1953–1990: My Time at Sydney University

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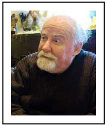
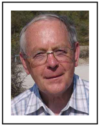
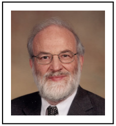
Influences

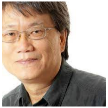
John Cannon 1943 –

Tim Wall; Charles Sims; John McKay; Joachim Neubüser

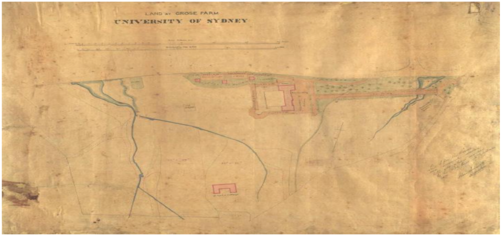
Norman Foo; Peter Grogono

Clement Lam; Reinhard Laue; Adrian Tsang; Justin Powlowski

University of Sydney Campus: 2023 + 1857

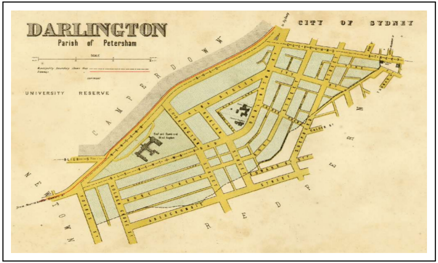
Figure 26 – 1857 map showing the university grounds

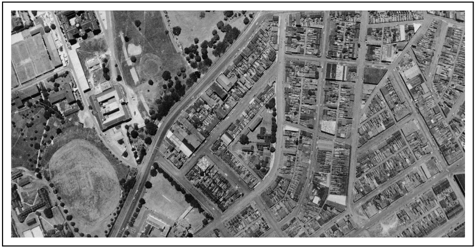


Source – University of Sydney Archives, G74/1/

1953 – 1972: Darlington becomes Engineering campus

48–50: Darlo ‘slum’ to SU





49–67: Family in Darlo

… Rose St Darlington
… Lander St Redfern
Camperdown from 1967 to 2003

53: Born in RPAH

59–63: Darlo Public School

64–65: Summer Hill O.C.

…amazing opportunity

1973 – 1980

SU Undergraduate

72: Y1 B.Sc for Chemistry

73: Y2: A Year of Changes

Dropped Chemistry.
… Started Computer Science.
Summer RA with JJC
Implement in Fortran

- Centralizer algorithm from Sims' 1970 paper
  OR
- Low index subgroups from Aachen machine code

I made the right choice!

Y3: CS and Math

…another summer RA with JJC

Honours Pure Mathematics

Thesis: *Computational Algorithms for Permutation Groups*
describe, prove correct, implement
… all known algorithms

SU Graduate

76: Masters by Research

Cwlth Postgraduate Research Award
Schreier-Sims for matrix groups
CPRA ok with trip to ETH Zürich
… amazing!

H2 1976

First paper: SYMSAC'76 NY
… then Montreal - John McKay
… then Zürich
Aachen visit

H1 1977

JJC: Write up or transfer into PhD?
JJC: Need a math. theorem for PhD
… Maximal subgroups of Held
visit Donald Livingstone (Birmingham)

ANU Summer Sch. 1977

Completed Thm on maximals of He
… Jan 1978 … CSIRO Cyber 76 used

PhD submitted July 1979

303 pages + 2 microfiches

PhD — Handle groups much larger than 10^6

Algorithms ... implementations .... proofs .... timings

Extend Schreier-Sims algorithm

+ matrix groups
Variations: Todd-Coxeter, random
Apply to JJC's algorithms: normal closure, commutator subgroups, series

Extend Sims' backtrack search

centralizer, conjugacy of elements, intersection, set stabiliser
+ normalizer, conjugacy subgroups
+ Sylow subgroups
... and to matrix groups (except normalizer)

Thm: Maximal subgroups of He

Other

Random algorithm for conjugacy class of elements
EARNS, Aut(G), canonical coset representative

Fortran

JJC Stackhandler (now Blockhandler) provided
... dynamic memory management ... objects
Enabled GB explicit runtime stack management for recursive backtrack searches
Backtrack search as template algorithm pattern

