

GAMS CODE, MODULES & REALIZATIONS

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Outline – GAMS code, modules, and realizations

- What is GAMS?
- General structure of the MAgPIE Model
- Structure of modules and realizations
- Coding etiquette: Variable and parameter naming
- Brief exercise

What is GAMS?

- MAgPIE is written in the **G**eneral **A**lgebraic **M**odeling **S**ystem (**GAMS**) language

*"GAMS is a high level modeling system for **mathematical programming** and **optimization**. It consists of a **language compiler** and a range of associated **solvers**."*

All major commercial
LP/MIP solver

Open Source Solver
(COIN)

Also solver for NLP,
MINLP, global, and
stochastic optimization

Useful links:

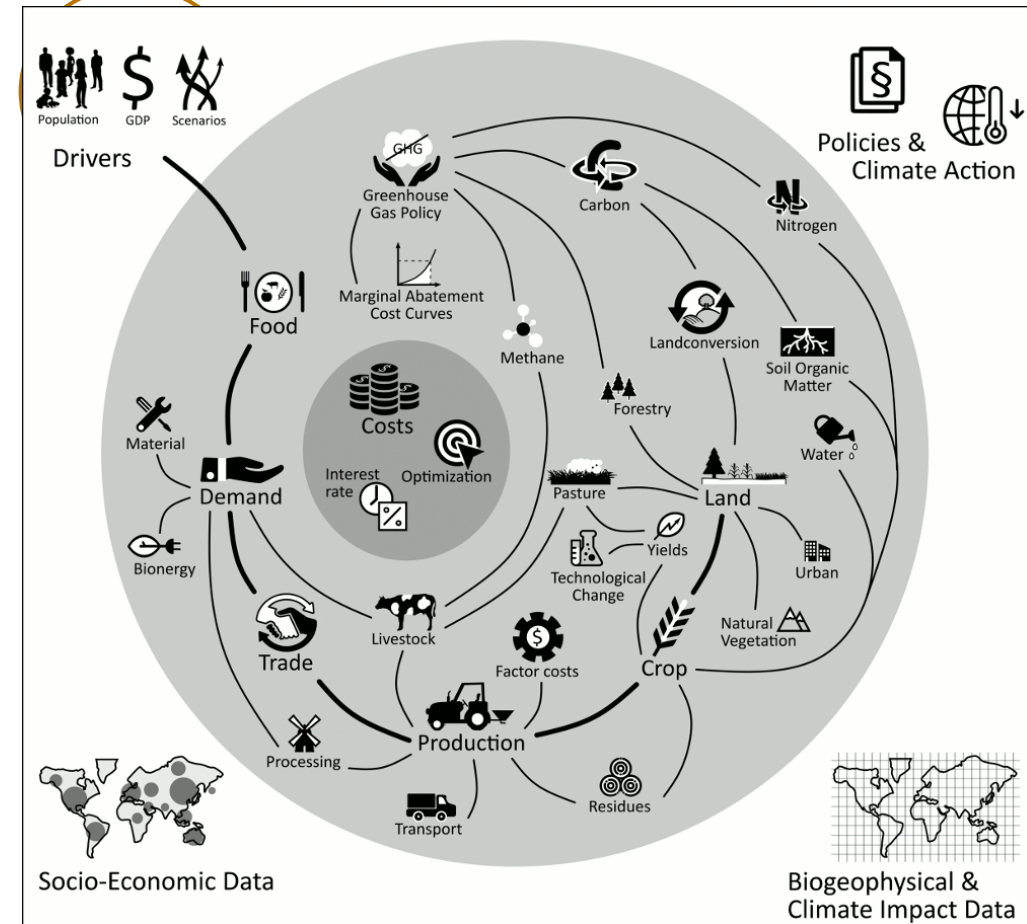
GAMS at a glance: <https://www.gams.com/products/gams/gams-language/>

