

Second NUS-Stanford Workshop in Quantitative Finance: Statistical Issues

❖ 16 May 2014 ❖ National University of Singapore ❖

Organized by:



NUS
National University
of Singapore

Centre for Quantitative Finance
Faculty of Science

Table of Contents

PROGRAMME

Overview	OV
Daily Schedule	FRI

ABSTRACTS

Talks	1
-------------	---

INFORMATION

Committee	8
Logistics	
Lecture Venues	9
Meals	9
Internet Access & Use of Computers	9
Fax Service	10
Getting Around NUS	10
General	
Public Transportation	11
Getting to the Airport	11
Food & Shopping	12
Bank Services & Foreign Exchange	12
Phones & Stamps	13
Useful Phone Numbers	13
Zonal Map	14



PROGRAMME
Overview | Daily Schedule

PROGRAMME OVERVIEW

Second NUS-Stanford Workshop in Quantitative Finance: Statistical Issues 16 May 2014, FRIDAY	
08:30 – 08:50	Registration
08:50 – 09:00	Opening Address
09:00 – 09:30	Hock Peng CHAN
09:30 – 10:00	Tze Leung LAI
10:00 – 10:30	Group Photo & Tea Break
10:30 – 11:00	Robert ANDERSON
11:00 – 11:30	Cheng-Der FUH
11:30 – 12:00	Ying CHEN
12:00 – 12:20	Ngoc-Minh DANG
12:20 – 14:00	Lunch
14:00 – 14:30	Steven KOU
14:30 – 15:00	Maria GRITH
15:00 – 15:30	Tiong Wee LIM
15:30 – 16:00	Tea Break
16:00 – 16:30	Michael WOLF
16:30 – 17:00	Raja VELU
17:00 – 17:20	Marco MARCHIORO
17:20 – 17:40	Tony SIT
17:40 – 17:50	Closing Address

Seminar rooms are equipped with desktop computer connected to LCD projector, projector screen, white board, and separate connection for personal notebook/laptop. Microphone is not provided.

FRIDAY, 16 May 2014

TIME	ACTIVITY	VENUE	PAGE
08:30 – 08:50	Registration	--	--
08:50 – 09:00	Opening Address	SR 1	--
09:00 – 09:30	Hock Peng CHAN National University of Singapore, Singapore <i>A Novel Approach to Markov Chain Monte Carlo and its Applications</i>	SR 1	Pg 1
09:30 – 10:00	Tze Leung LAI Stanford University, USA <i>Adaptive Particle Filters: Theory and Financial Applications</i>	SR 1	Pg 4
10:00 – 10:30	Group Photo & Tea Break	Staff Lounge	--
10:30 – 11:00	Robert ANDERSON University of California, USA <i>The Decision to Lever</i>	SR 1	Pg 1
11:00 – 11:30	Cheng-Der FUH National Central University, Taiwan <i>On Buy-and-Hold Mean-Variance Portfolio with Strategic Exit</i>	SR 1	Pg 3
11:30 – 12:00	Ying CHEN National University of Singapore, Singapore <i>Adaptive Functional Autoregressive Modeling for Stationary and Non-Stationary Functional Data</i>	SR 1	Pg 2
12:00 – 12:20	Ngoc-Minh DANG Kepler Cheuvreux, France <i>Using Short-Term Predictions for Participation-Rate Driven Trading Algorithms</i>	SR 1	Pg 2
12:20 – 14:00	Lunch	Staff Lounge	--
14:00 – 14:30	Steven KOU National University of Singapore, Singapore <i>Limit Order Books with Stochastic Market Depth</i>	SR 1	Pg 4
14:30 – 15:00	Maria GRITH Humboldt-Universität zu Berlin, Germany <i>Functional Principal Component Analysis for Derivatives of High-Dimensional Curves</i>	SR 1	Pg 3
15:00 – 15:30	Tiong Wee LIM National University of Singapore, Singapore <i>Option Hedging using an Adaptive Control Approach</i>	SR 1	Pg 5
15:30 – 16:00	Tea Break	Staff Lounge	--

* Staff Lounge is located beside Seminar Room 1 (SR1).

