000297
X buys Y	Y chief executive	0.000183
X acquires Y	Y ceo X	0
X acquires Y	Y chief executive	0
X acquires Y	X	0
Y ceo X	Y chief executive	0.969827
Y ceo X	X	0

Distributional Hypothesis

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Dataset: SAT Word Analogy Questions {SAT: Scholastic Assessment Test}

- SAT Analogy Questions have been used as a baseline to evaluate relational similarity measures. (Turney RANLP 2003)
 - SAT question: **Ostrich - Bird** (Each question has five choices; one is correct.)
 - Lion - Cat
 - Goose - Flock **correct answer**
 - Ewe - Sheep
 - Cub - Bear
 - Primate - Monkey
 - 374 SAT word analogy questions (2178 word pairs).
- Average SAT score by native senior high school students: **57%**
- WordNet-based approaches (Veale, ECAI 2004) [43%]
- Vector Space Model (Turney, Machine Learning 2005) [47%]
- Latent Relational Analysis (Turney, Computational Linguistics 2006) [56%] - 8 days
- Our Method [51%] - 6 hours

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Latent Relational Search Engine

[Japan Patent Application: 2009/12/03]

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Index (Lexical Patterns) Table

id	contents	freq	size size of this n-gram (s)
128115	maklyn bragg % with %y	1	4
128116	% with %y professor	1	4
128117	by maklyn bragg % with %y	1	5
128118	maklyn bragg % with %y professor	1	5
128119	% with %y professor post	1	5
128120	% professor post at %y	1	5
128121	at % %y	756	3
128122	% %y sensor	2	3
128123	post at % %y	2	4
128124	at % %y sensor	1	4
128125	% %y sensor lectur	1	4
128126	professor post at % %y	1	5

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Index Size for Wikipedia data

- All Wikipedia Articles (English and Japanese): **above 7M pages**
- Entities (only proper nouns): **6.7M**
- Entity Pairs: **3B**
- Time for constructing Indexes (using Amazon's AWS cloud): **6 hours per 1M pages**

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Latent Relational Search A : B = C : ?

Query example: Tokyo : Japan = ? : France

A: James Cameron, B: Avatar, C: Akira Kurosawa, D: ?

Relation keyword (optional):

Retrieved 45 entities in 8.34 seconds

- derru ucala Evidencecast
- rashimon Evidencecast
- kagemusha Evidencecast
- kurru Evidencecast
- yojimbo Evidencecast
- sanshiro sugata Evidencecast
- isapanese Evidencecast
- shadow warrior Evidencecast
- casual Evidencecast
- wolf Evidencecast
- masayuki mori Evidencecast
- rashimon Evidencecast
- low Evidencecast
- seven samurai Evidencecast
- kurusawa Evidencecast
- rashimon Evidencecast
- toharo miyano Evidencecast
- kyoshi kurusawa Evidencecast
- hidden fortress Evidencecast
- iya muronets Evidencecast
- chris marker Evidencecast
- joeph campbell Evidencecast
- academy award Evidencecast
- godelusden Evidencecast
- sampo Evidencecast
- sanshiro sugata part Evidencecast

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Latent Relational Search A : B = C : ?

Query example: Tokyo : Japan = ? : France

A: Margaret Thatcher, B: United Kingdom, C: Germany, D: ?

Relation keyword (optional):

Retrieved 72 entities in 1.47 seconds

- angels merkel Evidencecast
- british Evidencecast
- roschla fecher Evidencecast
- joseph goebbels Evidencecast
- frank-walter steinmeier Evidencecast
- joachim von ribbentrop Evidencecast
- interior Evidencecast
- max lebermann Evidencecast
- american Evidencecast
- obama Evidencecast
- naville chamberlain Evidencecast
- tony blair Evidencecast
- michael savage Evidencecast
- michael joseph savage Evidencecast
- gudo westerwede Evidencecast
- pál teleki Evidencecast
- david ben gurion Evidencecast
- bernie shern Evidencecast
- prussia Evidencecast
- tapa tchemoeff Evidencecast
- dr. manmohan singh Evidencecast
- winton churchill Evidencecast
- italy Evidencecast
- silvio Evidencecast
- david cameron Evidencecast
- ispan janchiro lozum Evidencecast
- turkey Evidencecast

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Latent Relational Search A : B = C : ?

