Computational Topics in Finance
1st R/Rmetrics Workshop
February 19/20, 2009, Singapore

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Workshop Booklet

Welcome

Program

Abstracts

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Mahendra Mehta	NeuralTechSoft Mumbai

Conference Office

Yohan Chalabi	ETH Zurich Switzerland
Andrew Ellis	Rmetrics Association Zurich

Welcome

Welcome to the first R/Rmetrics Singapore Conference on "Computational Topics in Finance". We are very glad that you found the time to come to the Singapore, and for the many of you traveling from the U.S., Europe and various places in Asia, we hope that your journey was not too arduous.

With the R/Rmetrics Singapore Conference, we want to create a new forum where fund and/or risk managers from banks and insurance firms, decision makers, researchers from industry and academia, and students can exchange ideas and engage in stimulating discussions.

The environment for this workshop should be a place a little bit aside from the mainstream conference of venues, and we are happy to have found this at the Risk Management Institute of the National University of Singapore.

About 40 participants are attending the conference, and the mixture, as planned, is quite heterogeneous. About half are from academia, and the other half from the software and financial industries, including banks.

Last but not least, we want to thank the organizing committee and our sponsors.

We wish you an interesting conference with many inspiring and stimulating discussions.

Diethelm Würtz

Program			Computational Topics in Finance February 19/20, 2010 NUS Singapore

	Friday, 19		**Saturday, 20**
08:30 - 09:30	*Registration*		*Chairman: Juri Hinz*
		09:00 - 09:30	Sun Defeng, RMI NUS Singapore Penalty Approach for Correlation Matrix ...
	Chairman: Diethelm Würtz		
009:30	*Opening - Welcome*	09:30 - 10:00	® Yohan Chalabi, ETH Zurich Outlier Resistent Volatility Modeling

09:45 - 10:30	® Stefano Iacus, University of Milano
	    The Yuima Project
		10:00 - 10:30	Joel Yu, University of the Philippines
			    Markov-Switching Models

10:30 - 11:00	**Coffee Break**	10:30 - 11:00	**Coffee Break**
	Chairman: Stefano Iacus		*Chairman: Mahendra Mehta*

11:00 - 11:30	® Juri Hinz, NUS Singapore
	    MC for stochastic control problems
		11:00 - 11:30	® Chee Kian Leong, Schhol of Business, Sg
			    Bayesian Nework for Risk & Credit Scoring

11:30 - 12:00	® David Scott, University of Auckland
	    Financial Return Distributions
		11:30 - 12:00	Diethelm Würtz, ETH Zurich
			    Postmodern Approaches to Portfolio Design

12:00 - 12:30	Marc Paolella, Swiss Banking Institute
	    Multivariate Student's t Distribution
		12:00 - 12:30	Pratap Sondhi, Gfmanagement Hongkong
			    Monitoring Resilience to Systematic Shocks

12:30 -14:00	**Lunch Buffet**	12:30	**Closing Address**
	Chairman: Marc Paolella		*Our Sponsors*
14:00 - 14:30	Vikram Kuriyan, K3 Advisors New York Financial Crisis and Stress		
14:30 - 15:00	Bernard Lee, Shih-Fen Cheng, Annie Koh, SMU Extreme Price Shocks and Liquidity		
15:00 - 15:30	Kam Fong Chan, United Overseas Bank Spillover Effects between CDS and Stocks		**ETH** Zürich **RMI**
15:30 - 16:00	**Coffee Break**		
	Chairman: David Scott		
16:00 - 16:30	® Andrew Ellis, ETHZ / Rmetrics Zurich What is R/Rmetrics?		FINANCE ONLINE REvolution computing
16:30 - 17:00	® Anmol Sethy, Citigroup Singapore Exchange Rate Analytics		
17:00 - 17:30	Karim Chine, Cloud Era Cambridge UK Cloud Computing - Video Presentation		CRC CRC Press Taylor & Francis Group
19:45	**Conference Dinner**		