FRIDAY, 16 May 2014

TIME	ACTIVITY	VENUE	PAGE
16:00 – 16:30	Michael Wolf University of Zurich, Switzerland <i>Nonlinear Shrinkage of the Covariance Matrix for Portfolio Selection: Markowitz Meets Goldilocks</i>	SR 1	Pg7
16:30 – 17:00	Raja VELU Syracuse University, USA <i>Modeling Market Impact</i>	SR 1	Pg 6
17:00 – 17:20	Marco MARCHIORO Quant Island, Singapore <i>Numerical Computation of VIX-Futures Risk Components</i>	SR 1	Pg 5
17:20 – 17:40	Tony SIT The Chinese University of Hong Kong, Hong Kong <i>Combining Returns and Option Prices in Empirical Likelihood</i>	SR 1	Pg 6
17:40 – 17:50	Closing Address	SR 1	--

* Staff Lounge is located beside Seminar Room 1 (SR1).

ABSTRACTS
TALKS



The Decision to Lever

Robert ANDERSON, University of California, USA

We express the return to a levered strategy in terms of five key drivers. A novel element of our expression is the covariance between leverage and excess borrowing return of the fully-invested *source* portfolio that underlies the levered strategy. In an empirical study of several volatility-targeting strategies over the period 1929--2012, the covariance term was negative for all of the volatility-targeting strategies, with the reduction in return ranging from 0.64% to 4.23% per year. Consequently, the Sharpe ratios of volatility-targeting strategies were diminished relative to their source portfolios and fixed leverage benchmarks.

Authors: Robert M. ANDERSON, Stephen W. BIANCHI, Lisa R. GOLDBERG, University of California, USA.

Keywords: Leverage; Sharpe ratio; source portfolio; trading cost; financing cost; unintended market timing; magnified source return; excess borrowing return; risk parity; pension fund; fixed leverage; dynamic leverage; volatility target

A Novel Approach to Markov Chain Monte Carlo and its Applications

Hock Peng CHAN, National University of Singapore, Singapore

Particle filters are well-known to be able to estimate latent states of complex hidden Markov models (HMMs), by simulating the states dynamically using a large number of particles, and then resampling each particle, either periodically or sequentially, according to its relevance to the observed variables. They have many applications, ranging from engineering to computational biology and finance. A long-standing challenging problem is in the design of adaptive particle filters, on HMMs with unknown parameters. Because the model parameters are static, degeneracy of the particles with respect to the unknown parameters occurs as a result of repeated resamplings. We have been able to address this problem by using a novel substitution step that rejuvenates the particles efficiently. This also leads to new MCMC methods that involve sequential state substitutions. We describe the basic theory and some applications.

This is a joint work with Tze Leung LAI.

Adaptive Functional Autoregressive Modeling for Stationary and Non-Stationary Functional Data

Ying CHEN, National University of Singapore, Singapore

We propose adaptive functional autoregressive (AFAR) modeling with time varying operators that allow it to be safely used in both stationary and non-stationary situations. Under stationarity, we develop a consistent maximum likelihood (ML) estimator with closed form, where the likelihood function is defined on the parameters' subspace or Sieves. For non-stationary data, the estimation is conducted over an interval of local homogeneity, over which the time varying data generating process can be approximated by an FAR mode with constant operators. The local interval is identified in a sequential testing procedure. Simulation study illustrates finite sample properties of the proposed AFAR modeling. Real data application on forecasting California electricity daily price curves demonstrates a superior accuracy of the proposed AFAR modeling compared to several alternatives.

This is a joint work with Bo LI.

Using Short-Term Predictions for Participation-Rate Driven Trading Algorithms

Ngoc-Minh DANG, Kepler Cheuvreux, France

We propose a decomposition of algorithm's *a priori* performance, from which we separate contributions came from different factors related to the algorithm's constraints, to the execution context and to the quality of execution. This key idea leads to an unified framework allowing one to plug-in any price and volume related signals to optimize execution. We show that, in combining estimations on volume and price and always taking into account the price-impact effect, one is able to optimize the execution in a sequential manner, which we refer to as *on-line optimization*. We illustrate the ability to adapt to real execution context, respect algorithm's constraint and achieve better performance of the proposed method in the optimal execution problem. The proposed framework is also shown suitable to design participation-rate driven algorithm: Percentage of Volume, Volume Weighted Average Price and Implementation Shortfall.

Key words: optimal liquidation, on-line optimization, VWAP, IS, PVOL, slippage

Authors: Ngoc-Minh DANG, Kepler Cheuvreux and JVN Institute, VNU HCM, Vietnam; Charles-Albert Lehalle, Capital Fund Management, France.

