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The Unification Problem for Confluent Right-Ground Term Rewriting Systems, Michio OYAMAGUCHI and Yoshikatsu OHTA: *Information and Computation* 183, pp.187-211, 2003.

The unification problem for term rewriting system (TRS) is the problem of deciding, for a given TRS R and two terms M and N , whether there exists a substitution θ such that $M\theta$ and $N\theta$ are congruent modulo R (i.e., $M\theta \rightarrow^*_R N\theta$). In this paper, the unification problem for confluent right-ground TRSs is shown to be decidable. To show this, the notion of minimal terms is introduced and a new unification algorithm for obtaining a substitution whose range consists of minimal terms is proposed. Our result extends the decidability of unification for canonical (i.e., terminating and confluent) right-ground TRSs given by Hullot (1980) in the sense that the termination condition can be omitted.

On the Unification Problem for Confluent Monadic Term Rewriting Systems [in Japanese], Ichiro MITSUHASHI, Michio OYAMAGUCHI, Yoshikatsu OHTA and Toshiyuki YAMADA: *Trans. of IPSJ*, Vol.44, No.SIG 4(PRO 17), pp.54-66, March. 2003.

The unification problem for term rewriting systems (TRSs) is the problem of deciding, for a TRS R and two terms M and N , whether M and N are unifiable modulo the congruence generated by R . The unification problem is undecidable even if we restrict ourselves to the class of right-ground TRSs, which is a subclass of TRSs. On the other hand, it has been shown to be decidable for the class of confluent right-ground TRSs by Oyamaguchi and Ohta (2001). In this paper, we extend their algorithm and show that the unification problem is decidable for the class of confluent TRSs consisting of not only right-ground rules but also collapsing rules.

On the Church-Rosser Property of Left-Linear Term Rewriting Systems, Michio OYAMAGUCHI and Yoshikatsu OHTA: *Trans. of IEICE*, Vol.E86-D, No.1, pp.131-135, 2003.

G.Huet (1980) showed that a left-linear term-rewriting system (TRS) is Church-Rosser (CR) if $P \rightarrow^* Q$ for every critical pair $\langle P, Q \rangle$ where $P \rightarrow^* Q$ is a parallel reduction from P to Q . This paper shows that Huet's result can be generalized under the assumption that a subsystem K of TRS R (i.e., K is a subset of R) is CR. That is, we show that R is CR if $P \rightarrow^*_K Q$ for every $\langle P, Q \rangle$ in $CP(K, R-K)$ and $P \rightarrow^*_{R-K} Q$ for every $\langle P, Q \rangle$ in $CP(R-K, R)$. Here, $CP(R_1, R_2)$ is the set of critical pairs obtained from some rule of R_1 and one of R_2 .

Proving Termination of Simply Typed Term Rewriting Systems Automatically, Takahito AOTO* and Toshiyuki YAMADA: *IPSJ Transactions on Programming*, vol. 44 (SIG 4 PRO 17), pp. 67-77, March 2003.

Simply typed term rewriting proposed by Yamada (RTA'01, 2001) is a framework of term rewriting allowing higher-order functions. In contrast to the usual higher-order term rewriting frameworks, simply typed term rewriting dispenses with bound variables. In this paper, we present a method to prove termination of simply typed term rewriting systems. We first give a transformation on term rewriting systems and show that termination of simply typed term rewriting systems is induced from that of the first-order term rewriting systems obtained by this transformation. We next introduce a labelling technique which facilitates termination proof of the first-order term rewriting systems obtained by our transformation. Contrary to the semantic method proposed by Yamada (RTA'01, 2001), our technique is based on a syntactic approach; and thus one can easily automate termination proof of simply typed term rewriting systems.

Termination of Simply Typed Term Rewriting Systems by Translation and Labelling, Takahito AOTO* and Toshiyuki YAMADA: *Proceedings of the 14th International Conference on Rewriting Techniques and Applications (RTA 2003)*, LNCS 2706, pp.380-394, June 2003.