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Outlier Resistant GARCH Modeling

Yohan Chalabi[1,*]**, Diethelm Würtz**[1]

1. Institute for Theoretical Physics - Econophysics Group, ETH Zürich

Generalized autoregressive heteroskedastic (GARCH) models are nowadays widely used to reproduce stylized facts of financial time series and play an essential role in risk management and volatility forecasting. Although these models are well studied, numerical problems may arise in the estimation of the parameters when outliers are present in the data set. Indeed, maximum likelihood estimation can be sensitive to outliers. To overcome this limitation, the weighted trimmed likelihood estimation (WTLE) has been recently introduced. In this talk, we extend the GARCH family models to the weighted trimmed likelihood procedure to obtain robust estimates. Other robust GARCH estimators will be presented and an extensive Monte-Carlo study will be applied to compare the different approaches.

Keywords: GARCH models; Robust estimation; Trimmed Weighted Likelihood; M-estimates; Outliers

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Spillover effect between the Credit Default Swaps (CDS) and the stock market using a general stochastic volatility with jumps model

Kam Fong Chan

Risk Analytics Division
Risk Management Department
United Overseas Bank (UOB) Ltd

This paper investigates the time-series dynamics governing the credit default swap indices (CDX), and volatility and jump spillover between the stock and CDX markets. We use daily returns data on the S&P500 and Dow Jones CDX North American Investment Grade 5-year (CDX.NA.IG.5Y) indices over the period between June 1, 2004 and June 30, 2009. Our empirical evidence suggests the presence of two components - (i) diffusive stochastic volatility; and (ii) jumps in returns and volatility - in both the stock and CDX markets. Further, our results show that the contemporaneous correlation between the stochastic volatilities of both markets decreased during financial crisis, suggesting greater diversification benefits between the stock and CDX markets in periods of financial downturn. In addition we find evidence of strong bidirectional Granger-causality between the stochastic volatility in the stock and CDX markets during the crisis period. We find no evidence, however, to suggest lagged jumps in the CDX market predict jumps in the stock marketand vice versa.

Elastic-R
a google docs-like portal for
data analysis in the cloud

Karim Chine

Cloud Era Ltd,
Cambridge UK

Abstract

Elastic-R is a new portal built using the Biocep-R platform. It enables statisticians, computational scientists, financial analysts, educators and students to use cloud resources seamlessly; to work with R engines and use their full capabilities from within simple browsers; to collaborate, share and reuse functions, algorithms, user interfaces, R sessions, servers; and to perform elastic distributed computing with any number of virtual machines to solve computationally intensive problems.

The R/Rmetrics Open Source Project

Rmetrics Association Zurich

Rmetrics Core Team

Presented by Andrew Ellis

Rmetrics is a collection of R packages originally created for teaching computational finance and financial engineering by the Econophysics Group at ETH Zurich. The Rmetrics packages cover a wide range of topics such as time series analysis, hypothesis testing, volatility forecasting, extreme value theory, pricing of derivatives, portfolio analysis, risk management, trading analysis and many more. Rmetrics offers an open source teaching solution with state-of-the-art algorithms to help the integration of academic research to industry. All packages are released under the GNU GPL license.

Many of the functions contained in this collection are not only used by students in education at the ETH in Zurich, but also in many other academic institutes and business schools worldwide. Furthermore, the Rmetrics packages are increasingly being used as a code archive for rapid model prototyping in business environments such as banks, fund management firms, and insurance companies.

Beside the software development the Rmetrics Association supports further fields: A high quality documentation project with the publication of ebooks and user guides for R/Rmetrics packages, supporting the R-in-Finance special interest group, the organization of user and developer workshops, summer schools and conferences, and the organization of student internships at ETH Zurich. The Rmetrics Association is a non-profit foundation under Swiss law.

www.rmetrics.org

A   Monte Carlo method for optimal stochastic control problems with convex value functions

Juri Hinz

National University of Singapore
Department of Mathematics
Faculty of Science

Abstract

We present a method for calculation of optimal control policies for problems with convex value functions. Such situations appear frequently in many applications and encompass important examples arising in the area of the so-called partially observed Markov decision processes.