Query example Tokyo : Japan = ? : France

A: Tokyo B: Narita Airport C: Boston D: ? Search

Relation keyword (optional)

Retrieved 79 entities in 1.14 seconds

- logan international airport [Evidences](#)
 - Partitioning For Bobby Fischer | CBS News Japanese immigration authorities then held Fischer in Tokyo's Narita Airport detention center for 16 days after refusing to let him leave the country due to an alleged passport violation, before transferring him to a long-term detention center pending deportation to the United States. http://en.wikipedia.org/wiki/John_Bosnich
 - In Boston's Logan International Airport, numerous flights were canceled or delayed to move planes to safety. [http://en.wikipedia.org/wiki/Hurricane_Edouard_\(1996\)](http://en.wikipedia.org/wiki/Hurricane_Edouard_(1996))
 - An example would be at Tokyo's Narita Airport, where local carrier All Nippon Airways, a member of the Star Alliance, and its partners operate in one terminal to facilitate partner connections and product offerings, even offering combined check-in, member lounges, and ground services. [http://en.wikipedia.org/wiki/Colocation_\(business\)](http://en.wikipedia.org/wiki/Colocation_(business))
 - The nearest airport to the Beverly Municipal Airport, with the nearest national and international air service being at Boston's Logan International Airport. http://en.wikipedia.org/wiki/Clowcocker,_Massachusetts
 - For years, Northwest Orient Airlines was the largest non-Japanese airline using Tokyo's Narita Airport. http://en.wikipedia.org/wiki/Northwest_Airlines
 - In another episode, the Elwood City Airport is shown to have a name that represents Boston's Logan International Airport. [http://en.wikipedia.org/wiki/Arthur_\(TV_series\)](http://en.wikipedia.org/wiki/Arthur_(TV_series))
- back bay [Evidences](#)
- north station [Evidences](#)
- logan airport [Evidences](#)
- beacon hill [Evidences](#)
- south station [Evidences](#)

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潜在関係検索 A : B = C : ?

クエリ例 Tokyo : Japan = ? : France

A: 東京 B: 日本 C: ? D: オーストラリア 検索

関係絞り込みキーワード(オプション)

66 結果 (7.83 秒)

- シドニー [解説](#)
- キャンベラ [解説](#)
- グルボルン [解説](#)
- ニューサウスウェールズ [解説](#)
- クイーンズランド [解説](#)
- ビクトリア [解説](#)
- 日本 [解説](#)
- ニューランド [解説](#)
- イギリス [解説](#)
- 南アフリカ [解説](#)
- アムステルダム [解説](#)
- プリンス [解説](#)
- Australian [解説](#)
- 南 [解説](#)
- 東 [解説](#)
- オーストラリア [解説](#)
- パラニューギニア [解説](#)
- カナダ [解説](#)
- 東京 [解説](#)
- 東京 [解説](#)
- ハース [解説](#)
- ユーフォー [解説](#)
- ヨーロッパ [解説](#)
- アムステルダム [解説](#)
- アムステルダム [解説](#)
- キンワリー [解説](#)

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潜在関係検索 A : B = C : ?