On Buy-and-Hold Mean-Variance Portfolio with Strategic Exit **Cheng-Der FUH, National Central University, Taiwan**

In this paper, we study a Markowitz-equivalent portfolio selection problem subject to one particular market exit strategy. The strategy is a threshold stopping rule and hence the resulting investment time horizon is uncertain. Under some regularity assumptions, we provide an analytical approximation, to which it can be used to characterize the optimal portfolio weights precisely. By using this obtained formula, we show that the portfolio decision is influenced by three features: the risk of original price movement, the risk of random market exit, and the interaction effect of the previous two risks. Indeed, the magnitude of such interaction effect along with the predetermined reference defining the stopping rule. Furthermore, we identify a specific reference indicator such that a risk-averse investor can benefit from such portfolio, in the sense of *extended Sharpe ratio*. This claim is confirmed by numerical simulations and an empirical study.

Keywords: portfolio selection, random horizon, Sharpe ratio, multivariate renewal theory.

This is a joint with Sheng-Feng LUO.

Functional Principal Component Analysis for Derivatives of High-Dimensional Curves

Maria GRITH, Humboldt Universität zu Berlin, Germany

This study is motivated by the evolution of state price densities (SPD) implied by option data. For a fixed maturity and under some general arbitrage conditions the SPD is proportional to the quotient of the European call options with respect to the strike price. If only options with a pre-specified maturity are to be analyzed, then SPDs are one-dimensional functions. A two-dimensional point of view can be adopted if maturities are taken as an additional argument and the SPDs are viewed as a family of curves. Our paper addresses both the challenge of statistical modeling the derivatives of higher dimensional functions and that of extracting the economic content embedded in the dynamics of SPD functions. We analyze a sample of noisy curves, recover their derivatives using functional principal component analysis and summarize their time variability with a few interpretable parameters.

This is a joint work with Wolfgang K. HÄRDLE, Alois KNEIP, and Heiko WAGNER.

Limit Order Books with Stochastic Market Depth

Steven KOU, National University of Singapore, Singapore

We propose a model for limit order books with stochastic, reverse U-shaped, market depth, consistent with empirical studies. Stochastic market depth is necessary to accommodate various order activities, such as limit order submission at and outside the best quotes and order cancellation, which may account for a large proportion of limit order activities. To show the analytical tractability of the model, in addition to a dynamic programming formulation of the optimal execution problem, we provide easily computable and tight upper and lower bounds for the optimal execution cost, as well as their resulting trading strategies via quadratic programming and jump-linear-quadratic control.

This is a joint work with Ningyuan CHEN and Chun WANG.

Adaptive Particle Filters: Theory and Financial Applications

Tze Leung LAI, Stanford University, USA

This talk is a continuation of that of Hock Peng Chan and shows how MCMC with sequential state substitutions introduced therein can be used to develop efficient adaptive particle filters, thereby resolving two long-standing problems related to particle filters. One is efficient estimation of unknown parameters in the nonlinear state-space model, as mentioned in Chan's talk. The other is related to estimation of the standard errors of the Monte Carlo estimates. Since the simulated trajectories (particles) are dependent ("interacting particles"), classical standard error formulas are no longer applicable. Applications to dynamic frailty models in joint default modeling of multiple firms and to stochastic volatility models with contemporaneous jumps in asset price and volatility are given to illustrate the approach.

This is a joint work with Hock Peng CHAN.

Option Hedging using an Adaptive Control Approach

Tiong Wee LIM, National University of Singapore, Singapore

In classical theories of option hedging, an interesting feature of the optimal strategy in the presence of transaction costs is that the investor should adjust the holding of stock only when the number of shares of stock falls too far out of line relative to the “target delta.” We make use of this feature to propose a new approach to hedging options with transaction costs using market data on stock and option prices. In our adaptive-control approach, which can be viewed as a hybrid of pure model-driven approaches and pure data-driven approaches in the literature, the parameters of a model-reference adaptive hedging strategy are tuned to minimize the mean squared hedging error. We present simulation and empirical studies of the S&P 500 futures options to illustrate the hedging performance of the model-reference adaptive strategy.

This is joint work with L. Chen and T. L. Lai.