Simply typed term rewriting proposed by Yamada (RTA 2001) is a framework of term rewriting allowing higher-order functions. In contrast to the usual higher-order term rewriting frameworks, simply typed term rewriting dispenses with bound variables. This paper presents a method for proving termination of simply typed term rewriting systems (STTRSs, for short). We first give a translation of STTRSs into many-sorted first-order TRSs and show that termination problem of STTRSs is reduced to that of many-sorted first-order

TRSs. Next, we introduce a labelling method which is applied to first-order TRSs obtained by the translation to facilitate termination proof of them; our labelling employs an extension of semantic labelling where terms are interpreted on a many-sorted algebra.

Proving Inductive Theorems of Higher-Order Functional Programs, Takahito AOTO*, Toshiyuki YAMADA and Yoshihito TOYAMA*: Information Technology Letters, vol. 2, pp. 21-22, August 2003.

Regarding a functional program as a set of equational axioms, an equational property of the program corresponds to an inductive theorem in equational logic. Using automatic method for proving inductive theorems in equational logic, we can efficiently verify specifications and programs. Only few attempts have been made to incorporate higher-order functions to automatic inductive theorem proving, although higher-order function is an important feature in functional programming. Based on the framework of simply typed term rewriting system, we propose a method to prove that a given equation is an inductive theorem of a set of equational axioms in the presence of higher-order functions.

A Parallel Program Debugger supporting Reverse Execution [in Japanese], Masao MARUYAMA*, Shigehiro YAMAMOTO*, Kazuhiko OHNO and Hiroshi NAKASHIMA*: Symposium on Advanced Computing Systems and Infrastructures SACSIS2003, pp.65-72, 2003.

Reverse execution is a powerful technique of debugging. Some serious problems arise, however, in applying it to parallel programs because of its indeterministic nature. Since a parallel program's behavior can be different from run to run, entire information for locating the bug must be checkpointed in single execution. It causes, in most cases, the users to collect much larger set of information than really needed. It is particularly serious when locating the irreproducible bugs. The users have to run the program repeatedly with costly checkpointing operation until the bug appears. Therefore we propose a debugging model for parallel program based on checkpointing/rollback combined with replay method to overcome these weak points. We applied it to a parallel programming language Orgel, and developed a debugger supporting execution rollback for Orgel programs. Our mechanism works at practical cost in execution, and can provide useful and powerful functions to the parallel debuggers which justify some extra cost.

A Task Parallel Script Language MegaScript [in Japanese], Yasunori OHTSUKA*, Tasuku FUKANO*, Hitoshi NISHIZATO*, Kazuhiko OHNO and Hiroshi NAKASHIMA*: Symposium on Advanced Computing Systems and Infrastructures SACSIS2003, pp.73-76, 2003.

This paper proposes a task-parallel script language named MegaScript for megascale computing. A MegaScript program has a two-tier parallelism; the lower is an ordinary parallelism such as SPMD and the upper is task-level parallelism in which thousands of lower level parallel tasks are involved. The MegaScript provides a hierarchical function library for lower level parallel task management, which is enough easy-to-write for end users and also enough detailed for heavy users. Moreover, the MegaScript has a special feature for meta-programming to represent an abstracted behavior of parallel tasks. This abstracted behavior, combined with compile-time analysis result and execution profile, is used for optimal runtime task scheduling. The MegaScript system consists of a translator, runtime, and scheduler. The translator builds the execution model of tasks from the meta-program. The runtime creates tasks and manages the communication among them. The scheduler determines the granularity, allocation and ordering/timing of the task execution referring the model and refines the model with the profile for future use.

High Speed Simulation of High Performance Processor [in Japanese], Takashi NAKADA*, Kazuhiko OHNO and Hiroshi NAKASHIMA*: Symposium on Advanced Computing Systems and Infrastructures SACSIS2003, pp.89-96, 2003.