クエリ例 Tokyo : Japan = ? : France

A: 東京 B: 日本 C: ? D: タンキスタン 検索

関係絞り込みキーワード(オプション)

25 結果 (1.72 秒)

- ドンシャンベ [解説](#)
 - 東京は日本の首都です。 <http://vn392kja.yahoo.com/enghuongle-89/article?wid=1985&id=-1>
 - ドンシャンベはタンキスタンの首都。 <http://genius.blog.jp/2215124/>
 - 以来台有赤味、いまや東京は、日本の首都として政治、経済、文化の中心となり、大変な発展を遂げました。 <http://enig.goods2008.com/010/>
 - ドンシャンベは、タンキスタンの首都。 <http://www.worldmapfinder.com/Jp/Asia/Tajikistan/Dushanbe/>
 - 東京は日本の首都。 <http://fsg.52web.com/dan/00061.html>
 - ドンシャンベはタンキスタンの首都。 <http://nason.blog.fc2.com/?mode=blog&no=209>
 - 東京は日本の首都です。 http://detail.chiebukuro.yahoo.co.jp/qa/question_detail/q11426377944
 - ドンシャンベは、タンキスタンの首都。 <http://www.gpoint.com/ptu/search.do?q=KAD9C9MADNAQAG87NAQCE3JAG8F9KAG8G>
 - 東京は日本の首都です。 <http://www.wakia.info/kujiyo.html>
 - ドンシャンベ(タジク)は、タンキスタン共和国の首都。 <http://ja.wikipedia.org/wiki/タンキスタンの首都>
 - Misa [解説](#)
 - ミサ [解説](#)
 - 東京 [解説](#)
 - クラスター [解説](#)
 - プラハ [解説](#)
 - キルギス [解説](#)

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Hopefully

Relational Search (or XYZ search)

If X is to Y, then Z is to?

If USA is to Lady Gaga, then Japan is to?

(USA, Lady Gaga), (Japan, ?)

<http://miresh.com>

Cross Language Latent Relational Search: Mapping Knowledge across Languages, AAAI 2011.

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CDLの位置づけ (written in 2006)

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Google announced Semantic Search, May 2012

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Google's Knowledge Graph

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New Tech. Committee on Semantic Computing in IEEE Computer Soc.

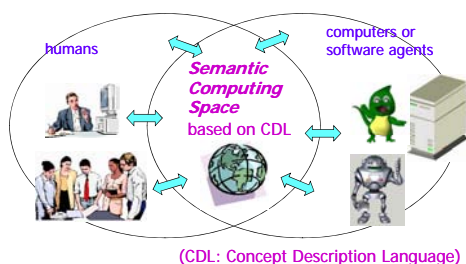
enable dislike button

Semantic Computing Gets Technical Committee

University of California Irvine professor Phillip C-Y Sheu, interim chair of the newly formed Technical Committee on Semantic Computing, is looking for volunteers for the Executive Committee. —Read more

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We need a Common and Universal Language of Representing Concept Meaning as a solid foundation of Semantic Computing on the Web



The aims of CDL are

- 1) to realize machine understandability of Web text contents, and
- 2) to overcome language barrier on the Web.

Major Differences from Semantic Web

Semantic Web

- Target of representation: Meta-data extracted from Web contents.
- Domain-dependent ontologies (which cause the difficulty of wide inter-boundary usage)
- RDF / OWL (description logic is hard for ordinary people to understand)

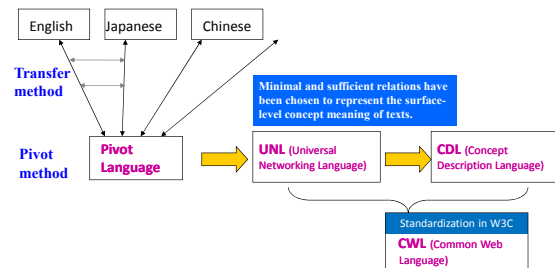
Tim Berners-Lee says that: "Data Web" or "Linked Data" is more adequate rather than "the Semantic Web". (2007)

Semantic Computing Initiative

- Target of representation: Semantic concepts expressed in texts.
- Universal vocabulary (+ additional specific vocabulary in a domain if necessary), and pre-defined relation set.
- CDL.nl (richer than RDF)