GAMS documentation: <https://www.gams.com/35/docs/index.html>

General structure of the MAgPIE Model

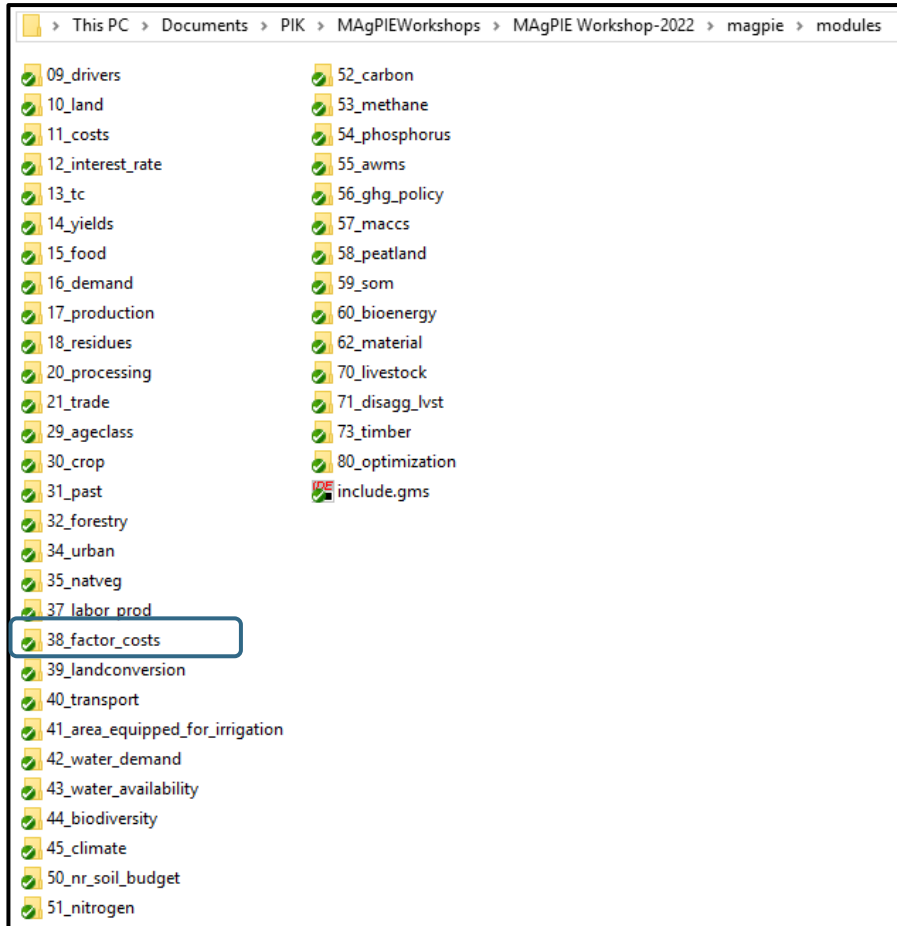

- Future **population** and **GDP** are the main drivers (different **scenarios**).
- **Food consumption** patterns lead to certain **demand**
- **Trade** patterns leads to regional **production**
- **Production and biophysical** yield and water availability data translate into **cropping patterns**.
- **Cropping patterns** drive **land use** decisions

These interactions and calculations are described in MAgPIE's modules



More info at: <https://rse.pik-potsdam.de/doc/magpie/4.4.0/>

Structure of modules and realizations

File Explorer view of the 38_factor_costs directory:

Name	Date modified	Type	Size
module.gms	23.02.2022 09:42	GAMS IDE file	2 KB
input	22.02.2022 16:01	File folder	
fixed_per_ton_mar18	22.02.2022 11:51	File folder	
mixed_feb17	22.02.2022 11:51	File folder	
sticky_feb18	22.02.2022 11:51	File folder	
sticky_labor	22.02.2022 11:51	File folder	

File Explorer view of the 38_factor_costs > sticky_feb18 directory:

Name	Date modified	Type	Size
input	22.02.2022 16:01	File folder	
declarations.gms	23.02.2022 09:42	GAMS IDE file	3 KB
equations.gms	22.02.2022 11:51	GAMS IDE file	3 KB
input.gms	23.02.2022 09:42	GAMS IDE file	2 KB
postsolve.gms	23.02.2022 09:42	GAMS IDE file	4 KB
presolve.gms	22.02.2022 11:51	GAMS IDE file	3 KB
realization.gms	23.02.2022 09:42	GAMS IDE file	3 KB
scaling.gms	22.02.2022 11:51	GAMS IDE file	1 KB
sets.gms	22.02.2022 11:51	GAMS IDE file	1 KB
not_used.txt	22.02.2022 11:51	Text Document	1 KB

In other modules you can also find: **preloop.gms**, **nl_fix.gms**, and **nl_release.gms**.

Structure of modules and realizations

This PC > Documents > PIK > MAgPIEWorkshops > MAgPIE Workshop-2022 > magpie > output > default_2022-02-23_09.42.37