Microprocessor simulation is indispensable not only for hardware systems design but also for software development of co-designed embedded systems. In both design fields, cycle accurate (or clock level) simulation of highly sophisticated microprocessor is required. However, existing simulators of out-of-order processors run programs thousands of times slower than actual hardware. The ultimate goal of our research is to develop a fast and accurate simulator which is capable of microarchitectural modeling and system level simulation. Here, we toward high speed simulation of high performance processor. Our primary contribution is the computation reuse to the expensive process of simulating an out-of-order microarchitecture. We record the instruction sequence of a loop together with its behavior and the microarchitecture states resulted from the sequence. When we find a

recorded state in the out-of-order microarchitecture simulation, we skip the simulation reusing the state until we encounter a sequence unseen previously. We evaluated the implementation using a sample program of summing up a one dimensional array to find our technique archives 8.1-fold speed up.

Design and Implementation of Megascala simulator Anastasia [in Japanese], Syunsuke SHIBATA*, Takeo SUZUKI*, Kazuhiko OHNO and Hiroshi NAKASHIMA*: Symposium on Advanced Computing Systems and Infrastructures SACSIS2003, pp.153-154, 2003.

We are pursuing a research project on megascale computing in which more than one million processors are involved. This paper proposes a simulator named Anastasia which provides a virtual megascale environment on a small to medium range PC cluster. Anastasia converts timing of megascale applications and software systems on the host cluster to that on the virtual target environment. To evaluate the validity of the timing management and scheduling, we build a prototype of Anastasia and measured its timing accuracy with a simple parallel application executed on a virtual PC cluster. The result shows that the timing error between the virtual and real cluster is only 3.6% at most.

A Proposal of Combined Method of Evolutionary Algorithm and Heuristics for Nurse Scheduling Support System, Takeshi INOUE*, Takeshi FURUHASHI, Hiroshi MAEDA* and Minoru TAKABA*: IEEE Transactions on Industrial Electronics, Vol.50, No.5, pp.833-838, 2003.

The Nurse Scheduling Problem (NSP) is a combinatorial optimization problem. There is a growing demand for practical automatic nurse scheduling systems. We have developed nurse scheduling support system using the Interactive Evolutionary Algorithm. The nurse-in-chief can modify/fix parts of candidate schedules. The system reschedules the parts that need improvement. The proposed system is required to produce high-quality schedules with a short computation time for good human-machine interaction. This paper presents a method that combines heuristics with genetic operations for generating good schedules quickly, especially for satisfying the equality among nurses. This paper clarifies the effects of the proposed heuristics and also studies effects of a combination of the proposed method and the conventional mutation operation. Experiments are conducted to demonstrate these effects.

Phase Transitions in Fuzzy Clustering Based on Fuzzy Entropy, Makoto YASUDA*, Takeshi FURUHASHI and Shigeru OKUMA*: Journal of Advanced Computational Intelligence and Intelligent Informatics, Vol.7, No.3, pp.370-376, 2003.

We studied the statistical mechanical characteristics of fuzzy clustering regularized with fuzzy entropy. We obtained Fermi-Dirac distribution as a membership function by regularizing the fuzzy c-means with fuzzy entropy. We then formulated it as direct annealing clustering, and determined the meanings of the Fermi-Dirac function and fuzzy entropy from the statistical mechanical point of view, and showed that this fuzzy clustering is a part of Fermi-Dirac statistics. We also derived the critical temperature at which phase transition occurs in this fuzzy clustering. Then, with a combination of cluster divisions by phase transitions and an adequate division termination condition, we derived fuzzy clustering that automatically determined the number of clusters, as verified by numerical experiments.

Interpretability Issues in Fuzzy Modeling, Toshihito SUZUKI*, Takeshi FURUHASHI et.al.: Conciseness of fuzzy models, Springer-Verlag, pp.568-586, 2003.

Fuzzy models are used to describe input-output relationships of unknown nonlinear systems in an interpretable manner for humans. Interpretability is one of the indispensable features of fuzzy models, which is closely related to their conciseness. The authors introduce the conciseness of fuzzy models, based on observations that humans grasp the input-output relationships by granules. The conciseness measure is then formulated by introducing De Luca and Termini's fuzzy entropy and a new measure is derived from the analogy of relative entropy. This chapter also discusses the conflicting relationships between the conciseness and the accuracy of fuzzy models. A fuzzy modeling with Pareto optimal solutions is presented. Numerical experiments are done to demonstrate the effects of the conciseness measure.