Main body:
 Institute of Semantic Computing (ISeC) in Japan (NPO法人セマンティックコンピューティング研究開発機構)
 Int'l Standardization Activity:
 W3C Common Web Language (CWL)-XG

From Machine Translation



Incubator Group Activity at W3C from Oct. 2006 to May 2008

Common Web Language Incubator Group Charter

The mission of the Common Web Language Incubator Group, part of the Incubator Activity, is to develop the CWL, a common Web Language, as a common language for exchanging information through the web and also for enabling computers to process information semantically. A pilot model of CWL platform will also be developed on the web. The CWL is used to describe contents and meta-data of web pages written in natural languages. Then CWL will make a language barrier free world in the web and will also enable computers to extract semantic, informative and knowledge from web pages accurately.

Join the Common Web Language Incubator Group

Start date	15 October 2007
Confidentiality	Proceedings are public
Initial Chairs	Hirotaka Uchida (ISeC)
Initiating Members	<ul style="list-style-type: none"> Institute of Semantic Computing (ISeC) Institute of Advanced Industrial Science and Technology (AIST) Autonomous Corporation
Usual Meeting Schedule	Teleconferences: once a month Face-to-face: twice a year (W3C/ISACA AC Meeting/Tokyo) 2006-2008 in Japan and May 2007 in Canada

Scope

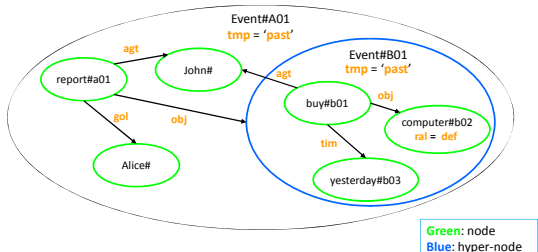
An attempt to describe texts in the web in a common language is provided in the Semantic Web Activity. The ISeC/W3C is used as a basic description language and can be used to describe texts in web pages. However, ISeC/W3C is originally designed to describe meta-data of resources, and at this moment there is no standard set of properties and vocabulary to cover general web pages. There are some activities to provide common bases for describing information in the web such as the [Vocabulary for Describing Academic Publications \(VADAP\)](#) for providing local bases, [Conceptual Logic for providing representation bases](#). The CWL initiative is an activity quite different from those activities. The CWL will provide not only representation scheme but also a vocabulary with semantic background. It is an initiative to integrate existing and ongoing activities for providing a common description language with widespread grammar and enough amount of resources based on the CWL, Concept Description Language, with an aim at describing every kind of information understandable for computers.

The CWL has the following characteristics:

1. CWL is designed to be independent from any natural languages and shall enable users to develop conversion systems between CWL and...

CDL Representation

- Text example: "John reported to Alice that he bought a computer yesterday."
- CDL graph notation:



CDL Representation

- Text example: "John reported to Alice that he bought a computer yesterday."
- CDL text notation:

```
{#A01 Event tmp='past';
  {#B01 Event tmp='past';
    <#b01:buy>
    <#b02:computer ral='def'>
    <#b03:yesterday>
    [#b01 agt #John]
    [#b01 obj #b02]
    [#b01 tim #b03]
  }
  <#John:John>
  <#Alice:Alice>
  <#a01:report>
  [#a01 agt #John]
  [#a01 obj #Alice]
  [#a01 obj #B01]
}
```