Name	Date modified	Type	Size
225a	23.02.2022 09:45	File folder	
.Rprofile	23.02.2022 09:43	RPROFILE File	1 KB
avl_cropland_0.5.mz	23.02.2022 09:43	MZ File	486 KB
avl_land_full_t_0.5.mz	23.02.2022 09:43	MZ File	5.171 KB
clustermmap_rev4.65_c200_h12.rds	23.02.2022 09:43	RDS File	80 KB
config.log	23.02.2022 09:45	Text Document	32 KB
config.Rdata	23.02.2022 09:43	RDATA File	6 KB
conopt4.op2	23.02.2022 09:45	OP2 File	1 KB
conopt4.opt	23.02.2022 09:45	OPT File	1 KB
default_2022-02-23_09.42.37.Rdata	23.02.2022 09:43	RDATA File	39 KB
f34_urbanland_0.5.mz	23.02.2022 09:43	MZ File	15.896 KB
f50_AtmosphericDepositionRates_0.5.mz	23.02.2022 09:43	MZ File	31.615 KB
f50_NitrogenFixationRateNatural_0.5.mz	23.02.2022 09:43	MZ File	1.707 KB
full.gms	23.02.2022 09:45	GAMS IDE file	83.545 KB
full.log	23.02.2022 09:45	Text Document	11 KB
full.lst	23.02.2022 09:45	LST File	71 KB
info.txt	23.02.2022 09:43	Text Document	2 KB
land_carbon_sink_adjust_grassi.mz	23.02.2022 09:43	MZ File	5 KB
lpj_watavail_total_c200.mz	23.02.2022 09:43	MZ File	17 KB
lpj_yields_0.5.mz	23.02.2022 09:43	MZ File	85.626 KB
m15_food_demand_p.gdx	23.02.2022 09:45	GDX File	2.142 KB
runstatistics.rda	23.02.2022 09:45	RDA File	1 KB
spatial_header.rda	23.02.2022 09:43	RDA File	25 KB
submit.R	23.02.2022 09:43	R File	6 KB
submit_medium.sh	23.02.2022 09:43	Shell Script	1 KB
submit_priority.sh	23.02.2022 09:43	Shell Script	1 KB
submit_priority_maxMem.sh	23.02.2022 09:43	Shell Script	1 KB

Contains the final code used in the current MAgPIE run, based on the selected settings and on one realization per module

Coding etiquette: Variable and parameter naming

```
equations
q38_cost_prod_crop(i,kcr)      Regi
q38_cost_prod_inv(i)          Regi
q38_investment_immobile(j,kcr) Cell
q38_investment_mobile(j)      Cell
;

positive variables
vm_cost_prod(i,kall)
vm_cost_inv(i)
v38_investment_immobile(j,kcr)
v38_investment_mobile(j)
;

parameters
p38_variable_costs(t,i,kcr)
p38_capital_need(t,i,kcr,mobil38)
p38_capital_immobile(t,j,kcr)
p38_capital_mobile(t,j)

p38_capital_cost_share(t,i)
p38_share_calibration(i)

p38_cropland_start(j,w,kcr)
;

##### R SECTION START (
parameters
ov_cost_prod(t,i,kall,type)
ov_cost_inv(t,i,type)
ov38_investment_immobile(t,j,kcr,type)
ov38_investment_mobile(t,j,type)
oq38_cost_prod_crop(t,i,kcr,type)
```

} q_ equations

} v_ variables

} p_ processing parameters

} o_ output parameter

```
$setglobal c38_sticky_mode free
* options: dynamic, free

scalars
*' Depreciation rate assuming roughly 20 years linear depreciation for investment goods
s38_depreciation_rate depreciation rate (share of costs) / 0.05 /
*' Share of immobile capital.
s38_immobile immobile capital (share) / 1 /
;

parameter f38_fac_req(kcr) Factor requirement costs in 2005 (USD05MER per tDM)
/
$ondelim
$include "./modules/38_factor_costs/sticky_feb18/input/f38_fac_req_fao.csv"
$offdelim
/
;
```

} c_ switch

} s_ scalars

} f_ file parameter

... In other realizations you find:

i30_avl_cropland_iso(iso) i_ input parameters

\$macro m_timestep_length m_ macros

Prefixes are extended using either **m** (used in multiple modules/core code) or a **two digit number** (only used in the current module).

Coding etiquette: Variable and parameter naming

Other extensions to prefixes:

- ?c_ current time step
- ?q_ parameter containing the value of an equation
- ?v_ paramter containing the values of a variable

```
oq10_land(t,j,type)
```

```
pcm_land(j,land)
```

```
ov_landreduction(t,j,land,type)
```

Suffixes indicate the **level of aggregation** of an object

- (no suffix) Highest disaggregation available
- **_setname** aggregation **over set**
- **_reg** regional aggregation
- **_glo** global aggregation

```
i42_wat_req_k(t,j,k)
```

```
v11_cost_reg(i)
```

```
i32_max_aff_area_glo
```


Exercise

(Green tick when you are ready) ✓

1. Within the magpie folder, find the **14_yield** module.
2. Open the declaration.gms file of the **managementcalib_aug19** realization
3. One example of:
 - Variable used **only** within the current module
 - An equation
 - A processing parameter used in **at least** this model and the core code.
 - An output parameter

THANK YOU

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