Code set design for digital polarity correlators in a multiple user sonar ranging system, Reo TSUJI, Tetsuji KODAMA, Takeshi FURUHASHI, Kenji NAKAHIRA and Hiroshi MAEDA: SICE Annual Conference 2003 in Fukui Proceedings, 2746-2750, 2003.

In pulsed ultrasonic distance measurement systems, the pulse compression techniques were adopted to eliminate frequent misreadings caused by crosstalk or external ultrasound sources. In this paper, we present digital polarity correlators designed for the binary coded frequency shift keyed signals. For the multiple user code set design, we propose the use of a combination of genetic algorithm and hill climbing.

Robust Regression Under Asymmetric or/and Non-Constant Variance Error by Simultaneously Training Conditional Quantiles, Ichiro TAKEUCHI, Noriyuki YAMANAKA and Takeshi FURUHASHI: IJCNN 2003 Proceedings (cd-rom).

We consider regression problems under asymmetric or/and non-constant variance error. We see this problem in several fields such as insurance premium estimation, medical cost analysis, etc. Applying the method of Least Squares (LS) to this problem yields unstable solution because of outliers that appears on one side of regression surfaces. Conventional robust techniques to deal with outliers, which intend to discard or down-weight the outliers equally from both sides of regression surfaces, do not help for asymmetric error. In this paper, we propose an robust regression estimator (an estimator of the conditional mean) under asymmetric or/and non-constant variance error by simultaneously training conditional quantiles in multi-layer perceptron (MLP). This is considered as a kind of learning from hint or multitask learning approach, i.e. we train the conditional quantile estimator as hints or extra tasks to improve generalization properties of the conditional mean estimator. Numerical experiments and an application to medical cost estimation problem have shown that our proposal has robustness and good generalization properties.

Noise Reduction Filter of Cascaded Sandglass-type Neural Network Adaptively Controlled by Noise Intensity for Speech Signal [in Japanese], Toshie NAMIKI*, Yuki FURUMOTO*, Hiroki YOSHIMURA*, Tadaaki SHIMIZU*, Naoki ISU and Kazuhiro SUGATA*: IEEJ Trans. EIS, Vol.123, No.3, pp.430-439, 2003.

An adaptive noise reduction filter composed of Cascaded Sandglass-type Neural Network (CSNNRF) is proposed to develop a hearing aid appliance. The number of unit sandglass-type neural networks (SNNs) is controlled adaptively by noise intensity. Usually the hearing aid works outside where noise intensity is altering all the times. An adaptive noise reduction filter controlled by noise intensity is essential to cope with these circumstances. Each SNN has a three-layer structure and consists of the same number of neural units in the input and output layers and a single neural unit in the hidden layer. SNNs are connected in cascaded to be CSNNRF. The number of unit SNNs is adaptively determined by our algorithms so that hearing intelligibility for speech signal may be processed more preferably. To determine the number of SNNs, we regard significance on the intelligibility more than numerical value itself such as S/N ratio of speech signal.

Optimal Phonemic Environmental Range to Select VCV Instances for VCV Speech Synthesis by Rule [in Japanese], Tadaaki SHIMIZU*, Masaya KIMOTO*, Hiroki YOSHIMURA*, Toshie NAMIKI*, Naoki ISU and Kazuhiro SUGATA*: IEEJ Trans. EIS, Vol.123, No.3, pp.467-474, 2003.

We proposed two selection methods, 1) selection method by using phonemic environmental resemblance score (PER method), and 2) selection method by searching minimal connective distortion path (MLD method), for small scale speech synthesis system. PER method requires phonemic environmental information for each VCV instance in a VCV unit dictionary. This paper investigated experimentally to what extent we can reduce the phonemic environmental information with keeping high quality of synthesized speech. We verified that two phonemes frontward and one phoneme rearward range to a current VCV instance is enough to synthesize similar quality of speech as five phonemes frontward and five phonemes rearward. This result gives an experimental basis on minimizing a size of VCV unit dictionary.