We show that an increase of the calculation performance can be achieved by an adaptation of the classical least-square approach. The modifications are based on the convexity-preserving property of the conditional expectation, valid in our framework.

The "yuima" package:
An R framework for simulation and inference
of stochastic differential equations

Stefano M. Iacus
on behalf of Yuima Project Team

Department of Economics, Business and Statistics
Università degli Studi di Milano, Italy

Most of the theoretical results in modern finance rely on the assumption that the underlying dynamics of asset prices, currencies exchange rates, interest rates, etc are continuous time stochastic proces-ses driven by stochastic differential equations. Continuous time models are also at the basis of option pricing and option pricing often requires Monte Carlo methods. In turn, the Monte Carlo method re-quires a preliminary good model to simulate whose parameters has to be estimated from historical data. Most ready-to-use tools in computational finance relies on pure discrete time models, like arch, garch, etc. and very few examples of software handling continuous time processes in a general fashion are available also in the R community. There still exists a gap between what is going on in mathematical finance and applied finance. The "yuima" package is intended to help in filling this gap.

The Yuima Project is an open source and collaborative effort of several mathematicians and sta-tisticians aimed at developing the R package named "yuima" for simulation and inference of sto-chastic differential equations. The "yuima" package is an environment that follows the paradigm of methods and classes of the S4 system for the R language.

In the "yuima" package stochastic differential equations can be of very abstract type, e.g. uni or multi-dimensional, driven by Wiener process of fractional Brownian motion with general Hurst parameter, with or without jumps specified as Lévy noise. Lévy processes can be specified via compound Poisson description, by the specification of the Lévy measure or via increments and stable laws.

The "yuima" package is intended to offer the basic infrastructure on which complex models and inference procedures can be built on. In particular, the basic set of functions includes the following: 1) Simulation schemes for all types of stochastic differential equations (Wiener, fBm, Lévy). 2) Different subsampling schemes including random sampling with user specified random times distribution, space discretization, tick times, etc. 3) Automatic asymptotic expansion for the approximation and estimation of functionals of diffusion processes with small noise via Malliavin calculus, useful in option pricing. 4) Efficient quasi-likelihood inference for diffusion processes and diffusion processes with jumps.

All simulation schemes, subsampling and inference are designed to work on both regular or irregular grid times (i.e. regular or irregular time series). In special cases also asynchronous data and sampling schemes can be handled. As proof-of-concept (but fully operational) examples of statistical procedures have been implemented like change point analysis in volatility of stochastic differential equations, asynchronous covariance estimation, divergence test statistics.

Global Financial Crises of 2008-2009

Vikram Kuriyan

K3 Advisors, New York

We will present an analytical approach that takes an investment management point of view to look at the financial landscape. This talk will focus on the path of the crisis, trace the mechanisms through which the crisis was transmitted globally and offer some ideas for the future. We will aim to understand the drivers of bank balance sheet exposures that are the drivers of this crises. We will also look at bank balance sheets from the eye of a derivative trader to demonstrate that the banking system has implicit but often not well-understood asymmetric payoff structures and how a deep understanding of derivatives can make the banking system less fragile. We will also examine the role of regulators and rating agencies as inadvertent catalysts for this particular collapse. Lastly, we will offer some suggestions for the future.