Numerical Computation of VIX-Futures Risk Components

Marco MARCHIORO, Quant Island, Singapore

We describe a method to perform risk simulations of VIX futures, according to the historical-simulation model. We assume a stochastic-volatility mean-reverting constant-elasticity-of-variance process to model the VIX dynamics. Following non-arbitrage arguments the market expectation of VIX futures price results in a function of three financial variables: the spot VIX index, the long-term expected VIX value, and a time-scale parameter.

Using the latest historical data we compute risk measures for VIX futures at different maturities and compare them with those of the VIX index. Finally, using a recently developed technique, we compute the component of risk coming from each risk driver. We show some numerical results that highlight the dependence on the maturity of the risk components of the VIX-futures risk drivers.

Keywords: Volatility models, risk management, risk measures, risk components, VIX index, and VIX futures.

Combining Returns and Option Prices in Empirical Likelihood

Tony SIT, The Chinese University of Hong Kong, Hong Kong

Empirical likelihood based on asset return series has been introduced in Chan et al. (2009) to estimate the parameters of various Levy processes via their characteristic functions. In addition to return series, prices of actively traded derivatives also contain information about the parameters of the underlying process. In this paper, we extend Chan et al. (2009) by proposing an empirical likelihood based method to combine the return series and the associated derivative prices for the purpose of estimation. The new method leads to shorter confidence intervals and more efficient ways to reflect current market information embedded in the derivative markets, which is especially useful during financial crises. In particular, empirically the estimators may be quite different even only one day option data are incorporated. The usual asymptotic properties, including consistency and asymptotic normality, are established under suitable regularity conditions.

This is a joint work with Steven KOU and Zhiliang YING.

Modeling Market Impact

Raja VELU, Syracuse University, USA

We study the effect of multiple market impact (MI) determinants in algorithmic trading (AT) using a large scale proprietary data on parent trades. We focus on the number of child orders and trade duration, two determinants that are unique to AT, in addition to trade size, volatility and market cap. The power law models that we develop, counter to the conventional wisdom to split a parent order, show that MI is increasing in the number of child orders. We also observe that the buy-sell MI asymmetry reported for block trades in the literature is significantly weaker in AT. We connect these findings to an ongoing debate on whether 'trade size' is the source for information leakage than 'order flow'.

Nonlinear Shrinkage of the Covariance Matrix for Portfolio Selection: Markowitz Meets Goldilocks

Michael WOLF, University of Zurich, Switzerland

Markowitz (1952) portfolio selection requires estimates of (i) the vector of expected returns and (ii) the covariance matrix of returns. Many proposals to address the first question exist already. This paper addresses the second question. We promote a new nonlinear shrinkage estimator of the covariance matrix that is more flexible than previous linear shrinkage estimators and has 'just the right number' of free parameters (that is, the Goldilocks principle). In a stylized setting, the nonlinear shrinkage estimator is asymptotically optimal for portfolio selection. In addition to theoretical analysis, we establish superior real-life performance of our new estimator using backtest simulations.

Authors: Olivier LEDOIT and Michael WOLF, University of Zurich, Switzerland.

Keywords: Large-dimensional asymptotics, Markowitz portfolio selection, nonlinear shrinkage.

INFORMATION

Committee | Logistics | General | Zonal Map



Committee

ORGANIZING COMMITTEE

Min DAI (National University of Singapore, Singapore)

Steven KOU (National University of Singapore, Singapore)

Tze Leung LAI (Stanford University, USA)

Logistics

LECTURE VENUES

All talks will take place in Seminar Room 1 (block S17, level 4).

Seminar rooms are equipped with desktop computer connected to LCD projector, projector screen, white board, and separate connection for personal notebook/laptop. Microphone is not provided.

MEALS

Tea breaks and lunches, served buffet-style at the foyer of the lecture theatre, are catered from a Halal-certified supplier. Usually some of the food items would be suitable for vegetarians.

Dinners are not included. Nevertheless, a wide variety of food at affordable prices (from S\$2.00) is available in the non-air-conditioned canteen and air-conditioned cafe near the venue for talks. More canteens, fast food outlets and restaurants are found in other parts of the campus (refer to Zonal Map). Some are less than 10-minutes' walk away from the conference venue while some are accessible by internal shuttle bus. Some stalls may open as early as 7.30am and close as late as 8.00pm. Halal and Vegetarian options are available in all canteens on campus.