Coding Method of LSP Residual Signals Using Wavelets for Speech Synthesis [in Japanese], Tadaaki SHIMIZU*, Masaya KIMOTO*, Hiroki YOSHIMURA*, Naoki ISU and Kazuhiro SUGATA*: IEEJ Trans. EIS, Vol.123, No.5, pp.946-952, 2003.

This paper presents a method to use wavelet analysis for speech coding and synthesis by rule. It is a coding system where LSP residual signal is transformed into wavelet coefficients. As wavelet analysis is implemented effectively by filter banks, our method is featured to require less computation than multipulse coding and others where complicated prediction procedures are essential. To achieve good quality speech at low bit rates, we verified to allocate the different bits onto the wavelet coefficients, with more bits in lower

frequencies, and less in higher. The synthesized speech by Haar wavelet with 16.538 kbits/s has nearly same perceptual quality with 6 bits mlog PCM (66.15 kbits/s). We are convinced that coding method of LSP residual signals using wavelet analysis is an effective approach to synthesize speech.

The Metaphorical Judgment Model for "Noun B like Noun A" Expressions [in Japanese], Takehiro TAZOE *, Tsutomu SHIINO*, Fumito MASUI and Atsuo KAWAI: Journal of Natural Language Processing, Volume 10, Number 2, pp.43-58, 2003.

We have been studying for the automatic recognition and extraction of metaphor expressions in practical sentences. This paper introduces our metaphorical judgment model for "Noun B like Noun A" expressions. "Noun B like Noun A" expressions are classified into two usages; simile and literality. To automatically judge whether a phrase is simile or literality, "Noun B like Noun A" expressions were classified into six patterns depending on the semantic information of a noun, and the metaphorical judgment model was constructed based on these patterns. When the "Noun B like Noun A" expressions from newspaper articles were judged by the model, and its judgment was compared with the correct judgment, it was approximately 80% correct. Thus, the model was found to be effective in the recognition of metaphor expressions in real-life situations.

A Model for Distinguishing Mass and Count Nouns, Ryo NAGATA, Fumito MASUI and Atsuo KAWAI: Pacific Association for Computational Linguistics, Halifax, Nova Scotia, Canada, pp.1-9, Aug. 2003.

This paper proposes a model for distinguishing nouns that are used only as mass nouns from the other nouns. This paper also describes a method for making a dictionary of ill-formed nouns such as '*informations' using the model. The model and the method should be useful for detecting errors of noun usage in compositions written by Japanese learners of English. Once a corpus and a few samples of mass nouns and count nouns are given, the model is constructed automatically. As a result of experiments, the model yielded high F-measure performance ($F=88.5$), and a dictionary that contained about 1,200 ill-formed nouns was obtained.

Tissue Characterization of Local Myocardium Using Phase Frequency Spectrum of Ultrasonic RF Signal, Hirotake ISHII, Shinji TSURUOKA, Muhammad Ibn IBRAHIMY, Fumikata KIMURA, Tetsushi WAKABAYASHI, Wataru OHYAMA and Kiyotsugu SEKIOKA*, Proc. of IEEE EMBS Asian-Pacific Conference on Biomedical Engineering (IEEE EMBS APBME2003), CD-ROM, #4.4.3, pp.1-2, 2003.

In this paper, to evaluate fine myocardium structure change from ultrasonic RF signal, we propose a new "Phase Frequency Spectrum (PFS)" analysis about a specified local myocardium during cardiac cycle. The analysis employs the small range centering on the point tracked by our tracking system on a RF signal, and applies time-frequency analysis (wavelet transform) to the envelope of the RF signal. The result of our analysis is shown as the two-dimensional image between frequency spectrum and cardiac-phase. We measured the change of the phase frequency spectrum, and we confirmed experimentally the diagnostic usefulness of our analysis for a lot of normal and abnormal hearts.