An Analysis of Extreme Price Shocks and Illiquidity Among Systematic Trend Followers

Bernard Lee
Singapore Management University - School of Economics

Shih-Fen Cheng
Singapore Management University - School of Information Systems

Annie Koh
Singapore Management University - School of Business

Abstract

We construct an agent-based model to study the interplay between extreme price shocks and illiquidity in the presence of systematic traders known as trend followers. The agent-based approach is particularly attractive in modeling commodity markets because the approach allows for the explicit modeling of production, capacities, and storage constraints. Our study begins by using the price stream from a market simulation involving human participants and studies the behavior of various trend-following strategies, assuming initially that their participation will not impact the market. We notice an incremental deterioration in strategy performance as and when strategies deviate further and further from the theoretical strategy of lookback straddles (Fung and Hsieh 2001), due to the negative impacts of transaction cost and imperfect execution. Next, the trend followers are allowed to participate in the market, trading against "uninformed" computer traders making randomized bids and offers. We notice that market prices begin to break down as the percentage of trend followers in the market reaches 80%. In addition, in a market dominated by "smart traders", it becomes increasingly difficult for any of them to generate profits using what is supposed to be a "long gamma" strategy. After all, trading is a zero-sum game: It is not feasible for any "long gamma" trader to generate a consistent profit unless someone else is willing to be on the other side of his/her trades. In any such market dominated by "smart traders" with low liquidity and extreme price instability, one proposed solution (as proposed earlier by the U.S. Commodity Futures Trading Commission) is to control position size limits, by either decreasing them (in the original proposal) or increasing them (for completeness in our analysis). Based on our simulation results, we have found no evidence supporting that such a solution will be effective; in fact, doing so will only lead to erratic price behavior as well as a variety of practical issues when imposing such changes to position size limits. An alternative proposal is to intervene in the market direct/indirectly, such as by using a market maker to inject/reduce liquidity. Our simulation results show evidence that injecting and reducing liquidity by the market maker can both be effective. However, a market maker can accumulate a large negative P&L by buying in a one-sided, falling market in which it is the only bidder, or vice versa. Therefore, in practice, no market maker may volunteer to participate in any such "market rescue" efforts unless governments are willing to underwrite some of its large potential losses. In short, direct/indirect intervention by controlling liquidity is not a panacea, and there are practical limits to its effectiveness.

Learning Bayesian Network for Credit and Risk Scoring

Chee Kian Leong [*]

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School of Business

Abstract

Financial credit and risk scoring is a very important aspect of risk management. In this paper, we demonstrate the applications of learning Bayesian network for credit and risk scoring. A learning Bayesian network is a graphical model which encodes the joint probability distribution for a set of random variables. The advantages of Bayesian network classifiers in credit and risk scoring is its capacity to provide a clear insight into the structural relationships between variables affecting risk and creditworthiness. The learning Bayesian network algorithm involves the construction of priors for network parameters and learning of parameters via conjugate updating. The network structure is developed using the network score via a heuristic search strategy. Illustrations using a credit scoring data set are demonstrated using R.

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An Asymmetric Multivariate Student's t Distribution Endowed with Different Degrees of Freedom

Marc S. Paolella

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University of Zurich
Zurich, Switzerland

 An open and active question concerns the construction of a multivariate distribution whose marginals are Student's t but with potentially different degrees of freedom. This is of particular value in empirical finance, where it is well known that the tail indices, or maximally existing moments of the returns, differ markedly across assets. While several constructions can be found in the literature, all have weaknesses. In this paper, we propose a new construction, which is also easily endowed with a different asymmetry parameter for each marginal. While the computation of the density via the definition is possible but time-consuming, thus prohibiting direct calculation and optimization of the likelihood, we discuss how the method of indirect inference can be used. An example using series comprising the DJIA is illustrated.

Modeling Financial Return Distributions Using the Generalized Lambda Distribution

Yohan Chalabi[1]**, David Scott**[2,*]**, Diethelm Würtz**[1]

1. ETH Zürich
2. University of Auckland

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Keywords: distributions; financial returns; generalized lambda distribution

We investigate the generalized lambda distribution with infinite support for modeling financial return series with power law tails. We derive expressions for the distribution, for random number generation, and for financial risk measures including value at risk, expected shortfall and tail indices.