Orange: entity
Blue: relation

CDL (UNL) Relations – 44 labels

Semantic Roles		Logical		Restrictive	
Intra-Event		Inter-Entity		Restrictive	
[Agent Relations]	[Instrument Relations]	[Logical Relations]		cnt (content, namely)	
agt (agent)	ins (instrument)	and (conjunction)		fmt (range, from-to)	
cag (co-agent)	met (method, means)	orr (disjunction, alternative)		fmr (origin)	
aoj (thing w/ attribute)	[State Relations]	[Concept Relations]		mod (modification)	
cao (co-thing w/ attribute)	src (source, initial state)	equ (equivalent)		nam (name)	
ptn (partner)	gol (goal, final state)	idj (included)		per (proportion, rate)	
[Object Relations]	via (interm. place or state)	iof (an instance of)		pod (part of)	
obj (affected thing)	[Time Relations]	Intra- and Inter-Event		pos (possessor)	
cob (affected co-thing)	tim (time)	[Cause Relations]		qua (quantity)	
opl (affected place)	tmt (initial time)	con (condition)		tto (destination)	
ben (beneficiary)	tmt (final time)	pur (purpose, objective)			
[Place Relations]	dur (duration)	rsn (reason)			
plc (place)	[Manner Relations]	[Sequence Relations]			
plf (initial place)	man (manner)	coo (co-occurrence)			
plf (final place)	bas (basis for a standard)	seq (sequence)			
scn (scene)		Discourse			

Semantic Role Labels in PropBank

The focus is on Predicate-Argument Structure.

- Arg0 (prototypical agent)
- Arg1 (prototypical patient)
- Arg2 (indirect object/benefactive/instrument/attribute/end state)
- Arg3 (start point/benefactive/instrument/attribute)
- Arg4 (end point)
- Arg5 ()
- TMP (time)
- LOC (location)
- DIR (direction)
- MNR (manner)
- PRP (purpose)
- CAU (cause)
- MOD (modal verb)
- NEG (negative marker)
- ADV (general-purpose modifier)
- DIS (discourse particle and clause)
- PRD (secondary predication)

These are defined wrt each word sense.

Ex) buy::
Arg0: buyer
Arg1: thing bought
Arg2: seller (bought-from)
Arg3: price paid
Arg4: benefactive (bought-for)

This set is not sufficient for representing every concept expressed in natural language texts. It cannot be used for every language due to its language (English) dependency.

Rich Attributes in UNL and CDL

- Express subjectivity evaluation of the writer/speaker for the sentence. (Ex.) tense, aspect, mood, etc.
- Time with respect to writer: @past @present @future
- Writer's view on aspect of event: @begin @complete @continue @custom @end @experience @progress @repeat @state
- Writer's view of reference: @generic @def @indef @not @ordinal
- Writer's view of emphasis, focus and topic: @emphasis @entry @qfocus @theme @title @topic
- Writer's attitudes: @affirmative @confirmation @exclamation @imperative @interrogative @invitation @politeness @respect @vocative
- Writer's feeling and judgements: @ability @get-benefit @give-benefit @conclusion @consequence @sufficient @grant @grant-not @although @discontented @expectation @wish @insistence @intention @want @will @need @obligation @obligation-not @should @unavoidable @certain @inevitable @may @possible @probable @rare @regret @unreal @admire @blame @contempt @regret @surprised @troublesome
- Describing logical characters and properties of concepts: @transitive @symmetric @identifiable @disjoint
- Modifying attribute on aspect: @just @soon @yet @not
- Attribute for convention: @passive @pl @angle_bracket @brace @double_parenthesis @double_quote @parenthesis @single_quote @square_bracket

The defining method of one unique sense of a word in UW (Patent of UN Univ.)

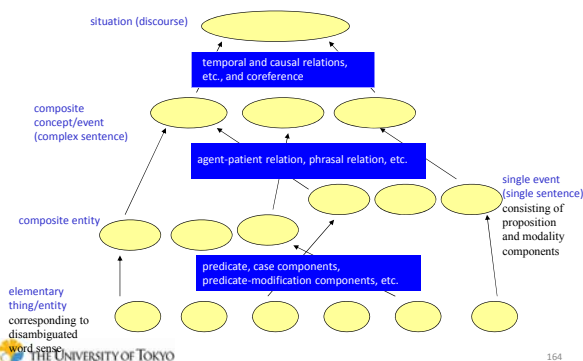
- Defining category: swallow(icb-bird) the bird "One swallow does not make a summer" the action of swallowing "at one swallow" the quantity "take a swallow of water"
- Defining possible case relations: spring(agt>thing,obj>wood) bending or dividing something spring(agt>thing,obj>mine) blasting something spring(agt>thing,obj>person, src>prison) escaping (from) prison spring(agt>thing,gol>place) jumping up "to spring up" spring(agt>thing,gol>thing) jumping on "to spring on" spring(obj>liquid) gushing out "to spring out"

