ICTP update

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HEALTHY FUTURES

• Finished at the end of 2014
• Special Issue released in Geospatial health in 2016
• Papers:
  – Historical malaria in Uganda
  – Migration in Uganda using 150000 phone records
  – Land use impact on malaria in Eastern Africa
  – New systems for forecast dissemination
Migration analysis basis

Identify home location, regular destinations and probabilities of a journey
Number of regular destinations

- 60% of people regularly move to 1 or more regular destinations
- <10% have 3 or more regular destinations

*Note: only 1 year of data
Quantile based comparison

**phone data**

Tambacounda
Need to sub-sample distance probabilities as a function of population density

Movement to/from Casamance overestimated – need for resistance maps to account for journey difficulty
Contributions to the WMO-WHO joint publication in 2016

CLIMATE SERVICES FOR HEALTH
Improving public health decision-making in a new climate

CASE STUDIES
(Soft) Constraint Genetic Algorithm for Ensemble Prediction
Model Parameter Setting

- Genetic algorithms used for a large variety of problems
- Can be used for model parameter calibration - “tuning”

Advantages:
- Simple, no adjoint required
- Framework suited to existing ensemble approaches
- Can handle highly nonlinear, discontinuous problems
Method based on evolution:

- Ensemble of models with different parameter settings
- Metric for their fitness determines their ability to pass parameters to child generation
- Mutation of parameters to search parameter space

repeat until convergence criterion met
Basic GA approach applied to Lorenz System

- 51 ensemble members
- Tested with the Lorenz system
- Perfect initial conditions
- Mutation rate and probability decays in time for efficient search at outset

\[
\begin{align*}
\frac{dx}{dt} &= \alpha(y - x) \\
\frac{dy}{dt} &= x(c - z) - y \\
\frac{dz}{dt} &= xy - \beta z
\end{align*}
\]

\[
\mathcal{L} = \eta F(\text{RMSE})
\]
Likelihood functional form
(defines the probability of a model becoming a parent)

- Could be based on $r^2$ or RMSE
- To minimize RMSE (equivalent to minimizing log-likelihood for a Gaussian variable) a sharp function such as $L \sim 1/\text{RMSE}$ produces a precise solution.
- But... preferable to account for observational uncertainty
- Assume observational errors are Gaussian in nature (usually possible to perform a variable transformation)
- Allows multiple metrics to be easily combined
- Produces “flat” penalty function once RMSE is within observational error.
Application to NWP: A soft constraint

- GA has been applied to a wide range of problems
- in theory perfectly suited to a NWP EPS framework
- However, the dimensionality of the problem is very high in NWP
- Introduce concept of soft constraint, penalty for departures of parameters around their default values (cf. 4DVAR)
- Advantages:
  - Reduction of dimensionality (search essential in a N-sphere)
  - Allow the uncertainty of each parameter to be accounted for, preventing unreasonable parameter settings
- Not the optimum system in terms of skill but best compromise solution within the realm of assessed uncertainty (flat cost minimum).

\[ L = \eta \left( P(C_s) \prod_{i=1}^{n} P(K_i) \right) \]

Assume parameters are Gaussian

\[ K_i \sim \mathcal{N}(K_{i0}, K_{i,\sigma}) \]
Fitness function – with strict skill

- Ensemble Calibration statistics
  - Equilibrium after 20 generations...
  - (c.f. 21 dimensional system took 60 generations)

- Fitness follows skill metric closely due to small RMSE tolerance and large parameter uncertainty

- Ratio of mean parameter departure to uncertainty
Ensemble mean parameter settings as a function of generation (for large tolerance setting)

- Initial parameter guess
- First 5 generations labeled
- Method, approaches solution within 20 generations
- Triangle: Solution (Perfect model assumption)
- Ensemble spread (not shown) at final solution similar to the mean temporal variation
Solut$on	
  is	
  robust	
  to	
  the
  parameter settings first guess

Each color represents a separate run with different first guess parameter settings (generations 1-5 labeled)

NOTE: Parameter uncertainty is large enough to contain solution
Ensemble mean parameters – sensitivity to first guess

2 parameters, deterministic run – 5 initial conditions

All experiments cluster around perfect solution after $O(20)$ generations

Convergence depends on dimensionality, a 23 dimensional problem required 50+ generations
CHFP article

• First draft now ready for circulation
• Based on OVERLEAF
• Link to be circulated today
Key schools and training activities since last WGSIP

- Workshop on Climate Applications for Food Security | (smr 2621) Niger AGRHYMET (with A. Robertson)
- Advanced School and Workshop on Subseasonal to Seasonal (S2S) Prediction and Application to Drought Prediction | (smr 2714)
- ICTP-IITM-COLA Targeted Training Activity (TTA): Towards improved monsoon simulations | (smr 2896)
- Summer School on Aerosol-Cloud Interactions and International CFMIP Conference on Clouds, Circulation and Climate Sensitivity | (smr 2832)
- ICTP Workshop on Teleconnections in the Present and Future Climate | (smr 2834)
- School on Climate System Prediction and Regional Climate Information | (smr 2720)
- Workshop on Climate Impacts on Health in Asia | (smr 2838)