Study on the Improvement in Accuracy of Automatic Tracking for Regional Myocardium Using Ultrasonic RF Echo Signal, Yoshikazu YASUMOTO, Shinji TSURUOKA, Tomohiro YOSHIKAWA, Tsuyoshi SHINOI, Fumikata KIMURA, Tetsushi WAKABAYASHI, Wataru OHYAMA and Kiyotsugu SEKIOKA*, Proc. of IEEE EMBS Asian-Pacific Conference on Biomedical Engineering (IEEE EMBS APBME2003), CD-ROM, #4.10.4, pp.1-2, 2003.

This paper describes a study on the improvement in accuracy of the automatic tracking by correlation method with confidence (CMC) proposed by our group. The tracking method employs the correlation coefficients at a position as the degree of confidence of the tracking for a specified observing point. It employs the position obtained by hierarchical correlation method for an observing point if the correlation coefficient of the observing point is high, and it employs the mean moved position of two nearby observing points at the same time if the correlation coefficient of the observing point is low. However, we found the unfortunate case for the tracking method, that is, the fact that the many points have low correlation coefficients at the same time. We found that the large movement of myocardium causes the tracking error for CMC.

Local Myocardial Motion Tracking Based on Correlation Weighted Phase Difference Method, Wataru OHYAMA, Norlaila Binti ISMAIL, Tetsushi WAKABAYASHI, Fumitaka KIMURA, Shinji TSURUOKA, and Kiyotsugu SEKIOKA, The Institute of Electronics, Information and Communication Engineers (IEICE) Transactions (Japanese Edition), Vol.J86-A, No.9, pp.917-928, 2003

In this paper, we propose a new method for automatically tracking the motion of local region in left ventricular myocardium by means of ultrasonic pulsed Doppler signal. This method consists of a velocity detection procedure based on correlation weighted mean instantaneous velocity and a motion tracking procedure employing a myocardial elastic model. Most of ultrasonic pulsed Doppler signals observed in clinical diagnosis contain considerable amount of speckle noise, which causes detection error of velocity. The detection error is accumulated in the motion tracking procedure and yields obviously incorrect motion trajectory. The procedure of correlation weighted mean velocity is aimed to reduce the velocity detection error, and the myocardial elastic model is used to avoid the accumulation of the error to keep track of the motion of the myocardium in reasonable accuracy. The result of evaluation test shows that this method is able to improve the accuracy of tracking approximately 40 % relative to a conventional CLS approach.

Mirror Image Learning for Autoassociative Neural Networks, Shusaku SHIMIZU, Wataru OHYAMA, Tetsushi WAKABAYASHI and Fumitaka KIMURA: Seventh International Conference on Document Analysis and Recognition (ICDAR'03) Proceedings, pp.804-808, September, 2003

This paper studies on the mirror image learning algorithm for the autoassociative neural networks and evaluates the performance by handwritten numeral recognition test. Each of the autoassociative networks is first trained independently for each class using the feature vector of the class. Then the mirror image learning algorithm is applied to enlarge the learning sample of each class by mirror image patterns of the confusing classes to achieve higher recognition accuracy. Recognition accuracy of the autoassociative neural network classifier was improved by the mirror image learning from 98.76% to 99.23% in the recognition test for handwritten numeral database IPTP CD-ROM1.

Accuracy improvement of automatic text classification based on feature transformation, Guowei ZU, Wataru OHYAMA, Tetsushi WAKABAYASHI and Fumitaka KIMURA: Proc. the 2003 ACM Symposium on Document Engineering (DocEng '03), pp.118-120, November, 2003

In this paper, we describe a comparative study on techniques of feature transformation and classification to improve the accuracy of automatic text classification. The normalization to the relative word frequency, the principal component analysis (K-L transformation) and the power transformation were applied to the feature vectors, which were classified by the Euclidean distance, the linear discriminant function, the projection distance, the modified projection distance and the SVM.