UW (Universal Words) in UNL

Universal Word
uw((equ>Universal Word))
adjective concept((icb>uw))
uw((aoj>thing|_and>uw,beno>thing,cao>thing,cnb>uw,cob>thing,com>uw,coo>uw,dur>period,man>how,obj>thing,or>uw,(aoj>thing),pic>thing,plb>thing,plb>thing,rns>uw,(aoj>thing),rsn>do,icb>adjective concept))
Achasan((icb>uw((aoj>thing)))
Alghani((icb>uw((aoj>thing)))
African((icb>uw((aoj>thing)))
African-American((icb>uw((aoj>thing)))
Ainu((icb>uw((aoj>thing)))
Alaskan((icb>uw((aoj>thing)))
Albanian((icb>uw((aoj>thing)))
Aleutian((icb>uw((aoj>thing)))
Alexandrian((icb>uw((aoj>thing)))
Algerian((icb>uw((aoj>thing)))
Altaic((icb>uw((aoj>thing)))
American((icb>uw((aoj>thing)))
Anglian((icb>uw((aoj>thing)))
Anglo-American((icb>uw((aoj>thing)))
Anglo-Catholic((icb>uw((aoj>thing)))
Anglo-French((icb>uw((aoj>thing)))
Anglo-Indian((icb>uw((aoj>thing)))
Anglo-Irish((icb>uw((aoj>thing)))
Anglo-Norman((icb>uw((aoj>thing)))
Arab((icb>uw((aoj>thing)))
Arab-Israeli((icb>uw((aoj>thing)))
Arabian((icb>uw((aoj>thing)))
Arabic((icb>uw((aoj>thing)))

40,000 lexicons are open to public.
The full vocabulary includes 200,000 lexicons as of 2007.

Hierarchical Construction of Concept Representation in CDL



Concept Description Levels



- There are several choices for the deep semantic-level description depending on applications. On the other hand, a certain consensus has been made wrt "Concept Description" which is slightly below the surface level, through decades-long researches on NLP, machine translation and electric dictionaries.
- Whereas a complete consensus has not been achieved yet regarding the Concept Description level and its description scheme, it is meaningful to set up a common concept description format as an international standard today.

町田健(名古屋大文学部)の共通言語論



UNL(CDL)-to-Spanish, Arabic



UNL(CDL)-to-Japanese, Chinese



Text-to-UNL(CDL); but considerable errors

Input text

UNL

Text back from UNL

Recognition of CDL Relations from dependency-analyzed text

Syntactic and Dependency-path features

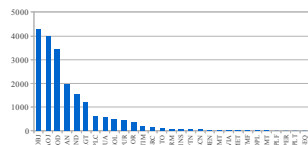
Lexical features from WordNet, VerbNet and UNLKB

Some labels of Connorx Machineise Analyser:
 ha (prepositional phrase attachment), phr (verb particle),
 pcomp (subject complement)

Performance for frequent 36 relations (out of 44)
 Precision 87.3% Recall 88.1% F-value 87.1%

Frequencies of CDL Relations

- Data sparseness :
 - The whole number of relation:13487
 - Relation types: 44
 - Average num per relation: 306.5



nam	Mod	Obj	Aoj	And	Agnt	Man	Plc	Gol	Tim	Pur	Qua
#rel	3128	2607	2060	1122	1046	788	446	395	321	280	260
nam	Pos	Sen	Ran	Sre	Cnt	Dur	Bas	Met	Equ	Nam	Con
#rel	86	71	65	63	61	58	49	47	46	41	41
nam	Ben	Tmt	Pof	Frm	Or	Fmt	Tmf	Seq	To	Iof	Cag
#rel	27	25	24	23	21	20	19	17	12	11	10
nam	Icl	Via	Coo	Per	Ins	Plt	Ptn	Plf	Cao	Opl	Cob
#rel	10	9	8	8	8	7	6	4	2	1	0