We introduce a new method of obtaining parameter estimates in which the data is standardized to have zero median and unit interquartile range and then a generalized lambda distribution with zero median and unit interquartile range is fitted to the data. This reduces the number of parameters to two allowing for more efficient parameter estimation. Using this idea we demonstrate a simple robust method of moments estimation approach using moments based on Bowley's skewness and Moors' kurtosis.

We compare the performance of several further estimation approaches including maximum log likelihood, maximum product spacing, goodness of fit testing, and histogram binning using Monte Carlo simulation with data derived from the NASDAQ-100 returns.

fxregime: A tool for exchange rate analytics

Achim Zeileis[1], Ajay Shah[2], Anmol Sethy[3], Ila Patnaik[2], Vimal Balasubramaniam[2]

Measurement of de facto exchange rate regimes has been an area of interest to the economics community as well financial market traders, albeit for different purposes. A continuous measurement of exchange rate flexi[1]bility at low frequency is useful to economists in obtaining results that provide a glimpse into the open-macro-economy framework. Traders on the other hand are more interested in looking for high frequency changes in the exchange rate regime to assimilate new information in expectations for currency movements.

In the economics literature, the existing measures of de facto currency regimes do not provide a fine structure of classifying exchange rate regimes, and often redefine classifications making comparison over time difficult. The situation is further complicated by the fact that information from the central banks is often limited and sometimes misleading as well.

The de facto exchange rate regime can be easily estimated by a least-squares regression for exchange rate returns and changes in the exchange rate regime correspond to changes in the regression parameters. However, unlike in classical least-squares methods (such as the Bai & Perron framework for structural change analysis), the error variance is not a nuisance parameter but of prime interest as well as it corresponds to the flexibility of the exchange rate regime. Hence, we extend the standard structural change framework to maximum likelihood models where we can easily incorporate the error variance as a full model parameter in an (approximately) Gaussian model. In this model we can perform testing (in historical data), monitoring (in incoming data to evaluate its divergence from historical data), and dating of structural changes in exchange rate regimes.

All three techniques (testing, monitoring, dating) are provided in the R package "fxregime". A particular challenge, however, is the dating of structural changes as the algorithm's complexity is of order $O(n^2)$. A simple way to speed this process up is to parallelize the search for the breakpoints.

This has been implemented through the use of foreach package in R. This is done in a manner that the code becomes impervious to whether the underlying system is a multicore (in which case the library deployed by the user is multicore) or a cluster (in which case the library snow is employed). Parallel computing, however, leads to computational and process time gain only when the time series under study is long.

[1]WU Wirtschaftsuniversität Wien (Austria)
[2]National Institute of Public Finance and Policy (India)
[3]Citigroup-Global Quant Research (Singapore)

The Evaluation of Bank and Sector Resilience to Systemic Shocks

Pratap Sondhi

GF Management, Hongkong

The economic fallout of the present crisis underscores the need for banks to maintain sufficient capacity to absorb systemic shocks. This capacity must be actively managed because the economic and business environment changes from time to time as well as the financial conditions of banks, individually and collectively. Thus, because of interbank linkages, each bank must be able to evaluate and monitor not only its own resilience to systemic shocks but also that of other banks and of the sector as a whole.

Some measures of bank and sector resilience are discussed and numerically illustrated that can be implemented and monitored to assist active management.

A Majorized Penalty Approach for Calibrating Rank Constrained Correlation Matrix Problems

Sun Defeng

Risk Management Institute
National University of Singapore

Abstract:

In this paper, we aim at finding a nearest correlation matrix to a given symmetric matrix, measured by the componentwise weighted Frobenius norm, with a prescribed rank and bound constraints on its correlations. This is in general a non-convex and difficult problem due to the presence of the rank constraint. To deal with this difficulty, we first consider a penalized version of this problem and then apply the essential ideas of the majorization method to the penalized problem by solving iteratively a sequence of least squares correlation matrix problems without the rank constraint. The latter problems can be solved by a recently developed quadratically convergent smoothing Newton-BiCGStab method. Numerical examples demonstrate that our approach is very efficient for obtaining a nearest correlation matrix with both rank and bound constraints.