1980 – 1990

79–81 Postdoc Concordia & McGill

John McKay (CS) & Hans Schwerdtfeger (Math)

1981–1990 CS Faculty member at SU

1982: married in Montreal (after Durham conference)

1990/01–07 Visiting Faculty Bayreuth

Reinhard Laue

CGT

Hom: perm-gp to perm-gp

Hom: perm-gp to p-gp

Sylow subgroups using Hom

Conjugacy classes of elements

Other

Algorithms, DB, reasoning

Cayley V4 language design (JJC)
deductive databases (with EAO)
"object" databases in Prolog/C

Need better understanding

software architectures
system modularity, re-use, etc
knowledge representation
... a never-ending journey
... still ongoing

1990: Moving On from CGT

Ticked off all CGT algorithms on my list

... except double coset enumeration

Algorithms become Case-Based Reasoning

Theorem 5.1 (O'Nan–Scott). *Let G be a group which acts primitively and faithfully on Ω with $|\Omega| = n$. Let $H = \mathrm{Soc}(G)$ and $\omega \in \Omega$. Then H is homogeneous of type T and exactly one of the following cases holds.*

1. *"Affine". T is abelian of order p, $n = p^m$ and $\mathrm{Stab}_G(\omega)$ is a complement to H which acts irreducibly on H.*
2. *"Almost simple". $m = 1$ and $H \lhd G \leq \mathrm{Aut}(H)$.*
3. *"Diagonal type". $m \geq 2$ and $n = |T|^{m-1}$. Further, G is a subgroup of $V = (T \wr S_m).\mathrm{Out}(T) \leq \mathrm{Aut}(T) \wr S_m$ in diagonal action and either*

   a) *$m = 2$ and G acts intransitively on $\{T_1, T_2\}$ or*
   b) *$m \geq 2$ and G acts primitively on $\{T_1, \ldots, T_m\}$.*

   In case a) T_1 and T_2 both act regularly. Moreover, the point stabilizer V_ω of V is of the form $\mathrm{diag}(\mathrm{Aut}(T)^{\times m}).S_m \cong \mathrm{Aut}(T) \times S_m$ and thus $H_\omega = \mathrm{diag}(T^{\times m})$.

4. *"Product type". $m = rs$ with $s > 1$. We have that $G \leq W = A \wr B$ and the wreath product acts in product action with A acting primitively, but not regularly, on d points and B acting transitively on s points. Thus $n = d^s$. The group A is primitive of either*

   a) *type 3a with socle T^2 (i.e. $r = 2$, $s < m$),*
   b) *type 3b with socle T^r (i.e. $r > 1$, $s < m$) or*
   c) *type 2 (i.e. $r = 1$, $s = m$).*

   We have that $W_\omega \cap A^s \cong A_1^{\times s}$ and $\mathrm{Soc}(G) = \mathrm{Soc}(W)$. Furthermore $W = A^{\times s}G$.

5. *"Twisted wreath type". H acts regularly and $n = |T|^m$. G_ω is isomorphic to a transitive subgroup of S_m. The normalizer $N_{G_\omega}(T_1)$ has a composition factor isomorphic to T. Thus, in particular, $m \geq k + 1$ where k is the smallest degree of a permutation group which has T as a composition factor.*

Recap: Highlights of My Life

Family

Opportunity Class at Summer Hill

JJC: Challenging Algorithm Research

JJC and Zürich

PhD

Montréal, Marriage, Fungal Genomics

Travel

Challenges for the Next Generation

Double Coset Enumeration

"Unfortunately, no really satisfactory algorithm for solving this problem has been found to date."

Holt, Eick, O'Brien, *Handbook of CGT*, 2005, page 131

Automate the McKay Connections

1. *Monstrous Moonshine of 1978* on Monster, simple groups, representation theory, modular functions, lattices, theoretical physics
2. *McKay's A-D-E Correspondence of 1979* on Dynkin diagrams, Lie theory, and geometric singularities
3. *Alperin-McKay Conjecture of 1972* on modular representations

Yang-Hui He, *John Keith Stuart McKay: 1939-2022*, arxiv 2023.

https://doi.org/10.48550/arXiv.2305.00850

Thank You!

Any Questions?