A Semi-automatic Conversion from NL Text to CDL

Natural Language Text

Syntactic and Dependency Parsing

Word Sense Disambiguation (WSD)

Rule-based Translation (UNL server)

CDL Description

Automatic and Manual Selection

Check & Post Editing (GUI)

Semi-automatic WSD (word sense disambiguation)

Demo:

Automatic selection evidence

Word senses (universal words)

Automatic WSD parameters

Semantic Info. and CDL Text Data

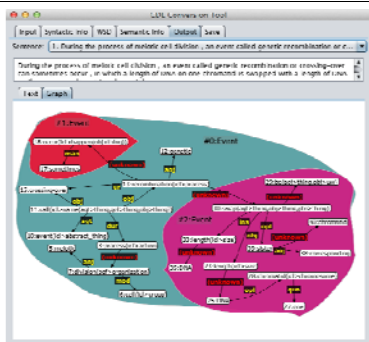
Relations change depending on the selected word senses

Semantic relations

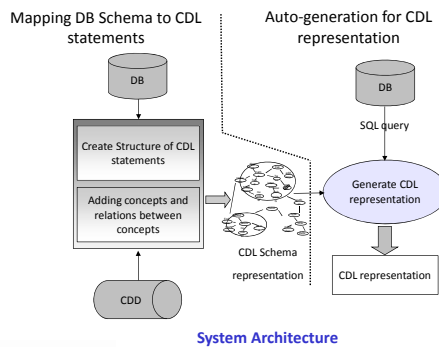
Hypernodes

CDL Text Notation

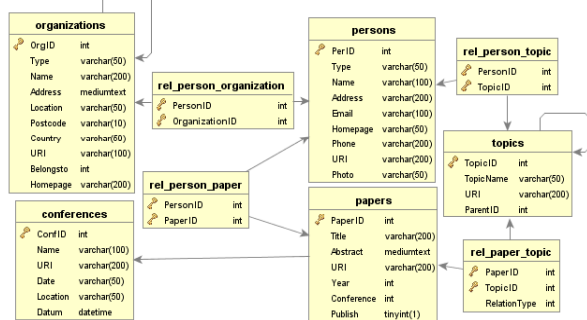
CDL Graph Notation



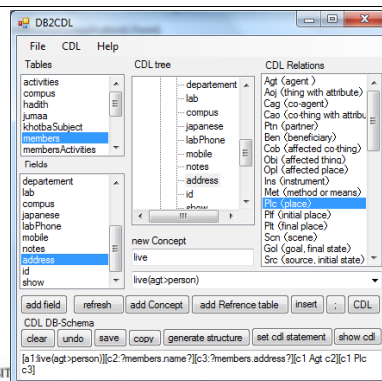
RDB2CDR (RDB to CDR)



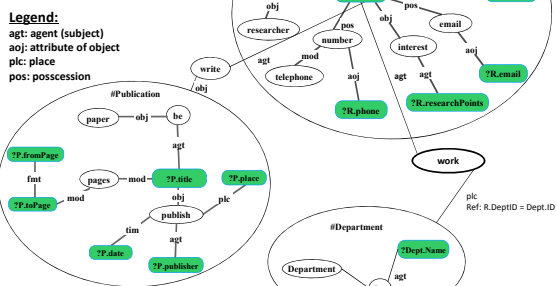
DB schema (an example)