This is a joint work with Yan GAO

Postmodern Approaches to Portfolio Design

Diethelm Würtz
Yohan Chalabi, Andrew Ellis, William Chen

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Rmetrics Association Zurich
Switzerland

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The underlying assumption of Markowitz' modern portfolio theory states that the measure of investment risk is described by the sample variance of asset returns and that all securities can be adequately represented by a multivariate elliptically-contoured distribution. These facts do not always represent the realities of the investment markets, where we are confronted with non-stationary behavior and unusual market behavior due to structural breaks, bubbles, and even market crashes. Risk is becoming more and more related to bad outcomes and losses, which are considered to weigh more heavily than gains. This view has been put forward by researchers in finance, economics and psychology, which has in turn lead to the introduction of more sophisticated risk measures and methods to analyze portfolios.

We give a summary of postmodern investment strategies and sophisticated methods which can make fund managers and their clients, show how to use them in practice, and how they are made available in the R/Rmetrics portfolio software package.

A Markov-switching Model of the Won-Dollar Rate

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Foreign exchange rate modeling has gone through a host of developments in accounting for its nonlinear characteristics. Since the seminal work of Hamilton (1989), markov-switching models (MSM) have been increasingly used to quantify the nonlinear aspects of exchange rates. Initial research papers show that the MSM can very well describe the movements of exchange rates over time (e.g., Engel and Hamilton, 1990). Today, this approach is widely used to characterize exchange rate movements and to explore the possibility of improving exchange rate forecasting.

This paper employs MSM in characterizing the short-term movements in the won-dollar rate. Its ability to account for non-linear aspects provides insights in identifying the relevance of explanatory variables in affecting the movements in the won-dollar pair under different states. Results provide a strong support for non-linearity in the weekly changes in the won-dollar rate for the period March 2000 to May 2009. The model shows that during periods of high volatility, changes in interest rates are not relevant in affecting the movements in exchange rates while equity return takes on an increased importance. These results may serve as a guide in monetary policy in Korea in terms of intervention during periods of highly volatile markets.

The Rmetrics Association

The Rmetrics Association was founded as an interest group in finance, and is organized as a non-profit foundation under Swiss law. The Rmetrics Association develops and provides software, offers a teaching environment with textbooks and user documentation, organizes and funds student projects and workshops, and is a partner for the banking and insurance industry.

Rmetrics Software Development

Rmetrics offers a collection of Open Source software packages for the R Environment created for teaching computational finance and financial engineering by the Econophysics Group at ETH Zurich. The software packages cover a wide range of topics, such as time series analysis, hypothesis testing, volatility forecasting, extreme value theory, pricing of derivatives, portfolio analysis, risk management, trading analysis and many more. Rmetrics offers an open source teaching solution with state-of-the-art algorithms to help the integration of academic research and industry. All packages are released under the GNU Public license (GPL). Many of the functions contained in this collection are not only used by students in education at the ETH in Zurich, but also in many other academic institutes and business schools worldwide. The Rmetrics packages are increasingly being used as a code archive for rapid model prototyping in business environments such as banks, fund management firms, and insurance companies.

Rmetrics Teaching Environment

Rmetrics offers the most complete teaching environment in financial analysis, covering a wide variety of state-of-the-art techniques, some of which are not even available in commercial software projects. Students not only become acquainted with open source software, but also learn the inner workings and algorithms of financial engineering concepts by studying the source code, which is not possible with commercial software. Rmetrics has been used for teaching in numerous universities and recognized business schools all over the world, and also to train practitioners in the industry.

Rmetrics Knowledge Transfer

The assimilation of new techniques and innovations in the banking and insurance industry is very challenging. Often, practitioners in the industry still rely on methods that have been shown to be unreliable or inadequate. Academic research has demonstrated how to overcome some critical limitations, but industrial practitioners often lag behind the pace of new academic research. The Rmetrics Association is trying to fill this gap by providing open source implementations of the latest research, thus making the resulting methods and techniques available to everybody. We are convinced that it is a fundamental role of academic institutions to share their scientific work with as large a community as possible.