INTERNET ACCESS & USE OF COMPUTERS

A computing lab (S17-03-02) will be open for participants' access during the event period. It is located at level 3 of block S17 and consists of 42 desktop units that are internet-ready and installed with Windows 7, standard Microsoft Office applications, SSH, Adobe Reader, MATLAB. Limited WI-FI accounts would also be made available during event period for the convenience of those using personal notebook/laptop.

Operating hours: 8.30am – 6.00pm (Wednesday – Thursday)
 8.30am – 5.30pm (Friday)

Participants will have to request for account name and password to use either the computer in the computing lab, or for WI-FI access on their own notebook/laptop. Approach the IT support staff for account name and password (subject to availability).

FAX SERVICE

Participants who wish to send faxes may do so at the general office of the Department of Mathematics (level 4, block S17). This service is chargeable at a flat rate of S\$0.50 per page.

Operating hours: 8.30am – 6.00pm (Monday – Thursday)

Operating hours: 8.30am – 5.30pm (Friday).

GETTING AROUND NUS

The internal shuttle buses A, B, C, D, and UT-FoS (free-of-charge) serve the Kent Ridge campus.

Bus A1 and A2 cover substantial parts of the campus. A1 stops outside Kent Ridge MRT station, near NUH Staff Canteen and opposite S17, while A2 stops outside S17, opposite NUH Staff Canteen and opposite Kent Ridge MRT station.

Bus A1E and A2E operates during term time on weekdays except public holidays. Bus A1E operates from 7.30am to 9.00am and stops outside Kent Ridge MRT station, and opposite S17. Bus A2E operates from 5.30pm to 7.00pm and stops outside S17, and opposite Kent Ridge MRT station.

Bus B is a loop service that serves Kent Vale and the other part of the campus. It does not stop at or anywhere near S17.

Bus C is a loop service that serves Kent Vale. It stops in front of and opposite S17.

Bus D is a loop service that serves the University Town. Bus D1 does not stop at or anywhere near S17. Bus D2 stops outside Kent Ridge MRT, opposite S17, University Town, outside S17 and opposite Kent Ridge MRT.

Bus UT-FoS is a direct service provided during term time on weekdays except public holiday at 9.40am, 9.50am, 11.40am, 11.50am, 1.40pm, 1.50pm, 3.40pm, and 3.50pm. Bus UT-FoS stops only at University Town and opposite S17.

More details on NUS internal shuttle bus can be found at:

<http://www.nus.edu.sg/oed/services/transport/shuttle-bus-services.htm>

The public bus SBS95 stops at the same stops as A1 and A2 between S17 and Kent Ridge MRT station. It also stops near and opposite Buona Vista MRT station (which is off-campus).

General

PUBLIC TRANSPORTATION

The public transport network in Singapore consists of bus, MRT (Mass Rapid Transit), LRT (Light Rail Transit) and taxi. Buses and MRTs are the most affordable modes of public transport with standard fares ranging from S\$1.00 to S\$2.20 (depending on distance). Bus fares are charged on board by tapping a stored-value card or paying the exact fare in Singapore currency to the driver. Bus and MRT fares can be calculated using the Fare Calculator on the Public Transport website (<http://www.publictransport.sg>), under eservices.

MRT fare is paid by tapping a Stored Value Card or a Standard Ticket at the gantry. The Standard Ticket can be used up to six times within 30 days from the date of purchase. The purchase price includes a deposit of 10 cents which will be automatically returned through an off-set against the passenger's fare on the third trip. A user also enjoys a 10-cent discount on the sixth trip. The Standard Ticket can be purchased at the General Ticketing Machine (GTM) at all MRT and LRT stations. LRTs are only available in selected residential neighbourhoods and operate similarly as MRTs.

Typically, the first bus and train starts running at 5.30am and the last service is 11.30pm daily. Special night bus services with specific routes that charge a flat rate of S\$4.50 are available from 11.30pm to 4.35am on Fridays, Saturdays and eves of Public Holidays.

Taxis can be flagged down 24 hours a day on most roads or at taxi-stands outside most major shopping centres and hotels. There is no need to bargain for prices as the taxis are all metered. The basic fare consists of a flag-down fare and a metered fare. The flag-down fare for the first kilometer or less is between S\$3.00 and S\$5.00, depending on the type of taxi (regular or premium). The metered fare after the first kilometer is based on the distance and waiting times during the journey. Additional charges may also be incurred depending on the time of travel and origin of the journey. A detailed rates guide is posted on the rear door of each taxi for reference.