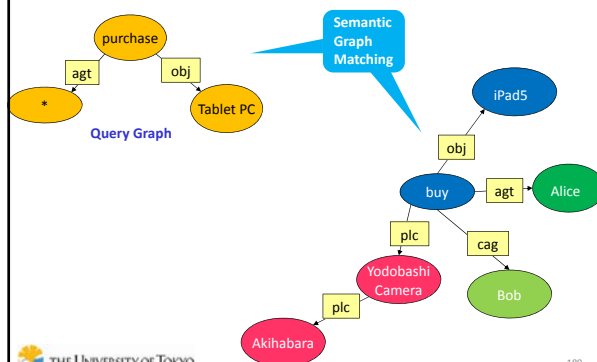
DB2CDL Tool



Semantic network of the DB schema (CDL Schema)



Semantic Search on CDL



American Approach ?

- Simplified English

<Short History>

- **Esperanto** - 1887
- **Basic English** -- by Ogden, 1930
 - 350 words for expressing concept meanings.
 - Learning Speed: English 7 years << Esperanto 7 weeks < Basic English 7 days
 - (cf. 基礎日本語 by 土居光知, 1933)
- **Controlled English** for int'l business (1970s -1980s)
 - Caterpillar, Douglas Aircraft, Boeing, IBM, GM, Xerox,

Globish



US Government's Plain Language



Wikipedia Simple



Summary

- **画像メディア処理, 生命的エージェント, マルチモーダルメディア**
 - 画像処理, パターン認識 (1978-80, 1982-85)
 - リアルスティックな顔をもつVSA(Visual Software Agent) (1988-2000)
 - 並列画像処理プロセッサTN-VIT (1888-93)
 - マルチモーダルメディア記述言語MPMLとその発展形 (1998--)
 - 生命的エージェントとの(Webを含む)インタラクション(1994--)
 - テキストからの感情センシング (2005-11)
 - モノログテキストからの対話生成 (2007--)
- **人工知能, 知能情報学**
 - エキスパートシステム, AIツール (1980-81:パデュエ大学, 1981-85)
 - 不確実な知識の扱い (1980-85)
 - 仮説推論, 特にその高速化 (1986-2000)
- **Web知能化**
 - Web変化検出, Webテキストマイニング, 要約, キーワード抽出, 構造化 (1995--)
 - 人間関係ネットワーク抽出, 属性抽出 (2003-10)
 - 関係類似性, 関係検索 (2007-12)
 - 意味計算基盤: Semantic Computing (2001--)

インパクトある研究 (情報処理コラムに書いたこと)

- **社会的価値** 工学
 - 使われて社会や生活の進歩, 改革に寄与.
 - ソフトの比重が大きい情報分野は, 使われて広まることによって評価が上がり, 大きなインパクトをもつ.
- **学術論文誌, トップ国際会議の論文になる研究 - 基礎的** コア
 - 社会的価値に繋がれば理想で幸せなのだが, 必ずしもそうでないところが悩ましい. 大学では論文は不可欠だが, 論文を目標に研究すると, 無駄とは言えないが社会的価値とはズレたものになってしまう.

□ **After WebでのIT**
 テクノロジー主導 → サービス主導 (ビジネス)
 ↓
 次のテクノロジー
 日本はこの時期に経済停滞期だった.

Social Thinking (S-Think) Board toward Social Intelligence

Social Thinking (S-Think) Board toward Social Intelligence

海外からの留学生、在籍者の国籍

- 中国(19), タイ(3), 韓国(3), 台湾(2), ベトナム(2), マレーシア(2), バングラデシュ(2), インドネシア(2), スリランカ(1), シンガポール(1), インド(1), エジプト(1)
- フランス(3), オーストリア(2), ハンガリー(1), ポーランド(1), ベラルーシ(1), オランダ(1), ロシア(1), スペイン(1), ドイツ(1), スウェーデン(1), ノルウェー(1), フィンランド(1)
- ブラジル(3), ペルー(1), メキシコ(1), ベネズエラ(1)

合計60名

どうもありがとうございました

Thank You