Rmetrics Association, Zurich
www.rmetrics.org

From AYE (via Clementi Road):
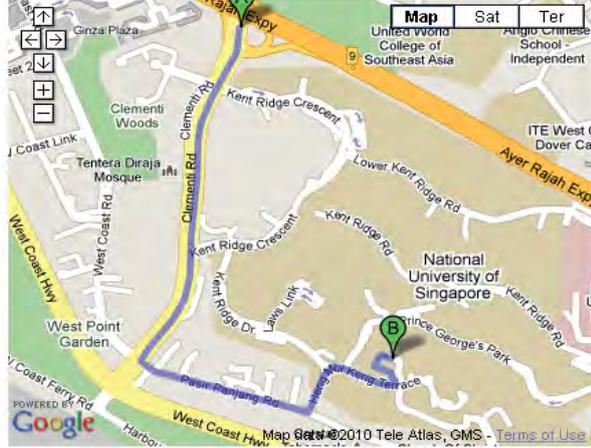
From the city:

Drive along the Ayer Rajah Expressway (AYE)
  towards Jurong

Exit at Clementi Road (AYE Exit 9)

Drive along Clementi Road in the direction of
  Pasir Panjang Road.

Turn LEFT into Pasir Panjang Road (towards
  Heng Mui Keng Terrace).

Turn LEFT into Heng Mui Keng Terrace (indicated
  by a sign which reads "Institute of Southeast
  Asian Studies" and "National University of
  Singapore").

At the Y-junction at the end of Heng Mui Keng
  Terrace, take the road on the right.

Drive up the hill and park at Car park 12B,
  located at the foot of the building

Alternate car parks nearby are 12 and 12A

From AYE (via South Buona Vista Road):
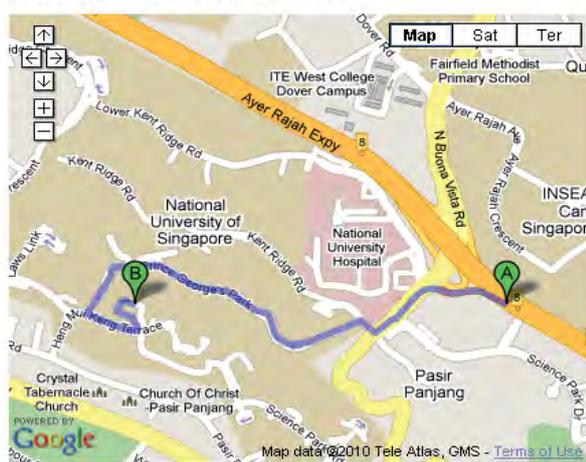
From Jurong:

Drive along the Ayer Rajah Expressway (AYE) towards
  the city

Exit at Clementi Road (AYE Exit 9)

Drive along Clementi Road in the direction of Pasir
  Panjang Road.

Turn LEFT into Pasir Panjang Road (towards Heng
  Mui Keng Terrace).

Turn LEFT into Heng Mui Keng Terrace (indicated by
  a sign which reads "Institute of Southeast Asian
  Studies" and "National University of Singapore").

At the Y-junction at the end of Heng Mui Keng Terrace,
  take the road on the right.

Drive up the hill and park at Car park 12B, located at
  the foot of the building.

Alternate car parks nearby are 12 and 12A

From West Coast Highway:

If you are taking the bus...

Take public bus nos 10, 30, 51, 143, 183, 188, 200, and
alight at Heng Mui Keng Terrace (near Kent Ridge Hall
and Sheares Hall).

If you are taking the MRT...

Bus service 183 is available from Clementi MRT station.

Internal Shuttle Services...

A1, D, BTC 1 (Towards Prince George's Park (PGP)
direction) A2, D (Away from PGP).