GETTING TO THE AIRPORT

The easiest way to get to the airport is by taxi. For reference, the journey from NUS with smooth traffic would take about 30 minutes and cost about S\$25.00 without surcharge. Surcharges may be incurred depending on time of travel and if the taxi was pre-booked via phone.

To get to the airport by MRT (Mass Rapid Transit), connect to the East-West line (green line) going in the direction of Pasir Ris/Changi Airport. The Changi Airport MRT station is located under Terminals 2 and 3 which are connected to Terminal 1 by sky train. A one-way MRT fare from Kent Ridge station is about S\$2.30 (using the Standard Ticket) and takes approximately 57 minutes. More Information on MRT Network Map and fare can be found at: <http://www.smrt.com.sg/Trains/NetworkMap.aspx>.

FOOD & SHOPPING

Food centres and food courts serving local, Asian and sometimes international cuisine at affordable prices are commonly found in neighbourhoods and shopping malls. There would usually be at least one each of Halal and vegetarian stalls in most establishments. Operating hours of the stalls vary but most of them open by 10am and close by 9pm.

Restaurants and cafes are usually found in shopping malls and bigger neighbourhoods. Operating hours depend on the types of meals served but most would be open between 11.00am and 9.00pm.

Most shopping malls in Singapore operate from 11.00am to 10.00pm every day.

BANK SERVICES & FOREIGN EXCHANGE

Participants may use major credit cards to withdraw cash using the Auto Teller Machines, which can be found in various locations on campus. Alternatively, the local banks offer regular banking services including processing foreign exchange and traveler's cheques. The nearest branches are:

DBS (Holland Village Branch)

Address: 257 Holland Avenue, Singapore 278984

Operating hours: 8.30am – 4.30pm (Monday – Friday)

8.30am - 1.00pm (Saturday)

DBS/POSB (NUS Remix Branch)

Address: 31 Lower Kent Ridge Road, #01-02 Yusof Ishak House, Singapore 119078

Operating hours: 8.30 AM - 4.30 PM (Monday to Friday)

8.30 AM - 1.00 PM (Saturday)

Only Personal Banking Services are available. Demand Draft and Remittance services are not available. All cash transactions must be made at Automated Teller Machines.

POSB (Buona Vista Branch)

Address: Blk 43 Holland Drive #01-59, Singapore 270043

Operating hours: 8.30am – 4.30pm (Monday – Friday)

8.30am - 1.00pm (Saturday)

UOB (Holland Village Branch)

Address: 211 Holland Avenue, #01-12 Holland Road Shopping Centre, Singapore 278967

Operating hours: 9.30am – 4.00pm (Monday – Friday)

9.00am - 12.30pm (Saturday)

PHONES & STAMPS

Public pay phones (cash and card) are available next to the male toilet at the foyer of Lecture Theatre 27 (opposite block S17). Pay phone cards and postage stamps can be purchased at the NUS Coop store below Lecture Theatre 27. Other goods and services available at the co-op include books, stationery, sundries and photocopying.

Operating hours (co-op): 9.00am – 6.00pm (Monday – Friday)

The Kent Ridge Post Office at Yusof Ishak House (three bus-stops from LT 27) provides a more comprehensive postal service.

Operating hours: 8.30am – 5.00pm (Monday – Friday)
8.30am – 1.00pm (Saturday)

USEFUL PHONE NUMBERS

Taxi (for current and advanced booking):

<u>Company</u>	<u>Telephone</u>	<u>Colour of vehicle</u>
CityCab	65521111	Yellow
Comfort Taxi	65521111	Blue
Premier Taxis	63636888	Silver
Prime Taxis	67780808	Copper (regular service); Blue (limousine service)
SMRT Taxis	65558888	White
Trans Cab	65553333	Red
Yellow Top Taxis	62935545	Yellow top with black body

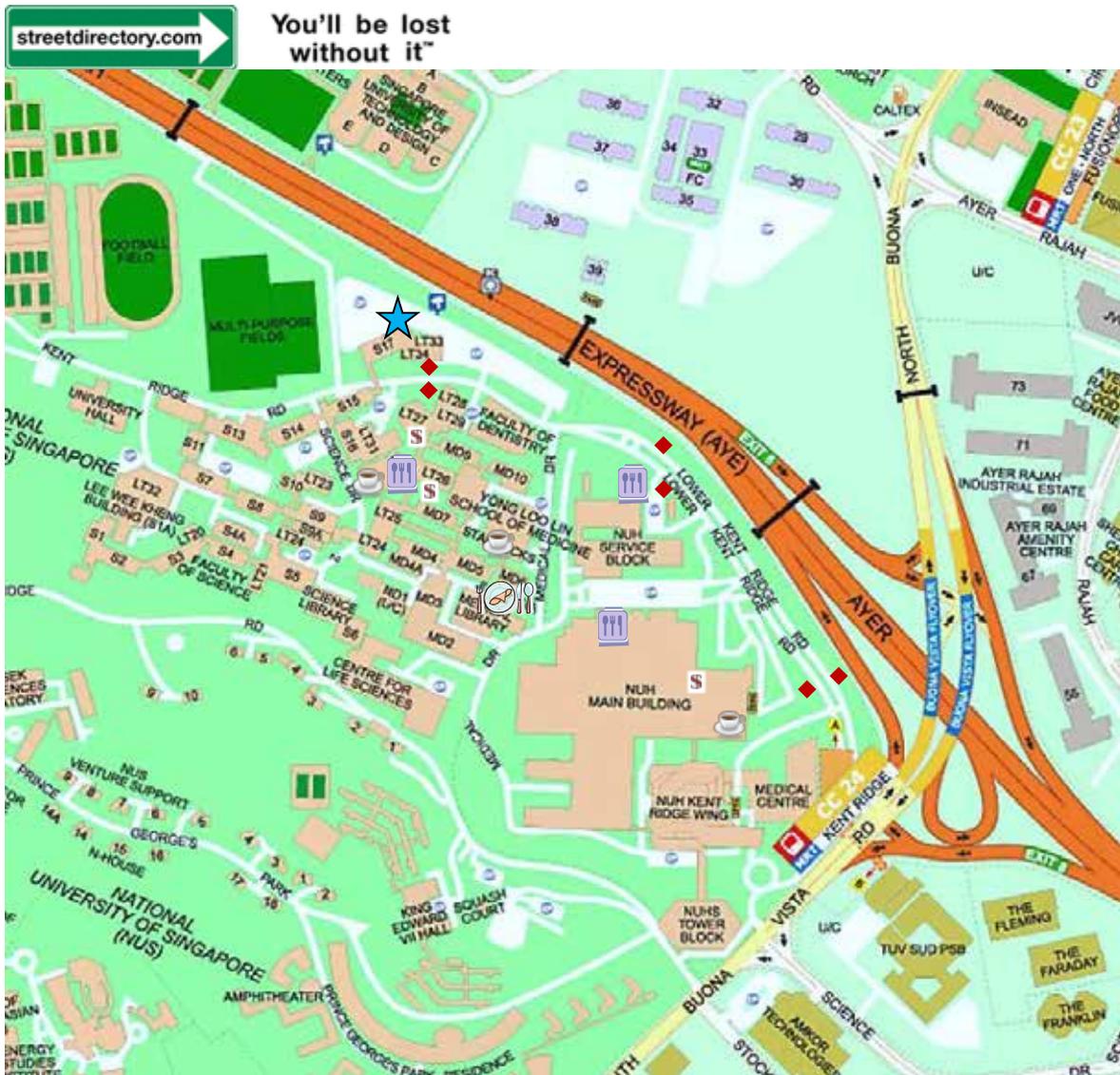
Local Emergency Services for Credit Cards:

American Express	62991997
Diner's Club Singapore	64160800(during office hours); 64160900 (after office hours)
MasterCard	800-1100-113
Visa	800-4481-250
JCB	001-800-3865-5486

Others:

Tourist Information	1800-7362000
24-hour Flight Enquiry (Changi Airport)	1800-5424422
Buona Vista Neighbourhood Police Post	1800-7779999
Police Emergency	999
Non-emergency Ambulance	1777
Fire Engine/Ambulance	995

Zonal Map



Map powered by Streetdirectory.com

-  Workshop venue (S17)
-  Bus-stop
-  Canteen/Food Court
-  Restaurant
-  Coffee joints (Platypus at Science Canteen; Spinelli at Science canteen; The Coffee Bean at NUH; Starbucks at School of Medicine)
-  Auto Teller Machine